

A Concise Overview of Plant Pathology and Plant Diseases

N.H. Shankar Reddy¹ and C. Gunaseeli²

¹Assistant Professor, Department of Plant Pathology, K.B.R. College of Agriculture and Horticulture, C.S. Puram (md), Andhra Pradesh

²Assistant Professor, Department of Plant Pathology, SRS Institute of Agriculture & Technology, Vedasandur, Tamil Nadu, India

SUMMARY

This article will help to understand Plant Pathology, a vital field in agriculture, mainly focuses on cause, impact, diagnostics, understanding and management of plant diseases caused by variety of plant pathogens like fungi, bacteria, and viruses etc. Continuous research and innovative approaches are essential to safeguard crops, ensuring sustainable agricultural practices worldwide. This article provides insights into the significance of Plant Pathology and plant diseases, covering aspects such as detection, diagnosis, and disease management.

INTRODUCTION

Plant Pathology is a branch of agricultural science which mainly deals with the scientific study of plant diseases. Plant Pathology also involved in the investigation of pathogen identification, disease origins, disease life cycles, economic implications, plant disease epidemiology, plant disease resistance, the impact of plant diseases on plants, humans and animals, genetics of plant-pathogen interactions, and combat strategies for disease management. Individuals specializing in studying the cause of plant diseases is known as “Plant Pathologist”, they involve in understanding the causes, mechanisms, and effects of plant diseases, as well as developing strategies to prevent, manage, and control these diseases. Plant Pathologists study a wide range of plant pathogens/ organisms responsible for plant diseases, including fungi, bacteria, viruses, viroids, phytoplasma, spiroplasma, protozoa, nematodes, and parasitic plants, to comprehend their interactions with plants and the environment. The knowledge gained from plant pathology research contributes to sustainable agriculture, as it helps in developing disease-resistant plant varieties, formulating effective disease management practices, and ensuring global food security.

What is Plant Disease?

Any abnormal deviation/ malfunctioning from the normal physiological functioning of a plant is known as disease (Agrios, 2005). The abnormal conditions occur due to varied groups of plant pathogens can alters the appearance of a plant by producing wide range of symptoms include leaf blights, leaf spots, root rots, wilts, yellowing, chlorosis, stunting, cankers, leaf curls etc. Plant diseases, from minor infections to severe epidemics, present substantial challenges to worldwide food security. Scientists employ diverse strategies, including resistant breeding, chemical and biocontrol methods to combat these diseases.

What causes plant diseases?

Plant diseases are caused by **biotic agents** (plant pathogens) and **abiotic agents** (environmental factors/ physiological disorders).

1. **Biotic factors** – The biotic factors primarily include plant pathogens such as fungi, bacteria, viruses, viroids, nematodes, protozoa, algae, parasitic plants and other microorganisms.
 - a. **Fungi** – Late blight of potato, Rice brown leaf spot, Wheat stem rust, Grapes downy mildew, Coffee rust and Rice blast etc.
 - (The domain Eukarya, kingdom fungi is classified into *Plasmodiophoromycota*, *Oomycota*, *Zygomycota*, *Ascomycota* and *Basidiomycota* etc.)
 - b. **Bacteria** – Fire blight of apple, Rice BLB, Citrus canker and Galls in stone fruits, bacterial wilts fruits and vegetables etc.
 - c. **Virus** – Tobacco mosaic virus (TMV), Cauliflower mosaic virus (CaMV) etc.
 - d. **Viroids** – Potato spindle tuber viroid, Coconut cudang cundang viroid etc.
 - e. **Nematodes** – Wheat seed gall nematode, Banana burrowing nematode, Cyst nematode etc.
 - f. **Protozoa** – Club root of cabbage
 - g. **Algae** – Red rust of guava, red rust of tea and red rust of mango
 - h. **Phanerogamic plants** – Cuscuta, Loranthus, Orobanche and Striga

- 2. Abiotic factors** – Nutritional deficiencies, Environmental factors such as humidity, temperature, sunlight, soil moisture can also contribute to disease development are falls under abiotic factors. Additionally, poor plant nutrition, inadequate soil drainage, and physical injuries can weaken plants, making them more susceptible to diseases.

Why plant diseases are important?

Plant diseases, ranging from minor infections to severe epidemics, significantly impact agriculture by reducing yield and quality, leading to food shortages and economic losses. Events like the potato late blight in Ireland and rice brown leaf spot in India showcase the social and economic disruptions caused by these diseases. Disease management, often involving costly fungicides and fertilizers, further strains socio-economic stability. Additionally, mycotoxins produced by fungi contaminate food, posing health risks. Tree diseases contribute to deforestation, affecting biodiversity and disrupting natural habitats.

List of important epidemics that changed our perception towards plant diseases

S. No.	Disease	Pathogen	Country
1	Late blight of potato	<i>Phytophthora infestans</i>	Ireland
2	Grapes downy mildew	<i>Plasmopara viticola</i>	France
3	Coffee rust	<i>Hemileia vastatrix</i>	Sri Lanka
4	Brown leaf spot of rice	<i>Bipolaris oryzae</i>	India (West Bengal)
5	Wheat stem rust	<i>Puccinia graminis tritici</i>	World
6	Rice blast	<i>Magnaporthe grisea</i>	Asia
7	Southern corn leaf blight	<i>Bipolaris maydis</i>	USA
8	Panama wilt of banana	<i>Fusarium oxysporium</i> f.sp. <i>cubense</i>	Australia, Cuba and Central America
9	Bacterial blight of rice	<i>Xanthomonas oryzae</i> pv. <i>oryzae</i>	Asia, Africa and Latin America
10	Chestnut blight	<i>Cryphonectria</i> (<i>Endothia</i>) <i>parasitica</i>	USA
11	Citrus canker	<i>Xanthomonas citri</i> pv. <i>citri</i>	USA

How do we recognise plant diseases?

Plant diseases can be recognised based on symptoms (of host plant) and signs (of pathogen).

- i. Symptoms – Any detectable external or internal changes in colour, normal physiological functioning of a plant in response to the pathogen infection results disease. Different types of diseases symptoms produced by plant pathogens were disclosed in Fig. 1.

• Eg – Leaf blights, leaf spots, root rots, wilts, yellowing, chlorosis, stunting etc.

- ii. Sign – Visual observation or evidence of a pathogen on the host plant include fruiting bodies, bacterial ooze out and cysts (nematode).

Observing changes in leaves, stems, flowers, and fruits can provide vital clues. Additionally, understanding the plant's growth patterns, considering environmental factors, and conducting laboratory tests like pathogen isolation and DNA analysis can help to identify specific diseases. Plant pathologists also use diagnostic tools like microscopes, genetic testing, and specialized software to accurately recognize and diagnose plant diseases.

Steps in disease diagnosis

- Field observation
- Sample collection
- Microscopic examination
- Pathogen isolation
- Laboratory analysis
- Molecular analysis
- Serological tests
- Biochemical tests

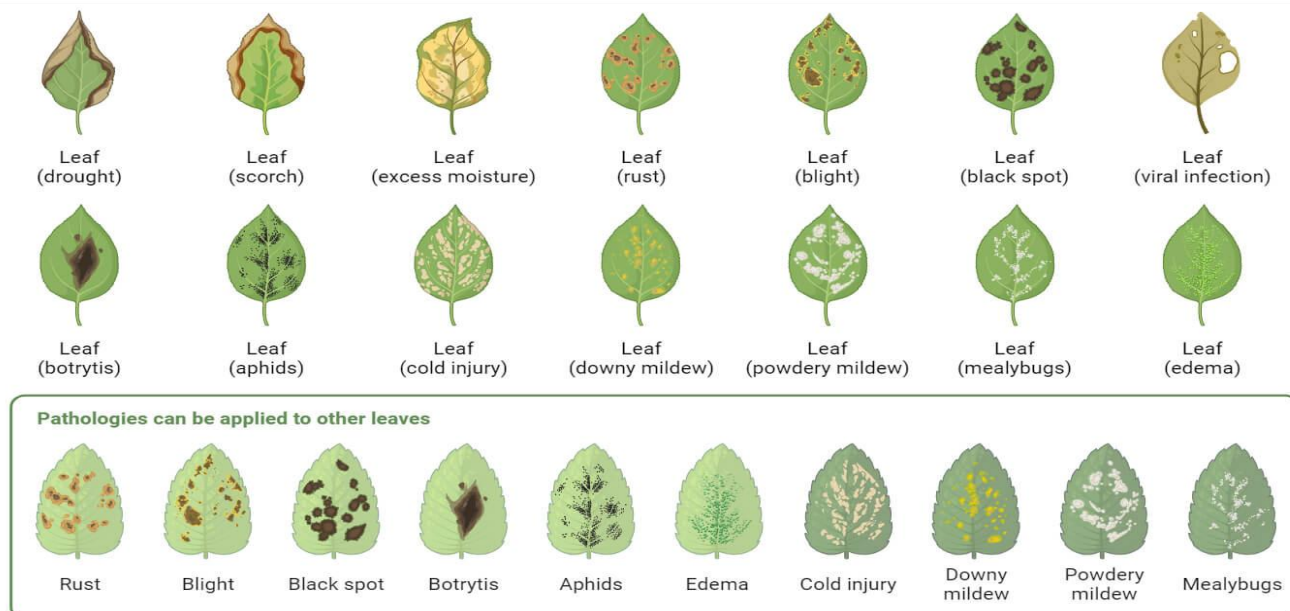
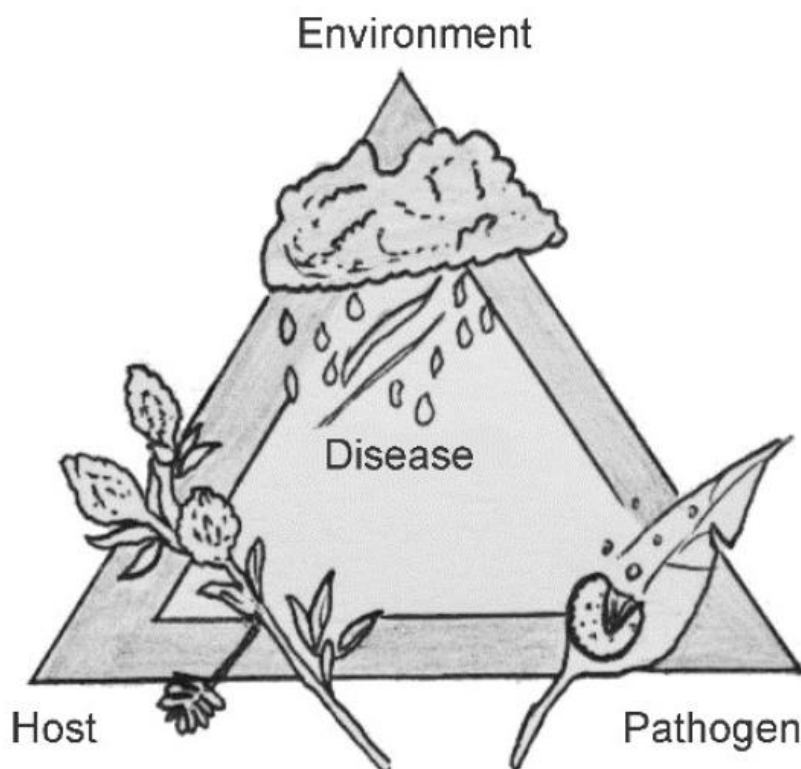


Fig 1. Different types of diseases symptoms produced by plant pathogens

How and when plant diseases occur?

Plant diseases are favoured by presence of three essential factors; **Host**, **Pathogen** and **Environment**. Disease occurs when the host is susceptible, the pathogen is virulent, and the environment is conducive for pathogen infection. The three factors put together called as “**Disease triangle**”. If any of these factors is absent, no disease will develop.



Host – Agent/ organism which harbour/ support the activities of a pathogen.

Pathogen – Organisms which are responsible for the initiation of a disease. The pathogen draws nutrients and interferes with metabolism of plant.

Environment – Different environmental factors affect the development and spread of the disease. The environmental factors include temperature, sunlight, humidity, rainfall, pH etc. Here environment plays a major role in survivability and spread of inoculum.

The addition of two more factors, **time** and **human** involvement, to the disease triangle forms the disease pyramid.

Here's how and when plant diseases commonly occur?

Susceptible host plants – Drought-stressed, nutrient-stressed, breakdown of resistance

Virulent pathogens – Pathogen movement

Conducive environment – Conducive temperature, high humidity, moisture, problematic soil and erratic weather and frequent rain.

Time – Crop growth stages, cyclic patterns, seasonal patterns and epidemic outbreaks.

How do we manage plant diseases (IDM)

Integrated disease management refers to the comprehensive approach of utilizing cultural practices, physical methods, resistant plant varieties, biological control methods, and careful application of agrochemicals to effectively manage plant diseases.

Cultural – Crop rotation, eradication of alternate host, mixed cropping and summer ploughing etc.

Physical methods – Solar heat treatment (wheat loose smut), Hot water treatment (sugarcane diseases) etc.

Resistant varieties – BPT 5204 (Rice blast), *Sr 31* (Wheat stem rust) etc.

Biocontrol methods – *Trichoderma* spp., and *Bacillus* spp., etc.

Biotechnology – Cross protection, meristem tip culture and hypovirulence etc.

Chemical methods – Wettable sulphur, Tridemorph (powdery mildews), Metalaxyl (downy mildews), Oxycarboxin (rust), Carboxin (smut), Tricyclazole (Blast), *Streptomycin* sulphate (bacterial diseases), Tetracycline (Phytoplasmal and spiroplasmal diseases) etc.

Other management practises include

- Use of healthy seeds (pathogen free certified seeds and transplants)
- Maintaining healthy soil
- Cultivation of less susceptible cultivars
- Disinfection of farm tools and implements
- Soil solarization
- Use of drip irrigation instead of overhead irrigation
- Adding required amount of organic matter to the soil
- Control weeds in the field
- Raised beds helps to improve drainage to manage soil borne pathogens
- Control insect vectors that vectors viruses
- Regular surveying and disease monitoring
- Remove severely infected plants to avoid spread of infection

CONCLUSION

In conclusion, understanding Plant Pathology is vital for safeguarding global agriculture. This field delves into the causes, impacts, and management of plant diseases caused by various pathogens. Plant Pathologists, through rigorous research, diagnose diseases and develop strategies for prevention. The interplay of host, pathogen, environment, time, and human influence forms the complex disease dynamics. Integrated Disease Management, combining cultural practices, biological controls, and judicious chemical methods, is essential. Continuous research and vigilance are paramount to ensuring sustainable agricultural practices and food security worldwide.

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