

Fundamentals of Plant Pathology

B.Sc Ag Semester II

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Fundamentals of Plant Pathology

4(3+1)

Theory

Introduction: Importance of plant diseases, scope and objective of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concept in Plant Pathology, Pathogenesis, diseases triangle and tetrahedron and classification of plant diseases, Important Plant pathogenic organism fungi, bacteria, fastidious vesicular bacteria, Phytoplasmas, Spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasite and nematodes with example of diseases caused by them. Diseases due to a biotic causes. Fungi: general character, definition of fungus, somatic structures, type of fungus thalli, fungal tissues, modifications of thallus, reproduction (Asexual and Sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi, key to divisions, sub-divisions, orders and classes. Bacteria and mollicutes: general morphological characters, basic methods reproduction. Viruses: nature of properties, structure and transmission. Study of phanerogamic plant parasites. Epidemiology: Factors affecting disease development.

Practical

Acquaintance with various laboratory equipments and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and koch's postulates. General study of different structure of fungi, study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Study of phanerogamic plant parasites. Identification of plant parasitic nematodes.

Science of Phytopathology or Plant Pathology and Its Importance

Plant protection has been accepted as broad area of research and technology at the national level by the Indian Council Agricultural Research, New Delhi; and Plant Pathology is an important discipline of Plant Protection

Plant Pathology- Definition

Plant Pathology, also known as Phytopathology is a branch of agricultural, biological or botanical science which deals with the study of diseases in plants - their causes, etiology, epidemiology, resulting losses and management.

Relation to other Sciences

Plant pathology is related to many other sciences such as virology, mycology, bacteriology, microbiology, physiology, chemistry, genetics, biotechnology etc., all of which provide the knowledge required for the correct diagnosis and management of plant diseases.

Objectives of Plant Pathology

- To study living, non-living and environmental causes of diseases or disorders of the plants.
- To study the mechanism of plant disease development.
- To study interaction between host/susceptible and the pathogens.
- To develop systems of management of plant diseases and reducing losses caused by them.

Importance of Plant Diseases or Plant Pathology

Losses they cause:

- About 34% of the crop produce is lost annually due to diseases, insect-pests and weeds on the global basis (Cramer, 1967); out of which, 12% is lost due to diseases (caused by [fungi](#), bacteria or viruses), 11% due to nematodes, 7% due to insect-pests and 3% due to weeds.
- When plant protection measures are not implemented, annual loss of 30-50% are common in major crops including horticulture (Encyclopedia Britannica, 2002)

Epidemics

- Late blight of potato caused by *Phytophthora infestans* was responsible for causing Irish famine in 1845 by destroying the potato crop, the staple food of the people.
- Hundreds of thousand people died of hunger and disease, and there was a large scale migration of the population to other countries including North American continent.
- The population of Ireland was 8 million in 1840, which was reduced to 4 million after the famine.
- This single disease forced man to realize the importance of plant diseases, and brought the science of Plant Pathology to lime light.

•Other Famines

Wheat rust epidemics occurred from time to time in many countries.

Wheat rusts forced farmers to change their cropping pattern and wheat was replaced by corn or maize or rye.

- Brown spot of rice caused by *Helminthosporium oryzae* was responsible for Bengal famine in 1943, which many people think one of the reasons for the division of Bengal

- Coffee rust caused by *Hemileia vastatrix* forced to cut down the coffee plants in Sri Lanka in 1867.

- Powdery mildew of grapevines caused by (*Uncinula necator*), by 1854, reduced the French wine production by 80 per cent.

- In 1878, the downy mildew caused by *Plasmopara viticola* ultimately led to the discovery of Bordeaux mixture.

Losses in India

Wheat rusts cause a loss of Rs. 400 crore annually.

- In the years of epidemics, losses are Rs. 5000 crore or more.
- Loose smut of wheat is estimated to cause an average loss of 3 per cent (about Rs. 500 crore) every year.
- Other plant diseases such as red rot of sugarcane, potato viruses, rice blast and blight, Karnal bunt of wheat, root knot of tomato, eggplant and cucurbits, apple scab, mango malformation, bunchy top of banana and sandal spike are responsible for huge losses.

Effect on Society

- Infected grains or the fruits may contain [toxins](#) (such as aflatoxin, fumonisin) which cause insanity, paralysis, stomach disorder and liver cancer.
- The money spent on the management of plant diseases is also a loss because in the absence of diseases this money could be saved.
- There are many other implications on the transport and agro-based industry in the event of plant disease inflicted yield loss.
- There is restriction on the movements of food grains and other agricultural produce due to the threat of quarantine pathogens and pesticide residues in the produce causing further loss.

CAUSES OF PLANT DISEASES

Causes of Plant Diseases

Plant diseases are caused by a variety of pathogens.

- The word pathogen can be broadly defined as any agent or factor that incites ‘pathos’ or disease in an organism. Thus in strict sense, the pathogens do not necessarily belong to living or animate groups.

Abiotic (Inanimate) factors

They include mainly the deficiency or excess of nutrients, light, moisture, aeration, abnormality in soil condition, atmospheric impurities etc.

Examples are: Black tip of mango (due to SO₂ toxicity), khaira disease of rice (due to Zn deficiency), whiptail of cauliflower (Mo deficiency), hollow and black heart of potato (due to excessive accumulations of CO₂ in storage), bitter pit of apple (due to Ca deficiency).

Mesobiotic causes

These are the disease incitants which are neither living nor non-living. They are considered to be on the threshold of life. They are:

- **Viruses:** They are infectious agents made up of one type of nucleic acid (RNA or DNA) enclosed in a protein coat. Examples of viral diseases of plants are: potato leaf roll, leaf curl of tomato and chillies, and mosaic disease of many plants.

- **Viroids:** They are naked, infectious strands of nucleic acid. They cause diseases like potato spindle tuber, citrus exocortis, chrysanthemum stunt, cadang cadang of coconut palm, star crack of apple, etc.

Biotic (Animate) causes

This category includes the pathogens which are animate or living or cellular organisms. They are:

Prokaryotes like bacteria which are unicellular prokaryotic microorganisms lacking true nucleus. Examples of diseases caused by true bacteria are: brown rot or wilt of potato, soft rot of potato and vegetables, , citrus canker, etc.

- i) Phytoplasma are wall-less prokaryotes and cause diseases like peach
- ii) Fastidious bacterium, *Xylella fastidiosa* causes almond leaf scorch, Pierce's disease of grapevine.

•Eukaryotes are the organisms with true nucleus.

i) Fungi: Potato wart, powdery mildew, rust, smuts, red rot of sugarcane (nearly 80% of plant diseases are caused by fungi).

ii) Straminopiles (Oomycetes): Downy mildews, late blight of potato, white rust of crucifers, damping off etc.

iii) Protozoa: Hart rot of coconut palm and phloem necrosis of coffee.

iv) Algae: Red rust of mango or papaya or litchi

v) Metazoan animals (Nematodes): Root knot of vegetables, ear cockle of wheat, citrus decline etc

vi) Parasitic flowering plants (Phanerogamic plant parasites): Dodder, Striga, Orobranche, Loranthus, Phoradendron, etc.

DEFINITIONS AND CONCEPTS

Disease: According to Horsfall and Diamond (1959), disease may be defined as a malfunctioning process that is caused by continuous irritation by a pathogen and/or environmental factor resulting in some suffering producing symptoms.

Disorder: The diseases caused by the deficiency of nutrients or unfavourable environmental are sometimes termed as disorders or physiological disorders.

Pathogen: It is the agent responsible for inciting ‘pathos’ i.e. ailment or damage.

Parasite: These are the organisms which derive the food materials needed for their growth from other living organism (the host). All the pathogens are parasites but all the parasites are not pathogens. As some of the parasites live on their hosts without causing any damage to them as symbiotic relationships, e.g., Rhizobium bacterium in legume roots, mycorrhizae and lichens.

Biotrophs are the organisms which regardless of the ease with which they can be cultivated on artificial media obtain their food from living tissues only in nature in which they complete their life cycle). They were earlier also called **obligate parasites**, e.g., rusts, smuts, powdery mildews etc.

Saprophytes/saprobies are the organisms which derive their nutrition from the dead organic matter. Some parasites and saprophytes may have the faculty or (ability) to change their mode of nutrition.

Facultative saprophytes are ordinarily parasites which can grow and reproduce on dead organic matter under certain circumstances. They are also called **hemibiotrophs** which attack the living tissues in such a way as biotrophs but continue to grow and reproduce after the tissues is dead.

A parasite is called **necrotroph** when it kills the host tissue in advance of [penetration](#) and then lives saprophytically, e.g. *Sclerotium rolfsii* and *Pythium* species. Similar to **necrotrophs** are **facultative parasites** which live as saprophytes but under favourable conditions they can attack living plants and become parasites. The necrotrophs are also known as **perthotrophs** or **perthophytes**.

Pathogenicity is the ability of a pathogen to cause disease under a given set of environmental conditions. Whereas, **pathogenesis** is the chain of events that leads to development of a disease in the host.

Parasitism is a phenomenon by which a plant parasite becomes intimately associated with the plant; it draws nutrition and multiplies and grows at the expense of the plant host.

Virulence is a measure or degree of pathogenicity of an isolate or race of the pathogen. The term **aggressiveness** is often used to describe the capacity of a pathogen to invade and grow in the host plant and to reproduce on or in it. This term like virulence is used as measure of pathogenicity.

Immunity of a plant against a disease is absolute quality. It denotes the freedom of plant from disease, when the pathogen cannot establish parasitic relationship with the host. High resistance and low susceptibility approach immunity.

Disease resistance is the ability of an organism to overcome completely or in some degree the effect of a pathogen or other damaging factor; whereas susceptibility is the inability of the plant to resist the effect of the pathogen or other damaging factor.

Hypersensitivity is the extreme degree of susceptibility in which there is rapid death of the cells in the vicinity of the invading pathogen. It halts the further progress of the pathogen. Thus, hypersensitivity is a sign of very high [resistance](#) approaching immunity.

Infection is the establishment of the parasitic relationship between the pathogen and host following entry or [penetration](#).

Incubation period is the time elapsing between [penetration](#) and completion of infection i.e. development of the disease symptoms.

Invasion and colonization is the growth and multiplication of the pathogen through the tissue of the host varying extent.

Effects of Disease

- The diseased plants do not function or look normal showing structural abnormality and / or physiological disorder and can not grow, develop and reproduce to its genetic potential.

CLASSIFICATION OF PLANT DISEASES

Based on plant part affected

- **Localized**, if they affect only specific organs or parts of the plants.
- **Systemic**, if entire plant is affected. or
They can be classified as root diseases, stem diseases, foliage/foliar diseases, etc.

Based on perpetuation and spread

- **Soil borne** -when the pathogen perpetuates through the agency of soil.
- **Seed borne** -when the pathogen perpetuates through seed (or any propagation material).
- **Air borne** -when they are disseminated by wind e.g. rusts and powdery mildews.

Based on the signs and symptoms produced by the pathogens

Diseases are classified as rusts, smuts, powdery mildews, downy mildews, root rots, wilts, blights, cankers, fruit rots, leaf spots, etc. In all these examples, the disease are named after the most conspicuous symptom of the disease appearing on the host surface.

Based on the host plants affected

They can be classified as cereal crop diseases, forage crop diseases, flax diseases, millet diseases, plantation crop diseases, fruit crop diseases, vegetable crop diseases, flowering plant diseases, etc.

Based on major Causes

They can be classified as fungal diseases, bacterial diseases, viral diseases, mycoplasmal diseases, etc.

Based on Infection Process

- **Infectious** -All the diseases caused by animate causes, viruses and viroids can be transmitted from infected host plants to the healthy plants and are called infectious.
- **Non-infectious**- Non-infectious diseases can not be transmitted to a healthy plant. Also referred as non-parasitic disorders or simply physiological disorders, and are incited by abiotic or inanimate causes like nutrient deficiency or excess or unfavorable weather conditions of soil and air or injurious mechanical influences.

Classification of Animate Diseases in Relation to Their Occurrence

- **Endemic diseases** -which are more or less constantly present from year to year in a moderate to severe form in a particular geographical region, i.e. country, district or location.
- **Epidemic or epiphytotic diseases** - which occur widely but periodically particularly in a severe form. They might be occurring in the locality every year but assume severe form only on occasions due to the favourable environmental conditions occurring in some years.
- **Sporadic diseases** occur at irregular intervals and locations and in relatively few instances.
- **Pandemic diseases:** A disease may be endemic in one region and epidemic in another. When epiphytotics become prevalent through out a country, continent or the world, the disease may be termed as pandemic.

Disease triangle

The interaction of the host, the pathogen and the environment results in disease development. It is generally illustrated by a triangle, also called a disease triangle.

Disease Development in Plant Population

This is determined by:

- **Host:** All conditions in host that favour susceptibility.
- **Pathogen:** Total of virulence, abundance etc.
- **Environment:** Total of conditions that favour the pathogen and predispose the host plants to pathogen attack.
- **Time:** Specific point of time at which a particular event in disease development occurs and the duration or length of time during which the event takes place.