PRINCIPLES

OF

PLANT PATHOLOGY

THE SCIENCE OF PLANT PATHOLOGY

Plant pathology or phytopathology (*Phyton*-Plant; *Pathos*-ailments/suffering; *logos*-knowledge/science) is branch of science (agricultural, botanical or biological) that deals with disease(s) in plants.

Plant Virology - the study of plant pathogenic viruses and their diseases

Plant mycology – the study of plant pathogenic fungi and their diseases

Plant bacteriology – the study of plant pathogenic bacteria and their disease

Plant nematology – the study of plant parasitic nematode and their diseases view of alleviating them.

Objectives of Plant pathology

1. Study of origin, causes or reasons. Study of living, non-living and other causes of disease or disorder in plants- Etiology:

2. Study of mechanism of disease development i.e. processes of infection and colonization of the host by the pathogen. This phase involves complex host-pathogen interactions- Pathogenesis

3. study the interaction between the causal agent and the diseased plants in relation to environmental conditions. Generally at the population level- Epidemiology

4. Development of management systems of the diseases land reduction of losses caused by them- Control/Management.

Plant pathology involves the study of interacting populations (host, pathogen and vectors, if involved) under agro-ecosystem.

The science of plant pathology, 150 years old has amassed a wealth of information from which valuable knowledge has been distilled in the form of

principles of plant pathology and **principles of plant disease management.** These Fundamental principles guide us in developing our understanding about the phenomena of plant disease development on individual plant or in plant population and in devising suitable technology for

their management. The ultimate aim is to manage the agro-ecosystem so as to minimize the crop damage (yield loss) and stabilize the production.

Disease is one of the major constraints of crop production. It could cause a total failure of crop production enterprises of a

farmer, thereby resulting in the loss of million of dollars and overall food shortage. Therefore, it become imperative to study the fundamental of plant diseases and their control strategies.

Origin of Plant Pathology

Plant pathology, a science of diseases in plants, originated as an offshoot of **botany** and developed to a status of recognized subject due to **economic** and **social** importance of **plant disease** and the scientific achievements during last

150 years. Plant diseases and their impact were topics of interest to economic botanists in British era.

Thus, plant pathogens and their economic impact (plant diseases) became integral part of study in botany. One of the fallout of this origin was seen in the initial interest

in basic studies on plant pathogens

- **taxonomy**,
- **morphology** and
- **physiology**,

and the focus became the diseased plant rather than plant populations. **Had the plant pathology emerged out of ecology?**

The focus would have been on population interactions and epidemiology would have been in the forefront since the beginning. But it was not to be and it took about 100 years to re-orient the pathologist's attentions towards the diseased populations. A paradigm shift towards practical solutions for prevention and

management of plant disease at population level was seen. Present day epidemiology is providing logical guiding principles for strategic plant disease management.

PLANT DISEASE: A CONCEPT

It is of first importance to understand that disease is a condition of abnormal physiology and that the boundary lines between the health and ill health are vague and difficult to define.

Our understanding about plant disease and its description is one of the gray areas of plant pathology, by now a well-developed science in its own. Marshal Ward in 19th century said that the boundary line between health and ill health are vague and difficult to define and Agrios while entering the 21st century observed “It is

difficult to pin point exactly when a plant is diseased.” This tells all about our thinking on plant disease.

Lack of proper communication is the main reason for our poor understanding about ‘disease’ whether it is of our pet or plant. When we notice visual changes

(symptoms); that is too late. A plant genetic potential. Horsfall and Dimond (1959) were very judicious in their approach: “to know what is diseased…… we should know what is normal.” We feel, the possible reason for our wild thinking about plant disease is due to different angles

(biological and economic) applied to view the same process/phenomena: Plant disease.

For a biologist plant disease is a biological process where any deviation at biochemical or physiological or cytological level is the beginning of the process.

The epidemiologist's attention is only on diseased populations. For **ecologists** plant disease is the outcome of natural relationship in ecosystem while **grower** is only concerned with performance/ productivity of plant population.

social scientists and **administrators** plant disease is relevant when it assumes severe epidemic or pandemic proportion and threatens the food security of the people.

The diseased plant is the central theme, but **what is a disease**? Though difficult to define, it a very easy to recognize. A normal plant lives in a balanced dynamic equilibrium with the environment. Any interruption of this balanced dynamic equilibrium disturbs the normal metabolism which appears in the

form of external visible signs. so disease is a malfunctioning process of the organism. Disease results from a **continuous irritation.** Disease should not be confused with the symptoms: **symptoms** are only visible manifestations of the invisible

improper functioning of the plants. **Disease** again is **not the pathogen**: pathogen cause disease, plant never catch “disease”; they catch the pathogen and develop disease.

Simply, disease of plant could be defined as any alteration of one or more of the ordered sequential physiological processes culminating in a loss of coordination of energy utilization as a result of continuous irritation by the presence or

absence of some factor or agents.

CLASSIFICATION OF PLANT DISEASES

Various schemes of classifying plant diseases have been proposed from time to time. Classification of infectious plant diseases have been based on

(1) **crops affected** (wheat diseases, rice diseases or cereal diseases or leguminous crop diseases),

(2) **organs attacked** (fruit, root, leaf or seedling diseases),

(3) **symptoms** (rusts, smuts, wilts, mildews, leaf spot, Blight),

(4) source of inoculum (seed-borne, soil-borne, air-borne),

(5) group of causal agent (fungal, bacterial, viral diseases),

(6) Taxonomy of the pathogen, e.t.c

(7) Based on occurrence and consequent effects, a disease may be

(i) **endemic** (constantly present in moderate to severe form in a locality),

(ii) **epidemic** (occurs widely, in severe and virulent form),

(iii) **sporadic** (occurs at very irregular intervals and location), or

(iv) **pandemic** (occur all over the world and cause mass mortality).

(8) Diseases have been classified according to the **nature of major causal agents** as **non-infectious** or **non-parasitic** or **physiological** (caused by abiotic factors) or **infectious diseases** (incited by

biotic and/or mesobiotic agents).

(9) Based on production and spread of the inoculum a disease may be a **single cycle disease** (simple interest disease) or **multiple cycle disease** (compound interest disease). In single cycle disease, the increase of disease is mathematically similar to **simple**

interest of money. There is only one generation of disease in the crop season. In multiple cycle diseases. The increase in disease is mathematically similar to compound interest of money.

There are several generations of the pathogen within a life cycle of crop

(10) Kommedahl and Windels (1979), based on **host-pathogen dominance system**, have divided diseases as **'pathogen Dominant Diseases'** (PDD) or 'Host Dominant Diseases' (HDD).

In PDD, the pathogen is dominant over the host, but the relationship is

transitory because host resistance is less initially than it becomes eventually. Such pathogens are tissue non-specific and attack young, immature root tissues or senescent tissues of a mature plant roots. The pathogenesis is due to the primary virulence of the pathogen. Physiological specialization is relatively uncommon.

Important pathogens in this group are

Macrophomina,

Phytophthora,

Pythium,

Rhizoctonia,

Sclerotium, etc.

In HDD, the host is dominant and the pathogen is successful only when factors

favour the pathogen over the host. The resistance of the host is strong enough to keep the pathogen from advancing too rapidly against the host defenses during the vegetative growth phase and the host thereby prolongs the relationship. Damage is most severe in plants in the reproductive and senescent phases. In this group some

pathogens are most tissue specific. Important pathogens are the species of

Armillaria,

Polyporus,

Helminthosporium,

Fusarium, etc.

PLANT PATHOGENS: CONCEPT AND CLASSIFICATION

Organisms suffer from diseases or disorders due to some abnormality in the functioning of their system. **These** abnormalities may be due to factors that **have no biological activity of their own (abiotic factors) or** those entities that **show some biological**

activity (mesobiotic agent) and those that are established as cellular organism.

A pathogen can be broadly defined as any agent or factor *that induces pathos/suffering or disease in an organism*, but the term is generally used to denote biotic or living? By intuition and

experience, we have known that a thing that does not grow, reproduce, move, or show response to external stimuli non-living and those that show these properties are living. However, when viruses appear in the picture, the whole concept of living vs. non-living becomes somewhat confused. The groups of the pathogens of causes of

plant diseases are given in the following chart:

Biotic

- Fungi
- Bacterial
- Virus
- Viroid
- Nematode
- Protozoa
- Algae

Abiotic

- Climate condition
  Temperature, Light,
  R.H, Rain, Hail storm
- Adverse soil condition
  Structure
  Aeration
  pH
  Organic matter

Following the terms should be conceived by the students of plant pathology:

SOME DEFINITIONS AND CONCEPTS

PATHOGEN: Can be define as any living agents that can cause plant disease or induce plant suffering.

VIRULENCE: Genetic ability of a pathogen to overcome host resistance. Genetic ability of a pathogen to multiply on host cultivar.

AVIRULENCE: opposite of virulence; inability of pathogenic race to establish compatible interaction in host plant. (with R

genes) in which other races may establish compatibility.

DISEASES CYCLE: The chain of events diseases development.

DISEASES DEVELOPMENT: Is refers to chain of events occur between of infection and complete expression of diseases.

DISEASES SYNDROME: The sum total of all symptoms and signs is the syndrome. Symptoms are visible expression of the host response to infection.

HETEROGENEOUS: A parasitic fungus that requires two species of host to complete its life cycle, as in many rust fungi (Uredinales).

HOST: The plant that is diseases is the host.

FITNESS: Ability of pathogen to persist in nature. It include virulence, aggressiveness, survivability and effective dispersal.

Attributes of a successful pathogen are:

- ❖ Reproductive fitness while living in host
- ❖ Considerable amount of damage to host

❖Host range of pathogen

❖Survivability, in absence of host

IMPERFECT FUNGI: One that is not known to reproduce sexually.

INFECTION: Is the process from the time the inoculums arises, on the host until the pathogen established in the host. It follows penetration. It does not mean production of

diseases symptom. There may be a longer period between infection and appearance of disease but ordinarily one follows closely after. The time between infection and appearance of disease in plant is called **INCUBATION PERIOD,** infection is distinct from diseases development.

INOCULUM: This is par of the agent or organism which caused diseases that firs come in contact with the host. It could be bacteria cell, virus particles eggs of nematode or spore of fragment of fungi.

PATHOGEN: The agent that by its persistent association causes the diseases is a pathogen. It may be living, including

fungi, viruses, nematodes and bacteria (infectious) or non-living (non-infectious). The pathogen will cause diseases under favourable factor like susceptible host plant and favourable environment.

PATHOGENESIS: The chain of metabolic events that brings about the disease is pathogenesis. It involves the

action of the pathogen, susceptibility of the plant and impact of the environment.

PATHOGENICITY: It is the capability of the pathogen to cause disease. It is defferent from virulence. Successful expression of pathogenicity is virulence. A pathogen is avirulent when it fails to cause diseases in plant.

PENETRATION: Refers to initial invasion of the host by an organisms. We know that many organisms penetrate cells of plant which are not susceptible and which do not respond with any sign of disease, moreover they do without proceeding beyond the stage of penetration. Thus we may have case

without infection.

PRE-DISPOSITION: May be defined as the effect of one or more environmental factors which makes a plant vulnerable to attack by a pathogen, it is a process which antedates penetration and infection.

RESISTANCE: May be regarded as counterparts of susceptibility and also may be influenced in its expression by environmental factors.

SUSCEPTIBILITY: Refers to a condition of a plant in which it is normal subject to attack by pathogen. It maybe increased by environmental factors.

How Pathogens affect Plants

There are many ways in which plant disease pathogens can affect plants

- By utilizing host cell contents
- By killing host or by interfering with its metabolic processes through their enzymes, toxins etc.
- By weakening the host due to continuous loss of the nutrients.

- By interfering with the translocation of the food, minerals land water.
  - They can suppress the chlorophyll content.
  - They can reduce the leaf area.
  - They can curb the movement of solutes and water through the stems.
  - They sometimes reduce the water-absorbing capacity of the roots.

- They suppress the translocation of photosynthates away from the leaves.
- They sometimes promote wasteful use of the products of photosynthesis as in the formation of galls.