Lecture 1: An introduction on Terminology-History-importance- Economic Significance of Seed-borne Diseases and seed-borne pathogens

TERMS AND CONCEPTS USED IN PLANT PATHOLOGY

Disease:

Any malfunctioning of host cells and tissues that result from continuous irritation by a pathogenic agent or environmental factor and leads to development of symptoms.

Disorder:

Non-infectious plant diseases due to abiotic causes such as adverse soil and environmental conditions are termed disorders. The common characteristic of noninfectious diseases of plants is that they are caused by the lack or excess of something (temperature, soil moisture, soil nutrients, light, air and soil pollutants, air humidity, soil structure and pH) that supports life. Non-infectious plant diseases occur in the absence of pathogens, and cannot, therefore, be transmitted from diseased to healthy plants.

Pathogen:

An entity, usually a micro-organism that can incite disease. In a literal sense a pathogen is any agent that causes pathos (ailment, suffering) or damage. However, the term is generally used to denote living organisms (Fungi, bacteria, MLO's, nematodes etc.,) and viruses but not nutritional deficiencies.

Parasite:

Organisms which derive the materials they need for growth from living plants (host or suspect) are called parasites.

Pathogenicity

is the ability of the pathogen to cause disease

Pathogenesis

Is the chain of events that lead to development of disease in the host (or) sequence of progress in disease development from the initial contact between the pathogen and its host to the completion of the syndrome.

Sign:

The pathogen or its parts or products seen on a host plant.

Symptom:

The external or internal reactions or alterations of a plant as a result of a disease.

Syndrome:

The set of varying symptoms characterizing a disease are collectively called a syndrome.

Biotroph:

An organism that can live and multiply only on another living organism. They always obtain their food from living tissues on which they complete their life cycle. Ex: Rust, smut and powdery mildew fungi.

Hemibiotroph (Facultative Saprophyte):

The parasites which attack living tissues in the same way as biotrophs but will continue to grow and reproduce after the tissue is dead called as facultative saprophytes.

Perthotrophs or perthophytes (Necrotroph):

A parasite is a necrotroph when it kills the host tissues in advance of penetration and then lives saprophytically Ex: *Sclerotium rolfsii*.

Inoculum:

It is the part of the pathogen which on contact with susceptible host plant causes infection (or) the infective propagules which on coming in contact with the host plant causes an infection are known as inoculum

Inoculum potential:

The energy of growth of a parasite available for infection of a host at the surface of the host organ to be infected (or) the resultant of the action of environment, the vigour of the pathogen to establish an infection, the susceptibility of the host and the amount of inoculum present.

Incubation period:

The period of time (or time lapse) between penetration of a host by a pathogen and the first appearance of symptoms on the host. It varies with pathogens, hosts and environmental conditions.

Predisposition:

It is the action of set of environments, prior to penetration and infection, which makes the plant vulnerable to attack by the pathogen. It is related to the effect of environments on the host, not on the pathogen, just before actual penetration occurs

Hypersensitivity:

Excessive sensitivity of plant tissues to certain pathogens. Affected cells are killed quickly, blocking the advance of obligate parasites.

Infection

is the establishment of parasitic relationship between two organisms, following entry or penetration (or) the establishment of a parasite within a host plant.

Systemic infection:

The growth of pathogen from the point of entry to varying extents without showing adverse effect on tissues through which it passes.

Epidemic or Epiphytotic disease:

A disease usually occurs widely but periodically in a destructive form is referred as epidemic or Epiphytotic disease. Ex: Late blight of potato – Irish famine (1845)

Endemic:

Constantly present in a moderate to severe form and is confined to a particular country or district. Ex: Club root of cabbage in Nilgiris Black wart of potato – Synchytrium endobioticum Onion smut – Urocystis cepulae

Sporadic disease:

Occur at very irregular intervals and locations and in relatively fewer instances. Ex: Udbatta disease of rice, Angular leaf spot of cucumber – Pseudomonas lachrymans.

Survival of plant pathogens

The means of survival are the first link in infection chain or disease cycle. The initial infection that occurs from the sources of pathogen survival (Infected host as a reservoir of inoculum, saprophytic survival outside the host or dormant spores and other structures in or on the host or outside the host) in the crop is primary infection and the propagules that cause this infection are called primary inoculum. After

initiation of the disease in the crop, the spores or other structures of the pathogen are sources of secondary inoculum and cause secondary infection, thereby spreading the disease in the field.

Ex: The fungus (*Phytophthora infestans*) causing late blight of potato survives in seed tubers or in soil. Infected tubers bring the primary infection in the field while primary inoculum (PI) present in soil causes primary infection of the crop from healthy seed. The PI may also be brought by wind from neighboring fields or long distances. Then the fungus produces spores on leaves. These spores are dispersed by wind and water and reach healthy plant surfaces to cause new infections. This is secondary infection. The primary infection initiates the disease and secondary infection spreads the disease.

Sources of survival of pathogens:

1) Infected host as reservoir of inoculum (or) survival in vital association with living plants.

2) Survival as saprophytes outside the host.

3) Survival by means of specialized resting structures in or on the host or outside the host.

4) Survival in association with insects, nematodes and fungi.

1. **Infected host as reservoir of inoculum:**
   a) Seed: Seed may be externally or internally infected by plant pathogens during the course of development and maturation in fruit or pod. Most seed borne pathogens survive as long as seed remains viable.
   Ex 1: The pathogen of loose smut of wheat, *Ustilago nuda tritici*, enters the stigma and style and infects the young seed, in which it survives as mycelium.

Ex 2: *Pseudomonas syringae* pv. tomato has been shown to survive in dried tomato seed for 20 years.

b) Collateral hosts / Alternative hosts (wild hosts of same families)
c) Alternate hosts (Wild hosts of other families)
d) Self sown crops: Self sown crops, voluntary crops and early sown crops are reservoirs of many plant pathogens.
e) Ratoon crops: Sometimes ratoon crops also harbour the plant pathogens. Ex: Sugarcane mosaic.
f) Survival by latent infection: Latent infection refers to the conditions in which the plant pathogens may survive for a long time in plant tissue without development of visual symptoms. Ex: Xylella fastidiosa, the causal agent of pierce's disease of grapevine infect different weeds without developing visible symptoms.

2. Saprophytic survival outside the host:

The ability to live saprophytically enables many plant pathogens to survive in the absence of growing susceptible plants.

In the absence of the cultivated host plant, fungi are capable of surviving as saprophytes and can be studied under three categories:

1. Soil inhabitants: Those organisms which survive indefinitely in the soil as saprophytes in the absence of the host plant. Ex: Species of *Pythium*, *Rhizoctonia* and *Sclerotium*
2. Root inhabitants: These are more specialized parasites that survive in soils in close association with their hosts. The active saprophytic phase remains as long as the host tissue in which they are living as parasites is not completely decomposed. Ex: Species of *Fusarium*, *Verticillium* (vascular wilt causing fungi) and root rot of cotton (*Phymatotrichum omnivorum*)
3. Rhizosphere colonizers: Those organisms which colonize the dead substrates in the root region and continue to live like that for a longer period which are more tolerant to soil antagonism. Ex: Leaf mold in tomato: *Cladosporium fulvum*

3. Survival as dormant spores or specialized resting structures:

Plant viruses: have no resting stage and are transmitted through a continuous infection chain.

Phytopathogenic bacteria: The plant bacteria also do not produce resting spores or similar structures. They continuously live in their active parasitic stage in the living host or as active saprophytes on dead plant debris.

Nematodes: They survive in the form of active parasitic phase on a living host and also survive through dormant structures, i.e., eggs, cysts, galls, formed in host tissues. These structures may be present in soil or in seed lots

Phanerogamic parasites: They survive in dormant state for many years through seeds. Ex; Seeds of Orobanchae survive in soil for more than 7 years.

Among plant pathogens, fungi are the only organisms that produce spores, analogous to eggs of nematodes, and other resting structures for their inactive survival. These dormant structures of survival can be classified in the following categories:

1) **Soil borne fungi:**
   a) Dormant spores {Conidia (Peach leaf curl pathogen, Taphrina deformans), Chlamydospores (Wilt pathogen, Fusarium sp.), oospores (Downy mildew fungi), perithecia (Apple scab pathogen, *Venturia inaequalis*) etc.}.
   b) Other dormant structures such as thickened hypha, sclerotia (Cottony rot fungus, *Sclerotinia sclerotiorum*), microsclerotia (*Verticillium*), Rhizomorphs (*Armillaria mellea*), etc.

   Factors affecting the survival of pathogen in the soil are a) physical factors (high temperature, irradiation, dessication and anaerobiosis), b) chemical factors (antibiotics, antagonistic chemicals produced by other microbes) and c) biotic factors (parasitism, predation by microflora and microfauna).

2) **Seed borne fungi:**
   a) Externally seed borne: Dormant spores on seed coat Ex: Covered smut of barley, bunt of wheat, etc.
   b) Internally seed borne: Dormant mycelium under the seed coat or in the embryo Ex: Loose smut of wheat (*Ustilago nuda tritici*).

3) Dormant fungal structures on dormant or active host:

In downy mildew of grapevine, powdery mildew of grapevine, apple etc., The fungus mycelium may be present in dormant state in the affected twigs or its oospores or perithecia may be embedded in the tissues of the affected organs. Parasitic phanerogams survive in the form of seeds, and in plant parasitic nematodes eggs, cysts and larvae serve as over seasoning structures.

4) Survival in association with insects, nematodes and fungi

Dispersal of plant pathogens

Dispersal, transmission or dissemination: is the transport of spores or infectious bodies, acting as inoculum, from one host to another host at various distances resulting in the spread of the disease. The dispersal of the pathogen or disease is important not only for spread of plant diseases but also for continuity of the life cycle and evolution of the pathogen. The knowledge of these methods of dispersal is essential for effective control of plant diseases because possibilities of preventing dispersal and thereby breaking the infection chain exist.

Dissemination in fungi:

productions of asexual and sexual spores follow the active vegetative growth of the fungus in or on the host tissues and are dispersed mechanically in time and space by various means.

Dissemination in bacterial diseases:

the bacterial cells come out on the host surface as ooze or the tissues may be disintegrated so that the bacterial mass is exposed and then dispersed by various physical and biological agencies.

Dissemination in viral diseases:

They have no such organs are transmitted by insects, mites, phanerogamic parasites, nematodes and human beings.

The dispersal of infectious plant pathogens in space occurs through two ways:

I. Autonomous or direct or active dispersal: In this method the dispersal of plant pathogens takes place through soil, seed and planting material during normal agronomic operations. There is no major role of external agencies like insects, wind, water, etc. in this type of dispersal.
II. Indirect or passive dispersal: Passive dispersal of plant pathogens happens through animate and inanimate agents.

Autonomous or direct or active dispersal include:

1. Seed as the source of autonomous dispersal
2. Soil as a means of autonomous dispersal
3. The plant and the plant organs as a means of autonomous dispersal

Seed as the source of autonomous dispersal:

Most of the cultivated crops are raised from seed and therefore the transmission of diseases and transport of pathogens has much importance. There are three types of dispersal by seed, viz., contamination of the seed, externally seed borne and internally seed borne.

a) Contamination of the seed: Seed borne pathogens move in seed lot as separate contaminants without being in intimate contact with the viable crop seeds. The

seeds of the pathogen or parasite and the host are mixed during harvest of the crop. In many cases, the identity of the seeds of the two entities (host and the pathogens) is difficult to separate. Ex: Smut of pearlmillet and ergot of rye. Smut sori and ergots mix easily with the seed lots during harvest and threshing.

b) Externally seed borne: Close contact between structure of the pathogen and seeds is established where the pathogen gets lodged in the form of dormant spores or bacteria on the seed coat during growth of the crop or at the time of harvest and threshing. Ex: Short smut of sorghum, bacterial blight of cotton, loose smut of barley etc. In many pathogens the externally seed borne structures such as smut spores can persist for many years due to their inherent capacity for long survival. Ex: The spores of Tilletia caries (Stinking smut of wheat) remain viable even after 18 years and those of Ustilago avenae (Oat smut) for 13 years.

c) Internally seed borne: The pathogen may penetrate into the ovary and cause infection of the embryo while it is developing. They become internally seed borne. Ex: Loose smut of wheat.

Differentiate Seed infection and infestation:

a) Seed infection: The seed in infected only when the pathogen has grown in or on it for sometime and established its relationship with the seed tissues. Ex: Loose smut of wheat, where the fungus grows in the embryonic tissues and becomes dormant when the seed enters dormancy.
b) Seed infestation: When the fungus or the pathogen is present on the seed coat and in the seed lot, it is only transport of the pathogen and the seed is infested.