Important plant pathogenic organisms- different groups- fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viriods, algae, protozoa and phanerogamic parasites with examples of diseases caused by them

Plant diseases are classified on the basis of type of pathogenic or non-pathogenic causes of the disease. The classification is based on the plant pathogenic organisms as follows.

A. Parasites: They include both biotic and mesobiotic agents. The diseases are incited by parasites under a set of suitable environment. Association of definite pathogen is essential with each disease.

i. Biotic agents: They are also called as animate causes. They are living organisms.

Biotic agents include

1. Prokaryotes

a. True bacteria or bacteria (Facultative parasites) e.g. Citrus canker.

b. Rickettsia-like bacteria (RLB) e.g. Citrus greening, Pierce's disease of grape

c. Mollicutes or wall-less prokaryotes

i. Mycoplasma-like organism (MLO) e.g. Sesame phyllody, egg plant little leaf.

ii. Spiroplasma e.g. Corn stunt, Citrus stubborn

2. Eukaryotes

a. Protists (Unicellular, coenocytic or multicellular with little or no differentiation of cells and tissues).

i. Fungi e.g. wilt of cotton

ii. Protozoa e.g. heart rot of coconut

iii. Algae e.g. red rust of mango

b. Plants - Parasitic flowering plants or phanerogamic parasites - Broomrape of tobacco.

c. Animals (Multicellular, extensive differentiation of cells and tissues) e.g. Nematodes -Root knot nematode.

ii. Mesobiotic agents: They include viruses and viroids. They are infectious agents. They can be crystallized and are considered non-living. But their multiplication in the living plants ensures that they are living. Hence they are called as mesobiotic agents.

Viruses e.g. yellow mosaic of blackgram

Viroids e.g. spindle tuber of potato

B. Non-parasites or Abiotic agents: They are also called as non-infectious or physiological disorders. When no pathogen is found, cultured from or transmitted from a diseased plant, then the disease is said to be caused by a non-living or environmental factor. These diseases occur because of disturbances in the plant system by the improper environmental conditions in the air or soil or by mechanical influences. They are listed below.

i. Too low or too high temperature

ii. Lack or excess of soil moisture

iii. Lack or excess of light

iv. Lack of oxygen

v. Air pollution (Toxic gases in the atmosphere etc.)

vi. Mineral deficiencies or toxicities

vii. Soil acidity or alkalinity

viii. Toxicity of pesticides

ix. Improper agricultural practices.

a. FUNGI

Fungi are eukaryotic, achlorophyllous organisms that may reproduce sexually and asexually and whose filamentous branched somatic structures are typically surrounded by cell walls containing chitin or cellulose.

b. BACTERIA

Bacteria are microscopic, unicellular prokaryotes, which lack chlorophyll. These microorganisms are with a primitive nucleus lacking a clearly defined membrane. The bacteria are smaller than fungi and measure about 0.5 to 1.0 x 2.0 to 5.0 μm in size. More than 1,600 bacterial species are known. Majority of them are saprophytes. Several species cause diseases in human beings and animals. About 200 species of bacteria cause diseases in plants. First report of plant disease by bacteria was made by T.J. Burrill of the University of Illinois. He showed that fire blight of apple and pear is caused by a bacterium, *Erwinia amylovora*. Bacteria have been defined by Clifton as "extremely minute, rigid essentially unicellular organisms, free of true chlorophyll and generally devoid of any photosynthetic pigments; most commonly multiplying asexually by simple transverse fission, the resulting cells being of equal or nearly equal size".

Fastidious vascular bacteria (Rickettsia-like bacteria – RLB)

Fastidious vascular bacteria are otherwise called Rickettsia - Like bacteria, Rickettsia like organisms (RLO), or fastidious prokaryotes or rickettsia -like walled bacteria. They are small bacteria with a cellular ultrastructure of typical gram- negative bacteria. They are very exacting in their nutritional requirements, refusing to grow on routine bacteriological media. They have a cell wall unlike MLO and spiroplasma. MLO is restricted to phloem tissues where as RLB are restricted mostly to xylem or phloem. A common habit for both is the insect body fluid (haemolymph). Both the groups are dependent on insect vectors for transmission. Non-tissue restricted RLB have also been observed in plant diseases. They reproduce by binary fission. Mostly insect vectors transmit them. Nematode *(Xiphinema index)* also helps in transmission of RLB (yellow disease of grapevine). Mechanical inoculations (as in Pierce's disease of grapevine, almond leaf scorch and alfalfa dwarf) or vegetative propagation also reproduce disease symptoms. They produce phytoalexins, which induce characteristic symptoms of the disease. They are cultured in artificial media e.g., Pierce's disease of grapevine, almond leaf scorch, phony disease of peach and plum leaf scald. Xylem restricted RLB can be more successfully cultured than limited-limited bacteria.

Penicillin is effective against RLB. Sulpha drugs also inhibit them. The RLB can be divided into three groups.

1 Xylem-limited RLB

2 Phloem-limited RLB and

3 Non-tissue restricted RLB

1. Phloem-limited RLB

Phloem limited bacterium was first recognized by D.Lefleche and J.M.Bowe in 1970. Twelve phloem-restricted RLB have been identified Examples of phloem limited RLB include citrus greening, clover club leaf (CCL), white clover disease, clover rugose leaf curl, potato leaflet stunt, little leaf of *Sida cordifolia* and stunting of dodder.

a. Symptoms: Stunting, yellowing of young leaves, virescence of floral parts, premature death of the entire plant.

b. RLB: They are mostly rigid rods and Gram-negative and sensitive to penicillin. The cells measure 0.2 to 0.5 x 1.0 to 2.0 (0.3 x 1.3) μm and are bound by a double membrane or a cell wall and cytoplasmic membrane. RLB have not been cultured *in vitro* and Koch's postulates

proved. Therefore, not much is known about their nature, taxonomy and serological relationships.

Transmission: Transmission is by leafhoppers, dodder and grafting. Citrus greening is transmitted by citrus psylla (*Psyllina* sp.) and by vegetative propagation. Clover clubleaf multiplies in its vector, *Agalliopsis novella.* The vector retains infectivity throughout its life cycle and the RLB is transovarially transmitted.

2. Xylem-limited RLB

Pierce's disease of grapevine, almond leaf scorch, phony disease of peach, wilt of periwinkle, Sumatra disease of cloves, elm leaf scorch, alfalfa dwarf, plum leaf scald. The RLB causing phony disease of peach is named as *Xylella fastidiosa*. **Symptoms:** Symptoms include marginal necrosis of leaves, stunting of plants, decline in vigour and reduction in yield.

RLB: In general xylem-limited Gram-negative bacteria have elongated cells of 0.2 to 0.5 into 1.4 μm size (Davis *et. al.,* 1981). The cells usually have well defined cell wall and plasma membrane. Both are triple layered in structure. The walls are ridged or ripped due to periodic infolding of the outer membrane of the wall. These width of the ridges is about 45 to 75 nm. The cell wall ultrastructure is typical of Gram negative bacterial. In culture, the cells of Pierce's disease of grapevine and almond leaf scorch are non-motile, gram negative, oxidase negative and catalase positive.

They are susceptible to tetracyclines but not to penicillin. The G+C content of the DNA is about 53.1 moles per cent.

Transmission

Transmission of RLB takes place mostly through xylem feeding insects. Sap transmission and transmission through vegetative propagation have been reported. The insect vectors belong to sharp shooter leafhoppers (Cicadellidae) and spittle bug or froghoppers (Cercopidae). Pierce's disease of grapevine is spread by *Homaladisca coagulata, Oncometopia undulata, Cuerna costalis, Draeculacephala portola, D.minerva, Corneocephala fulgide* and *Graphocephala atrapunctata.* RLB of Pierce's disease of grapevine is transmitted by the vector in a non-circulative but persistent manner. There is no incubation period in the body of the vector and infectivity is lost after moulting. This is because the RLB accumulate only in the salivary syringes where they appear to attach in a polar orientation. The transmission is accompanied by

regurgitation of the bacteria into the xylem stream. The RLB are not pathogenic to the vector. There is no transovarially transfer of RLB.

3. Non-tissue restricted RLB: They are also found in parenchyma and meristematic cells of yellows of grapevine, chlorosis and Aspermy of wheat, apple proliferation, carrot proliferation and necrosis of grapevine. A yellow of grapevine is transmitted by a nematode, *Xiphinema index.* Not much is known about RLB of these diseases.

PHYTOPLASMA

Phytoplasma lack cell wall and are bounded by a unit membrane. They are pleomorphic. They lack cell wall. They have fried egg appearance of colony. They are filterable through 450 nm membrane. They have both DNA and RNA. They cannot be grown on artificial media. They produce symptoms like little leaf, phyllody, spike, yellows, stunting, witches' broom etc. They are mostly transmitted by leafhoppers. They are insensitive to penicillin and sensitive to tetracycline. e.g. phyllody of sesame, little leaf of brinjal.

SPIROPLASMA

Spiroplasma is helical, wall-less prokaryotes requiring cholesterol for growth and cause diseases in plants, insects and rats. They are insensitive to penicillin and sensitive to erythrocin and tetracycline. e.g. corn stunt, citrus stubborn.

VIRUS

Viruses are ultramicroscopic, nucleoprotein entities, which are infectious agents and obligately parasitic pathogens, which are less than 200 mμ in size. They are devoid of enzymes and depend on the host protein synthesis machinery (ribosomes). They have only one type of nucleic acid viz., RNA or DNA. Most of the plant virus is having RNA. e.g. TMV. Few viruses contain DNA. e.g. Cauliflower mosaic virus, banana bunchy top virus, maize streak virus and sugar beet curly top virus.

VIROIDS

Viroids are small low molecular weight ribonucleic acids that can infect plant cells replicate themselves and cause disease. They are also called as mini viruses. e.g. Potato spindle tuber, Chrysanthemum stunt, Coconut *Cadang cadang.*

ALGAE

Algae are eukaryotic, unicellular or multicellular organisms and mostly occur in aquatic environments. Many algae thrive as terrestrial or subterranean algae. The size of algae ranges

from 1.0mm to many centimetres in length. They contain chlorophyll and are photosynthetic. They reproduce by asexual and sexual processes. The study of algae is called phycology or algology.

PROTOZOA

Protozoa (trypanosomatid flagellates) belonging to the class Mastigophora, order Kinetoplastida and family Trypanosomatidae have been known to parasitize plants. Protozoa attacking plants move by flagella. Protozoa or trypanosomatid flagellates belonging to the class Mastigophora, order: Kinetoplastida and family Trypanosomatidae have been known to parasitize plants. The Mastigophora, or flagellates, are characterized by one or more long slender flagella at some or all stages of their life cycle. The flagella are used for locomotion and food capture. They are also used as sense organs. The body of the flagellates has a definite long, oval or spherical form, which is maintained by a thin, flexible membrane cover.

In some groups it may be armoured. Flagellates reproduce by longitudinal fission. Flagellates apparently cause the phloem necrosis disease of coffee, the heart rot disease of coconut palm and the Marchitez suppressive (sudden wilt or wither) disease of oil palm, Marchitez suppressive is one of the important diseases in oil palm. *Phytomonas staheli* was described from sieve tubes of coconut and oil palm.

PHANEROGAMIC PARASITES

Phanerogamic parasites are flowering plants or seed plants, which lead a parasitic life on other living plants. They parasitize a great number of economic plants and cause considerable loss in yield. The phanerogamic parasites invade stem or root of the host plants. Some of these parasites possess chlorophyll, which manufacture carbohydrates to a limited extent and depend on the host for mineral, salts and water.

These are generally called as semi or partial parasites. Some of the parasites, which do not have chlorophyll, depend entirely on the host plants for their food materials. They are called holo or total parasites. Nearly 2,500 species of phanerogamic parasites in 11 families have been recorded throughout the world. Among them Orobanchaceae, Scrophulariaceae, Loranthaceae, Convolvulaceae and Lauraceae are important.

Classification of plant diseases

There are thousands of diseases, which attack crop plants. Classification can be made based on several criteria. The various ways of classifying diseases of plants are given below.

1. Type of infection

a. Localized diseases: These diseases are limited to a definite area of an organ or part(s) of a plant. e.g. leaf spots and anthracnoses caused by different fungi.

b. Systemic diseases: In these diseases the pathogen spreads from a single infection point so as to infect all or most of the host tissues. e.g. Downy mildews caused by fungi and mosaics and leaf curls caused by viruses.

2. Type of perpetuation and spread

a. Soil-borne diseases: The causal agents perpetuate and spread through soil. e.g. Damping off caused by fungi like *Pythium* sp. and root rot caused by *Rhizoctonia* spp.

b. Seed-borne diseases: Seed or seed materials help in the perpetuation and spread of this disease. The disease causing agents may be internally seed-borne or externally seed-borne e.g. Loose smut of wheat caused by *Ustilago nuda tritici* (internally seedborne) and blast of rice caused by *Pyricularia oryzae* (externally seed-borne).

c. Air-borne diseases: In these type of diseases the causal agents are spread by wind (air). e.g. Early leaf spot and late leaf spot of groundnut caused by *Cercospora arachidicola* and *Phaeoisariopsis personata* respectively.

3. Extent of occurrence and geographic distribution

a. Endemic diseases: It is also known as enphytotic disease. When a disease is more or less constantly occurring year after year in a moderate to severe form in a country or locality then it is called as an endemic disease. e.g. Wart disease of potato caused by *Synchytrium endobioticum* is endemic in Darjeeling, citrus canker caused by *Xanthomonas campestris* pv. *citri* is endemic in Asia and sorghum rust caused by *Puccinia purpurea* is endemic in India.

b. Epidemic or epiphytotic diseases: An epidemic or epiphytotic refers to sudden outbreak of a disease periodically over a widespread area in a devastatingly severe form causing extensive losses or complete destruction. Epidemic disease may be present constantly in the locality but assumes a severe form only on occasions. This is because of the occurrence of favourable environment responsible for the rapid development of the disease. But the pathogen may be irregular in appearance or there may be lack of sufficient inoculum to cause the disease. e.g. wheat stem rust (*Puccinia graminis tritici*) and powdery mildew (*Erysiphe graminis* var. *tritici*), late blight of potato (*Phytophthora infestans*), sugarcane red rot *(Physalospora*

tucumanensis), downy mildew of grapevine (*Plasmopara viticola*) and rice blast *(Pyricularia oryzae).*

c. Sporadic diseases: Sporadic diseases are those, which occur at irregular intervals over limited areas or locations. They occur in relatively few instances. e.g. *Fusarium* wilt of cotton (*Fusarium oxysporum* f.sp. *vasinfectum*), grain smut of sorghum (*Sporisorium = Sphacelotheca cruenta*) and wheat loose smut (*Ustilago nuda tritici*).

d. Pandemic diseases: A disease is said to be pandemic when it is prevalent throughout the country, continent or world involving mass mortality. e.g. Late blight of potato and wheat stem rust.

4. Multiplication of inoculum

Based on the multiplication of inoculum, diseases are classified as

a. Simple interest disease and

b. Compound interest disease.

a. In simple interest disease (monocyclic epidemics) the disease increase is just like simple interest in money. Here inoculum comes from a reservoir and hence amount of inoculum for a given season's crop is fixed. So there is no repetition of the disease cycle within the crop season. Hence the disease spread will be slow. e.g. Soil inhabiting pathogens like *Pythium* sp., *Rhizoctonia* sp. and *Sclerotium* sp.

b. In compound interest disease (polycyclic epidemics) the disease increase is just like compound interest in money. Inoculum is multiplied several times (every 7 to 15 days for wheat rust) during crop growth in a season. So the disease spread will be fast. e.g. Wheat stem rust, rice blast, powdery mildew diseases of different crops.