LEC.1

PLANT PATHOLOGY

The term **'Pathology'** is derived from two Greek words 'pathos' and 'logos'. 'Pathos' means suffering and 'logos' means the study / to speak / discourse. Therefore it etymologically means "study of suffering". Thus the plant pathology is the "study of suffering plants".

Plant Pathology or Phytopathology is one among the branches of agricultural science that deals with cause, etiology, resulting losses and management of plant diseases

In general disease is an interaction among the host, parasite and the environment.

"**Irish famine**

Late blight of potato (*Phytophtora infestans*)

- Late blight of potato (*Phytophtora infestans*) caused severe potato losses in **Northern Europe** in the 1840's - absolutely destroyed the potato crop in Ireland in 1845 and 1846 and caused the great "Irish famine". - death of thousands of people and emigration of more than one and half million people from Ireland to the United States.

Bengal famine

Rice due to attack of *Heliminthosporium oryzae* leaf spot disease

- Bengal had faced a serious famine (Bengal famine). One of the reasons to which this famine has been attributed is the loss in the yield of rice due to attack of Heliminthosporium oryzae leaf spot disease

Mycology

1729 - MICHELI studied fungi and saw their spores and also called as **Founder of Mycology.**

1755 - TILLET published a paper on bunt or stinking smut of wheat

1840 - Tulasne is called as **Reconstructor of mycology**

1866 - ANTON DE BARY - is truly regarded as the **"FOUNDER OF MODERN MYCOLOGY".**

1858 - **Julius f Kuhn**, Published first text book plant pathology namely **"The diseases of cultivated crops, their causes and their control".**

1920- E.J.BUTLER initiated an exhaustive study on Indian fungi and the diseases caused by them. He can also be called as the **"FATHER OF MODERN PLANT PATHOLOGY IN INDIA".** He is the first director of Imperial Mycological Institute (now International Mycological Institute) in England. He wrote"Fungi and Diseases in Plants"

1955 - **FLOR** contributed on gene to gene hypothesis of diseases resistance and susceptibility.

1948 - **B. B. MUNDKAR** started Indian Phytopathological Society with its journal Indian Phytopathology.

1970 - S.D. GARETT investigated in the management of root diseases and he contributed in the field of biological control. He is the father of Biologicsal control

1886-1971-J.F.DASTUR is the first Indian Plant Pathologist who is credited with detailed study of fungi and plant diseases. His special field of study was the genus *Phytophthora.*

1953 - J.C. LUTHRA - developed solar heat treatment for wheat loose smut.

Plant Bacteriology

1876 - LOUIS PASTEUR and ROBERT KOCH - They proved that anthrax disease of cattle was caused by specific bacterium. They disproved the

theory of spontaneous generation of diseases and propose **germ theory** in relation to the diseases of man and animal.

1876 - ROBERT KOCH of Germany described the theory called "KOCH'S POSTULATES." He established the principles of pure culture technique.

1882 - American Plant Pathologist - T. J. BURRILL first time proved that fire blight of apple and pear was caused by a bacterium (now known as *Erwinia amylovora*)

1905-1920-E.F.SMITH of U.S.A gave the final proof of the fact that bacteria could be incitants of plant diseases. He also worked on the bacterial wilt of cucurbits and crown gall disease. He is also called as **"Father of Phytobacteriology**".

Plant Virology

1886 - ADOLF MAYER -Born in Germany and worked in Holland on Tobacco Mosaic Virus of tobacco. He demonstrated the sap transmission of the disease.

1892 - DIMITRII IVANOWSKI (Russia) demonstrated that the agent of tobacco mosaic virus could pass through even those filters that retained bacterial cells.

1898 - BEIJERINCK - a Dutch microbiologist and founder of virology proved that the virus inciting tobacco mosaic is not a microorganism. He believed it to be *contagium vivum fluidum* (infectious living fluid)

1935 - W.H.STANLEY proved that viruses can be made as crystals. He got Nobel Prize.

1936 - BAWDEN F.E. and PIRIE (Britain) found that the crystalline nature of the virus contains nucleic acid and protein.

1967 - DIENER and RAYMER discovered the potato spindle tuber was caused by viroid.

Phytoplasms

1898 - NOCARD and ROUX discovered another agent of diseases (Mycoplasma Like Organism) caused in animals which was similar to viruses in size but which could be cultured on artificial media. This group was known as mycoplasma.

1967 - DOI AND ISHIE, Doi observed that MLO's are constantly present in phloem **Spiroplasma**

1972 - **Davis** *et al*., - spiroplasma.

CONTRIBUTION OF PLANT PATHOLOGISTS IN INDIA

J.F. Dastur N. Prasad	-	Late blight of potato
G.S. Kulkarni D. Suryanarayana	-	Downy mildew of sorghum
B.B.Mundkur C.V. Subramanian	-	Wilt of cotton – (Book) **Fungi and Plant Diseases**
K.C.Mehta	-	Wheat Rusts
J.C. Luthra	-	Solar seed treatment of wheat seeds
S.Y.Padmanabhan and S.B. Chattopadhyay	-	Diseases of rice
M.J. Thirumalachar	-	Antibiotics in plant disease - control.
R.N. Tandon	-	Diseases of fruits and vegetables
M.K. Patel M.K. Hingorani	-	Bacterial diseases of crop plants
P.N. Patel G.S. Kulkarni	-	Bacterial diseases of crop plants
P.R. Mehta	-	Diseases of cereals and millets.
H.K. Saksena	-	Gram rust and Rhizoctonia diseases
D.N. Srivastava	-	Bacterial blight of paddy
R.S. Singh	-	Pythium - Plant Diseases – (Book).

Y.L. Nene - " Fungicides in Plant Disease control" – (Book)

V.V. Chenulu

S.P. Raychaudhuri - Virus diseases

Kapoor and A. Varma

S.B. Mathur - Seed pathology

G. Rangaswami - Diseases of crop plants in India (Book)

Bacterial Plant Diseases in India (Book)

R.K. Saksena - Fungal root diseases

A. Mahadevan - Biochemical changes in diseased plants and enzymes.

P.Vidhyasekarn - Physiology of plant Pathology

Lec 2

CAUSES OF PLANT DISEASES

Biotic

I .Fungi

2.Bacteria

3.Virus

4. Viroid

5.Phytoplasma like Organisms

6. Spiroplasmas

7.Algae

8. Phanerogamic Parasites

Abiotic

All envt.facters

Soil PH

FUNGI

Fungi are the eucaryotic protist, achlorophyllus, nucleated, branched, unicellular or multicellular organisms that may reproduce by the division of vegetative cells, well defined asexual and sexual spores. The body of the fungus is called as 'Thallus'.

BACTERIA

Bacteria are unicellular, microscopic, chlorophyll less, prokaryotic microorganism reproduce mainly by fission.

About 180 species of bacteria are known to cause diseases in crop plants. Most of the plant pathogenic bacteria are facultative saprophytes and can be grown artificially on nutrient media, however some fastidious vascular bacteria are difficult to grow in culture. The most important botanical families attacked by bacteria are the gramineae, solanaceae, leguminaceae and Rosaceae.

VIRUS

These are the submicroscopic, infectious obligate parasites, do not have metabolism of their own but depends upon other living cells for their multiplication. They neither have any sexual reproduction nor produce any resting structures as that of fungi and bacteria.

VIROID

Virus without protein coat is called as viroid. They consist of only RNA and are subviral in size and reported to cause diseases to crop plants

Phytoplasma

They lack of cell wall are bounded by single triple layered highly elastic unit membrane.

Have cytoplasm, ribosome (RNA) and strands of nucleic acid (DNA) similar to bacteria. Usually ovoid (or) irregularly tubular to filamentous in shape

Generally present in the sap of a small number of phloem sieve tubes and cannot be grown on artificial nutrient media.

Sensitive to antibiotics particularly those of tetracycline group.

Transmitted through vegetative propagative materials, dodder, grafting/budding and also by insect vectors. The leaf hoppers rank first in transmitting phytoplasmas from plant to plant.

SPIROPLASMAS

They facultative saprophyte. Similar to bacteria, they have ribosome (RNA) and DNA .Spiroplasma are very in shape from spherical to slightly ovoid to helical and branched non helical structures. They do not have any flagella but have rotary motility and reproduce mainly by fission.

Spiroplasmas are resistant to penicillin but inhibited by tetracycline and are transmitted mostly by leaf hoppers.

RICKETTSIA LIKE BACTERIA (RLB):

RLB are otherwise called as RLOrganisms or fastidious prokaryotes or rickettsia like walled bacteria. They are small bacteria with a ultrastructure of typical green negative bacteria. They are very exacting in their nutritional requirements, refusing to grow on routine bacteriological media..

- have cellwall
- RLB are restricted mostly to xylem and phloem.

Eg: Citrus greening, Potato leaflet stunt, Little of *Sida cordifolia*, Stunting of dodder

ALGAE

Algae are the eukaryotic thallophytes having chlorophyll as their primary photosynthetic pigments. The plant body made up of single or many cells. But they lack vascular tissue.

The study of algae (Singular alga) is known as phycology of algology.

PHANEROGAMIC PARASITES DISEASES

Certain flowering plants (Phanerogams) also parasitize the crop plants in addition to the microorganisms. They produce flowers and seeds and parasitize their host by drawing nutrition and water.

What are Koch's Postulates?

How would you prove that a particular organism is responsible for the cause of a plant disease?

I. Pathogen must be found associated with every incidence of diseases

II. Pathogen can be isolated and pure cultured

III. Pathogen can be artificially inoculated into healthy plants

IV. The artificially inoculated Plant can produce diseases symptoms

V. Pathogen also can be isolated from the artificially inoculated plant

VI. Both symptoms and pathogen are similar to original one

Lec 3

GENERAL CHARACTERS OF FUNGI

(Types of mycelium and resting bodies)

FUNGI

Fungi are eukaryotic, small, usually filamentous, branched, spore bearing microorganisms that lack chlorophyll and have cell wall. containing cellulose or chitin or both. Reproduce sexually and asexually

Mycelium (Pl. mycelia): mass of hyphae constituting the body of a fungus

Hypha(pl. hyphae).

The individual filament is called hypha

Thallus (pl. thalli)

The entire fungal body is called thallus

Plasmodium

Some of the lower fungi lack mycelium. Members of Chitridiales are composed of dissimilar strands and the members of Plasmodiophorales possess a naked motile mass of multinucleate protoplasm called plasmodium.

Special structures of fungi

1.Appressorium

-helps for attachment with the host

2.Haustorium helps to absorb nutrient from the host

3. Rhiziod

Root like –devoid of nuclei-absorbing organ

Types of Mycelium (Based on the colour and Septations)

The mycelium may be coloured or hyaline,

with or without septations.

Hyphae Separated by cross wall called septum

(partition).

Absence of septa is referred as aseptate or coenocytic.

(Based on the Presence /Locations)

Ectophytic mycelium

The entire thallus being present on the surface of the host or affected parts. E.g. Powdery mildew of peas- Erysiphe polygoni

Endophytic mycelium

The thallus being present inside the host tissue,

E.g. Late blight of potato - Phytophthora infestans.

Ect- Endophytic mycelium

The thallus being present both on the surface and inside the host tissue.

E.g.Powdery mildew of mulberry-Phyllactinia corylea

The mycelium may be intercellular or intracellular.

1. Intercellular mycelium.

If the mycelium occurs in between the cells is called as intercellular mycelium.

Eg. *Phytophthora infestans.*

2.Intracellular mycelium

If the mycelium occurs or present inside the host cell, is called as intracellular mycelium.

E.g. ***Pythium aphanidermatum***

3.I**nter - and intracellular mycelium.**

If the mycelium occurs **both in between and inside** the host cell it is called as inter- intra cellular mycelium.E.g. ***Fusarium sp***

RESTING BODIES

1.Rhizomorph (Gr. rhiza = root + morphe = shape)

It is a thick strand of somatic hyphae in which the hyphae have lost their individuality. with the whole mass behaving as an organized unit. The structure of the growing tip of the rhizomorph sometimes resembles that of a root tip, hence the name.

E.g. ***Armillariella mellea***

2.Sclerotium (Gr. Skleron = hard) It is a hard resting body resistant to unfavourable conditions which may remain dormant for long periods of time and germinate on the return of favourable conditions.

E.g. ***Sclerotium oryzae***

3.Chlamydospore (Gr. Chlamys = mantle + spora = seed, spore)

It is a thick walled hyphal structure that generally functions as a resting spore. It may be terminal or intercallery.

E.g. *Fusarium sp*

Reproduction of the Fungi

(Types of asexual spores and sexual spores).

Inoculum

It is any part of a plant pathogens that is capable of establishing infection.

Spores: Minute propagative units of the fungus.

Spores are produced through sexual and asexual reproduction. These spores are either coloured or hyaline and with or without septations.

Asexual spores are formed without fusion of male and female gametes.

Sexual spores are formed with fusion of male and female gametes.

Classification based on colour and septations

Asexual spore

Classification based on motility

1.Aplanospores : (Gr) A -not

- A non motile spore.

Eg : Rhizopus, Mucor

2.Planospores - Motile or Zoospores

Flagella - Flagellum - Whiplash or tinsel like structure with which zoospore - move.

A. Zoospore (Gr. Zoon= animal + spora = seed, spore)

It is a motile, asexually produced spore.

Eg. Pythium, Phytophthora, Plasmodiophora brassicae etc.,

B.Sporangiospore

It is a non-motile asexual spore borne within a sporangium.

Sporangium: It is a sac-like structure, the entire protoplasmic contents become converted into an indefinite number of spores.

E.g. White rust of Crucifers - Albugo candida

C.Conidiospore

An asexually produced fungal spore formed at the end of a conidiophore. E.g. F.udum - pigeonpea wilt.

Conidioma - a specialised conidium bearing or conidium-containing structure

Asexual Fruiting Bodies

. i. Pycnidium ii. Acervulus iii. Sporodochia iv. Synnemata v .Sorus

(a)Pycnidium: (PI. Pycnidia)

An asexual, hollow flask shaped fruiting body, lined inside with conidiophores.

Eg: Macrophomina, Phoma, Diplodia, Botryodiplodia etc.

b)Acervulus :– heap (Acervuli (P))

A mat or hyphae giving rise to short conidiophores closely packed together and forming a bed like mass

Eg: Colletotrichum

(c)Sporodochium : A cushion shaped stroma covered with conidiophores. Eg: Fusarium

Stroma (Gr) - Mattress. Compact somatic mat like structure on which fruiting bodies develop.

(d) Synnema :

A group of conidiophores cemented together and forming elongated spore-bearing structure. Eg. Graphium

e.Sorus :The spore bearing hyphae are grouped in to small masses or clusters.eg.Smut sori, Rust sori

Sexual spores

Homothallic fungi : Fungi in which every thallus is sexually self fertile

No need of another/secondry thallus.

Heterothallic: Fungi in which every thallus is sexually self sterile

need of another/ secondry compatible thallus.

i) Oospore

It is a thick-walled spore that develops from an oosphere through either fertilization or parthenogenesis. Oosphere

It is a large, naked, non motile, female gamete

Eg (class Oomycetes-Oospores)

1. Fruit rot of cucurbits- Pythium aphanidermatum.

2. Late blight of potato- Phytophthora infestans.

ii) Zygospore

It is a resting spore that results from the fusion of two gametangia in the zygomycetes. E.g. Soft rot of sweet potatoes - Rhizopus stolonifer.

iii) Ascospore

Spores produced by ascomycetes. E.g. Powdery mildew of peas- Erysiphe polygoni. .iv) Basidiospore

It is a spore borne on the outside of a basidium following karyogamy and meiosis.E.g. Smut of sugarcane - Ustilago scitaminae

SEXUAL FRUITING BODIES

Ascocarp: The fruiting body containing asci is termed as ascocarp.

Types of ascocarp

i) Naked asci - ascocarp not present

Taphrina deformans ii) Cleistothecium: Completely closed ascocarp - Closed

(eg.) Erysiphe, Leveillula

iii) Apothecium : Store house

(eg.) *Ascobolus sp*

iv) Perithecium :

Flask shaped closed ascocarp with an opening called ostiole and ascus wall is single.

(eg.) *Venturia inaequalis*

2.Basidiocarp

Fruiting body of basidiomycotina bearing basidiospores.

(eg) Pleurotus, Ganoderma, Armillaria

Lec 4

General characters of protozoa:

Protozoa(singular protozoan)derived fron two greek words “protos” and “zoan” which means “first animal”. The kingdom Protozoa contains 115,000 known species. Members have extremely diverse cell structure, patterns of nutrition, metabolic needs, reproduction and habitat.

Kirk et al., (2008) described about 1038 fungal protozoan analogous in the 10th Dictionary of the fungi.

The general characters are’

1. Have phagotrophic or phagocytosis mode of nutrition, but plant parasites obtain food by absorption.
2. Presence of naked unicellular plasmodial or ameboid somatic phase. They don’t form hyphae and generally lack cellwall.
3. Produce motile zoospore as asexuzl spore.
4. Zoospores hav flagella which never rigid and tubular withput heptoneme and have tubular mitochondrial cristae.

Taxonomy is a part of Biological science that deals with the study of naming and classification of organisms

Phylum: mycota

Sub Phylum: mycotina

Class: mycetes

Sub class:mycetidae

Order:ales

Family:aceae

Genus :

Species:

Club root of cabbage - *Plasmodiophora brassicae*

Symptoms:

Leaves are pale green to yellow and wilting takes place during day time

Infected plants remain alive but fail to produce heads

The infected roots enlarge rapidly to form “clubs” due to hypertrophy and hyperplasia

Yellowing stunting and wilting of plants with decomposing spots present on the root

hypertrophy (excesive enlargement of cells)and hyperplasia (excessive multiplication of cells)

Pathogen

- Naked mass of multinucleate protoplasm called plasmodium
- It produces two types of sporangium namely plasmosporangium and cystsporangium.
- Resting spores are developed from the cyst sporangium, Resting spores or cysts germinate and releases the swarm cells.
- The swarm cells or zoospores have two flagella of unequal length. It is known as heterokont.
- The swarm cells infect the root hairs and causes club root disease in the affected plants.

Lifecycle:

It has 2 phases

1. Primary phase:
    - Infected host roots – rsting spores are released into soil. The resting spores are tiny, hyaline, spherical, uninucleate with spiny walls
    - During germination – zoospore released.
    - The zoospores get attached to the host.
    - They enter in the host cellwall which is spherical and amoeboid in shape.
    - The ameboid zoospores are called myxamoebae
    - Plasmogamy takes place – haploid amoeboid protoplast result in the formation of multinucleate primary plasmodia
    - Later by cleavage multinucleate segments are delimited, each of which develops into zoosporangium. Each sporangium 4-8 uninucleate anteriorly biflagellate zoospores developed and released.
2. Secondary phase:

    The flagellated zoospores enter into root hair – forms as secondary plasmodium – developed a multinucleate secondary plasmodium – the karyogamy and meosis takes place.

    Then, Akaryotic stage developed and the symptoms are appeared. From the infected resting spores developed. Then the cycle repeats similarly. Hence, this is called as alternation of generation.

Lec 5

General characters of chromista:

Chromista means coloured

This kingdom comprises of eukaryotic cell walled micro organisms

The members are photosynthetic

The photosynthetic chromists often carry various pigments in addition to chlorophyll which are not found in plants.

Hese pigments give them their characteristic brown or golden colour.

The phylum also hyaline chromista.

Have uni or multinucleate somatic phase with absorptive type of nutrient

Have cellwall rich I cellulose

The asexual spore is biflagellate zoospores with 2 flagella – whiplash and tinsel

Late blight of potato

FOLIAGE (LEAF) SYMPTOMS :

- Symptoms on foliar parts of the potato starts appearing usually in the month of January in our country.
- They appear,at first as circular or irregular water -soaked spots usually at the tips or edges of the lower leaves.
- In moist weather the spots enlarge rapidly and form brown, blighted areas.soon the entire leaflet and then all the leaflets on a leaf are infected, die

Tuber symptoms

- Affected tubers, at first, show more or less irregular, purplish -black or brownish areas with a metallic dark, dull colour.
- Such areas may cover the entire surface of the tuber; the infection generally confines to surface region and does not spread deeper into the tissues of the tuber.
- When cut open, the infected tissue of tuber appear water-soaked, dark, somewhat reddish - brown, and the infection extends only upto 5-15 mm into the flesh of the tuber.

Life cycle:

Asexual :

The sporangiophores are sympodially branched (zig zag) with characteristic swellings.

Lemon shaped papillate sporangia are borne at nodes.

Zoospores come to rest – encyst

- Germinate by a germ tube new mycelium which is hyaline, coenocytic mycelium.

Sexual:

Heterothallic

Sexual reproduction takes place by means of antheridia and oogonia of opposite mating types.

The oogonia penetrate and grow through the antheridium and form a globose structure above the antheridium. This type of antheridium is known as amphigynous.

Migration of the single antheridial nucleus occurs through the oogonial wall by a fertilization tube and fusion takes place.

The fertilized egg secretes a heavy wall around itself become an oospore (resting spore)

After rest period of several weeks, the oospore germinates by means of germ tube – and produces the zoospore.

The zoospore germinates – to produce new thalli.

Importance of this disease

IRISH FAMINE:

Late blight disease attracted the attention of the scientists when it

Caused an epidemic on potatoes in Ireland during 1843- 1845 resulting

In the migration and death of about 20 million people due to starvation.

The unfortunate historical event of Ireland is popularly known as " Irish Famine."

However,the disease was first introduced in India in Nilgiri Hills between 1870-1880.

DAMPING-OFF- *Pythium spp*

Symptoms

- Damping off is caused by *Pythium* sp that kill or weaken the seeds or seedlings before or after they germinate
- 1. Pre-emergence damping- off in which the seed and radicle rot, before the seedlings emerge out of the soil. There are patches with no seedlings at all.
- **Post-emergence damping –off**
- in which the newly emerged seedlings are killed at ground level after they emerge from the soil causing them to collapse or topple over.
- Seedlings that emerged show water soaking, shriveling and browning of stem tissue at soil level (Collar region)
- This disease is mostly noticeable in nursery beds, greenhouse and row crops.

Lifecycle:

Asexual:

Mycilum : coenocytic, both intra and inter cellular… haustoria absent

The sporagiophore consists of sporangia from a bulb like vesicle arises

The sporangial protoplast moves rapidly through the tube into vesicle

Inside the vesicle zoospore development takesplace

On the maturity the vesicular wall burst- release the zoospores in all directions

The zoospores have 2 lateral flagella. After the spore comes to ret, encyst and germinates by a germ tube.

Sexual:

Oogonia and antheridia are developed often on the same hypha

The oogonium is globe with nucleate oosphere surrounded by layer of periplasm

Antheridia much smaller and somewhat elongated or clubshaped

Upon gametangial contact a fertilization which takes place in fertilization tube

Then meiosis takes place and undergoes haplophase and plasmogamy

The oospore develops into thick walled smooth oospore which germinates directly or indirectly after undergoing a rest period

Difference b/w *Pythium & Phytophtora*

• Facultative parasite	F saprophytes
• Hyphal wall contains greater amount of protein	Less amount
• Approssoria and haustoria absent	Present
• Sporangia either terminal or intercalary	Always terminal
• Sporangia irregularly lobed	Lemon shaped
• Zoospore diffrentiation in vesicle itself	Vesicle absent …so in sporangia itself
• Oogonial wall is smooth &spiny	Warty not spiny
• Antheridia is paragynous	amphigynous

Lec 6

Downy Mildews

- Downy mildew of grape (*Plasmopara viticola*)
- DOWNY MILDEW OF PEA (*Pernospora tabicina)*
- All are polycyclic and require cool, wet environmental conditions for severe infections.
    - Disease cycle similar to *Phytophthora and Pythium*
    - Produce sporangia, zoospores and oospores
    - All are obligate parasites
    - All can spread very quickly, in a few days

Downy Mildew of Grape
(*Plasmopara viticola*)

Symptoms

- Downy growth of the fungus is seen, later, turn into dirty grey.
- On the upper surface of leaves irregular light yellow spots are seen.
- Number of spots coalesce to form large necrotic areas.
- Symptom on fruits
- Fungal growth is confined to the inside of berries and results in light green or brown colour of fruits.

Pathogen

- Mycelium is intercellular, coenocytic, thin walled and hyaline
- sporangiophores branching at right angles bearing sporangia.
- Oospores are thick walled

DOWNY MILDEW OF PEA

(Peronospora pisi)

SYMPTOMS:

- A downy growth(whitish) is observed on the lower surface of the leaves which appears in the form of patches of varying size.
- On the upper surface of the leaves these patches appear as yellow to brown spots

Pathogen:

- The mycelium is endophytic ,branched, aseptate. The conidiophores are unbranched in the lower portion. The conidia are purple, green or red coloured.
- The oospores are rounded, thick walled, yellowish green.

Life cycle:

Asexual:

Mycelium is hyaline, coenocytic, intercellular and produced globose haustoria.

Sporangiospores arise from the hyphae and branch at right angle to main axis.

Each branch has 2 or 3 secondary branches.

Lemon shaped sporangia produced

Sporangia germinate and biflagellate zoospores produced – which encyst – germinate and produce new mycelium.

Sexual:

The fungal is heterothallic and hence two mating types are present

Spherical, thick,dull brown oospores are formed later due to union of antheridium and oogonium.

Oospores germinate – after a period of rest and produce zoosporangium.

Zoospores released from sporangium – produce new mycelium.

WHITE RUST OF AMARANTHUS

(Albugo bliti)

Symptoms

- It is common on several cruciferous crops such as cabbage, turnip, mustard and radish.
- *Albugo bliti* causes white rust on amaranthus.
- *A. candida* causes white rust on crucifers

- White or cream yellow pustules of various sizes and shapes appear on all aerial parts mostly on the lower surface of the leaves. In some crucifers the leaves may become thick, fleshy and rolled.
- When infection is severe, the size of the leaves may be decreased and plants stunted.

Pathogen

- Sub hyaline ovoid sporangia of the fungus are borne in chains on short, hyaline sporangiophores. Dark, spherical, reticulate oospores formed abundantly in the leaves.

Lec 7

Important characters of *Rhizopus:*

It is one of the largest families of *Mucorales* with example genera *Mucor, Rhizopus*.

Members are either homo- or heterothallic and produce multispore columellate nonapophysate sporangia with either deliquescent or persistent walls.

Zygospores have opposed non appendaged.

Species of *Mucor* and *Rhizopus* cause postharvest rots in fruits and vegetables.

The *Rhizopus* stolonifera occurs very frequently on bread and hence called bread mould.

It is a common contaminant of culture media, heterothallic, rarely produces chlamydospores and cause postharvest rots in fruits and vegetables*, R.atrocarpi* causes fruit rot of jack.

Fruit rot of jack: *Rhizopus atrocarpi*

Systemic position:

Kingdom : Fungi

Phylum : Zycomycota

Subphylum : Mucoromycotina

Class : Mucorales

Order : Mucorales

Family : Mucoraceae

Genus : Rhizopus

Species : atrocarpi

Symptoms:

Young fruits and male inflorescences become rotten, covered with greyish white mycelial growth and black sporangial heads and fall off.

Life cycle:

Asexual:

Stolons are aerial hypha that grows horizontally over the surface of substratum.

They are comparatively stouter, slightly arched and less branched aerial hyphae.

The sporangiophore swells at the tip into the knob like vesicle and the cytoplasm along with many nuclei flows into the swollen vesicle which represnents the young sporangium.

The sporangial wall and the columella breaks and the dry spores are liberated in the air.

The spore germinates by producing a germ tube that develops into fluffy,well branched white aerial mycelium.

Sexual:

They reproduce sexually by the process of conjugation which results in the formation of zygospores.

In this heterothallic species the two fusing mycelia beog to two different mating types., + strain and – strain and they fuse to form a zygospore.

The zygospore wall is made up of two layers, of which the outer dark thick and warty layer is calle exine and the inner thin layer is called intine.

After a period of rest, meiosis takes place at the time of zygospore germination.

On germination a lateral crack is formed on its wall. The inner thin intine comes out in the form of a hypha like germ tube, which is also called promycelium. The spores germinate to form fresh mycelium.

Ometimes the gametangia fail to fuse. They develops into a thick walled zygospore called azygospore or parthenospore

Lec 8

Classification of ascomycotina- important characters:

Ascomycotina (sac fungi)

It is the largest phylum of the kingdom of fungi. 64,000 known species in 3,500 genera.

The species incite variety of diseases in crop plants.

Eg. Scab, ergot, anthracnose, powdery mildew, sooty mould, etc.

The members of the phylum ate literally known as sac fungi because the sexual spores(asco spores) are produced in a sac like structure commonly known as ascus.

The ascoma may of different types:

1. **Naked asci:**

The ascus with ascospores may be developed nakedly or inside the special fruiting body called ascoma

2. **Cleistothecium:**
   It is usually globular and completely closed without ostiole.
   It may be dark brown to black, smooth and often provided with hyphal outgrowth called appendages
   Ascospores are discharged violently by decay or irregular splitting of ascus and peridum wall
3. **Perithecium:**
   It is flask shaped ascoma, narrow neck, globular ostiole
   The ostiolar canal lined with slender,sterile, short and delicate hair like periphyses.
   The club or cylindrical asci intermingled with araphyses are arranged in a regular manner.
4. **Apothecium:**
   It is an open ascocarp
   Disk or cup shaped
   Asci arranged in palisade layer
   An apothecium consists of three parts viz., hymenium, hypothecium and excpulum
5. **Ascostroma:**
   It is wall-less ascoma. Each ascostroma has single locule.

Lec 9

Aspergillus (Eurotium)

- Name Of Disease ; Collar Rot Of Ground Nut
- Kingdom : Fungi
- Phylum : Ascomycota
- Sub-phylum : Pezizoomycotina
- Class : Eurotiomycetes
- Order : Eurotiales
- Family : Trichomaceae
- Genus : *Eurotuim*
- *Species : niger*

Symptoms

- Pathogen attack emerging young seedlings
- Cause rotting of cotyledons, hyphocotyls, collar region and stems
- Affected portions become soft resulting in the collapse of the seedlings
- Affected collar regions show profuse black mouldy growth

Fungal characters

- Hyphae : hyaline ,septate and branched
- Conidiophore : long , erect arise from thick walled foot cell
- It forms terminal swollen vesicle on which arising of bottle shaped structure called sterigmata or phiallide
- From this production of chain of conidia at the tips
- Conidia : chain ,circular, multinucleate and thick rough wall

Pencillium (Talaromyces)

- Name Of Disease ; soft rot disease (green mould)

- Kingdom : Fungi
- Phylum : Ascomycota
- Sub-phylum : Pezizoomycotina
- Class : Eurotiomycetes
- Order : Eurotiales
- Family : Trichomaceae
- Genus : *Talaromyces*
- *Species : digitatum*

Symptoms

- Pathogen attack fruits , it is a storage rotting fungus
- Diseased fruits show soft rot symptoms with velvety green mouldy growth
- Later rotting of fruit takesplace

Fungal characters

- Hyphae : hyaline ,septate and branched
- Conidiophore : long ,septate arise from any cells of hyphae not from foot cell as in aspergillus
- Conidiophore branched once or twice called primary stergimata and secondary serigmata
- Coniadial apparatus which resembles a brush or broom is called " **pencillus**"
- Conidia : chain ,globose or ovoid,look like galss beads under microscope

Aspergillus	*Penicillium*
The conidiophore is aseptate and unbranched	Conidiophore is long slender septate and branched
Conidiophore arises from a specialized T shaped thick walled foot cell	Conidiophore arises from any vegetative cell of the mycelium .There are no foot cell.
Conidiophore enlarges into a vesicle at its tip which bears the finger like sterigmata .The structure forms a spherical head	The conidiophore ends in a whorl of branches which gives a broom like appearance
The peridium is quite soft.	The peridium of cleistothecium is thicker and generally consist of loosely interwoven hyphae
Ascogonium : A small loosely coiled septate hyphal branch (latter becomes tight and close) the archicarp arises from the vegetative hypha	A long erect, multinucleate (32-64) aseptate tubular structures . At times the upper end of the ascogonium may be curved like the handle of the umbrella

Taphrina

Eg. Taphrina deformans- peach leaf curl

T. maculans – leaf blotch of turmeric

- Name Of Disease ; PEACH LEAF CURL
- Kingdom : Fungi
- Phylum : Ascomycota
- Sub-phylum : Taphrinomycotina
- Class : Taphrinomycetes
- Order : Taphrinales
- Family : Taphrinaceae
- Genus : *Taphrina*
- *Species : deformans*

Symptoms

- The leaves become thickened, puckered, curled, silvery and brittle
- Leaf tissue changes yellow

- Finally turns to reddish purple tinge covered with whitish gloom of fungus on under surface of leaves
- Affected leaves and petioles may curl and droop prematurely

Fungal characters

- asexual reproducton by round or ovoid blastospore by budding
- Sexual spore are ascospore produced in naked asci
- Ascus is unitunicate (single layered)
- Ascocarps are not produced. Asci are naked. Sex organs are not formed..

POWDERY MILDEW FUNGI

SYSTEMATIC POSITION

- Domain : Eukarya
- Kingdom : Fungi
- Phylum : Ascomycota
- Sub-Phylum : Pezizomycotina
- Class : Leotiomycetes
- Order : Erysiphales
- Family : Erysiphaceae

Erysiphaceae

Genus :

- ✓ *Erysiphae sp,*
- ✓ *Leveillula taurica*
- ✓ *Uncinula necator*
- ✓ *Podosphaera leucotricha* - Apple
- ✓ *Sphaerotheca pannosa* - Rose
- ✓ *Phyllactinia corylea* - Mulberry
- ✓ *Microsphaerea sp.*

Causal organism	Host
Erysiphe polygoni	Pulses
Erysiphe cichoracearum	Cucurbits, Bhendi, Sunflower
Erysiphe graminis	Wheat
Uncinula necator	Grapes
Oidium mangiferae	Mango
Oidium tingitanimum	Citrus
Leveillula taurica	Red gram, chilli, castor
Phyllactinia corylea	Mulberry

General characters

- Obligate parasite of flowering plants
- Mycelium hyaline, septate, branched and made of monokaryotic cells
- Obtain food through haustoria
- Asexual reproduction : Conidiogenesis
- Sexual reproduction : Gametangial contact

  antheridium & ascagonium
- Sexual fruiting body : Chasmothecium

Asci : globose to ovoid, bitunicate evanescent arranged on a basal layer

Classification based on mycelium and conidiogenesis

Description	Oidium	Oidiopsis	Ovulariopsis
Mycelium	Hyaline, septate, ectophytic	Hyaline, septate, endophytic.	Hyaline, septate, ecto and endophytic
Conidiophore	Short club shaped, non septate	Long branched septate	Long , single or branched
Conidia	Cylindrical or barrel shaped in chains	Single celled, club shaped/ clavate shaped	Diamond shaped

Oidium – *Erysiphe*

- Haustoria: Present in epidermis
- Ectophytotic mycelium
- White powdery patch on upper surface
- Wheat, barley, cucurbits, black gram, green gram

Oidiopsis – *Leveillula*

- Haustoria : Present in epidermis and spongy cells.
- Endophytotic mycelium
- Orange powdery growth on lower surface, correspondingf upper surface yellow discolouration.
- Red gram, Chilli, Castor.

Ovulariopsis – *Phyllactinia*

- Ecto and Endophytotic mycelium
- Epidermal haustoria absent
- White powdery patches on both lower and upper surface.
- Mulberry

Symptoms

- Infected plants display white powdery spots on the leaves and stems.
- The lower leaves are the most affected, but the mildew can appear on any above-ground part of the plant.
- As the disease progresses, the spots get larger and denser as large numbers of asexual spores are formed, and the mildew may spread up and down the length of the plant.
- grows well in environments with high humidity and moderate temperatures

Lec 10

HELMINTHOSPORIUM – Brown spot of rice

(Cochliobolus miyabeanus)

Anamorph: (Bipolaris oryzae)

Symptom:

Sesame shaped, dark brown to black spots appear on leaves.

Several spots coalesce and the leaves dry up.

Pathogen:

Mycelium is greyish – brown to dark brown, septate, inter and intracellular

The conidiophores are dark brown to olivaceous, short.

Conidia are pale olive green to golden brown, cylindrical, 6-14 septate boat shaped with curved tapering ends.

ALTERNARIA – Early blight of potato leaf blight in tomato

(*Alternaria solani)*

Symptoms:

Leaf spot with concentric rings are the typical symptom initially smaller in size and enlarge in to entire lamina petiole and fruits/tubers.

Pathogen:

The conidia develops at the tips of the conidiophores which are short, dark coloured. Conidia is flask/ muriform shaped with longitudinal and horizontal septations, dark coloured.

CERCOSORA – Leaf spot of ground nut

(Cercospora sp.)

Symptoms:

The leaf spots are circular to irregular, gre center with bright yellow halo.

Pathogen:

Conidiophores are brown, short, 1-2 septate, unbranched

The conidia are cylindrical or obclavate curved with 1-9 septa.

FUSARIUM – wilt of pegion pea

Fusarium Udum – Redgram wilt

Fusarium moniliforme - Rice root rot

Symptoms:

Gradual yellowing, withering, droopimg, drying the entire plant / some time its branches(partial drying)

If cut open the infected plant vascular discolouration is the distinguished symptom for wilt disease.

Blocks the vessels by producing tyloses and ultimately the plants wilt.

Pathogen:

Mycelium hyaline, inter and intracellular. The pathogen produce macro, micro conidia and chlamydospores.

Macro conidia – sickle shaped, 4-5 septate

Micro conidia – hyaline bicelled/ single celled.

At the time of stress, the fungus produc chlamydospores which are oval shaped and may be terminal/ intercalary.

LEC 11

COLLETOTRICHUM:

They cause anthracnose disease in several crops and hence they are called as anthracnose fungi

Gleosporium is another anthracnose fungus. It differs from colletotrichum only in lacking septae

Mango anthracnose- *Glomerella cingulata, Colletotrichum, Gleosporiodes*

Symptoms:

Depressed spots seen on leaves with short hole

Twigs exhibit dieback symptom

Fungus has a long, saprophytic phase on dead plant parts. It produce hyaline septate and branched mycelium.

pathogen

Mycelium produce stroma which bears acervuli

Conidiophores are hyaline, short, simple, aseptate. Conidia are hyaline, single celled, cylindrical shaped with two oil globulus.

PESTALOSIA – Grey blight

Symptoms:

P. mangiferae causes grey blight on mango leaves.

In coconut *P. palmarum* causes grey blight

Pathogen:

The conidia are spindle shaped with five cells. The center three cells are dark and upper, the lower cells are hyaline.

MACROPHOMINA – *M.phaseolina* – pycnidial stage

Rhizactonia bataticola (Sclerotial stage)

Symptoms:

Sudden death of plants

Affected plants show complete rotting , easy pullout, bark shredding is a typical symptom, black sclerotia is seen on the inner walls of the shredded bark.

Pathogen:

Mycelium is greyish white, inter or intracellular, septate, thick mycelium with right angle branching near the septum.

During a sexual reproduction dark brown, globose, pycnidia with an ostiole.

Pycnidiophores are hyaline, short, rod shaped. Pycnidiopores are hyaline thin single celled.

At the end of the growing season, the fungus produces spherical, black and smooth sclerotia. Sclerotia survive in the soil for a longer period.

Lec 12

Basidiomycotina important characters

Characters:

It is the second largest phylum of the kingdom including 31535 sp. both parasite and saprophytes. The lower basidiomycetes cause rust and smut diseases and destroy several million rupees worth of the crops every year.

The higher basidiomycetes are as wood rotters. Some members are ectomychorriae association with roots of forest trees.

The most familiar mushrooms, bracket fungi, birds nest and jelly fungi are belong to the higher basidiomycetes.

The saprophytic basidiomycetes play a vital role in decomposing the organic matters.

Like ascospores, the basidiospores are the sexual spores formed after karyogamy and meiosis.

The mode of formation of ascospore and basidiospore are same.

Mycologist considered them as homologous group and sister groups but the other distinct features of this phylum include the extensive dikaryophase, clamp connections.

For smut, rust and bunt fungi asexual reproduction by conidia or oidio.

The rust fungi exhibit polymorphism by forming several types of spores in life cycle. Uredospores act as asexual spore.

Sexual:

Organs absent in majority of the members. Opposite mating type are brought together mostly by somatgamy of the species.

Fruiting body:

Most fungi in the phylum basidiomycotina except smuts and rust produces highly attractive and beautiful fruiting body or variable size, colour, shape and texture.

The wellknown basidiomycotina are agaricus, pleurotus, volvariella.

Lec 13

PUCCINIA:

Kingdom : Fungi

Phylum : Basidiomycota

Class : Pucciniomycetes

Order : Pucciniales

Family : Pucciniaceae

Genus : Puccinia

Species : graminis

Symptom:

Reddish brown rust pustules(uredia) are noticed mainly on stem than leaf sheath and leaves.

At maturity brown and black lesions can be seen(telia).

Life cycle:

Wheat crop at maturity – teliospores appear mostly on stem. Urediiospore are also produced in same sori.

Teliospores are binucleate, 2 celled. The teliospores are not capable of produce immediately require long period for rest.

The basiodiospores can infect only the alternate host which barberry(Barberis vulgaris) developed spermagonium – aeciospores are borne from converted yellow cup shaped structure . the aeciospore produce the binucleate mycelium and masses of uredinial cells from which binucleate urediospores arise.

The urediospores are one celled, oval brown structure, thick wall having numerous spiny projections called echinulations.

Later uredio germinate and produce teliospore (bicelled).

Bean rust *(Uromyces appendiculates):*

Symptoms:

Brown pustules (uredio) – teliospores are formed later.

Coffee rust *(Hemileia vastatrix)*

Ustilago:

Smut:

The word smut means a soft charcoal like substances or a sooty powder.

The order comes under ustilaginales are called smuts because they form a black powder(small spore) on the affected parts of the host plants.

Types of infection in smut:

1. Seedling infection:
   Smut spores are ususally smooth walled. Externally seed borne and germinates when the seed has sown. The infection of the seedling takes place before it emerges out of the soil.
2. Floral or blossom infection:
   Spores are rough walled and wind borne to fresh flowers where they germinate to cause infection of the ovary. The infection is internally seed borne and when the seed germinates, the fungus also grows up and finally appears as black powdery mass in the inflorescence.
3. Shoot infection:
   The spores fall on the surface of host and germinate causing infection of buds and may fall on ground.

According to the effect on the host, the smuts may be 2 types:

1. Ovariculous:
   The contents of the ovary are destroyed and replaced by smut spore mass.
2. Culmiculous:
   The full development of the inflorescence is suppressed.

Loose smut:

Spore wall will be eaten away and the smut spores are easily exposed to be disseminated by wind.

Covered smut:

Ovary wall remains intact thus keeping the apores together unless the wall is mechanically broken.

e.g.: Loose smut of wheat – *Ustilago tritici*

Common smut of maize – *Ustilago aydis*

Grain smut of sorghum – *Sporisorium sorghi*

Loose smut of wheat: *(Ustilago tritici)*

Systematic position:

Kingdom: Fungi

Phylum : Basidiomycota

Class : Ustilagomycetes

Order : Ustilaginales

Family : Ustilaginaceae

Genus : Ustilago

Species : tritici

Symptoms:

This disease is found on wheat crops in the plains.

Loose smut manifests when the ear emerge from the boot leaf. Usually spikelets are affected and transformed into black powdery spores.

Life cycle:

The dormant mycelium established in the embryo of the seed.

They active at the time of the germination of the infected seed and grows along the apex of coleoptile.

The fungus systemic and the mycelium travels throughout in the stem.

On the emrgence of the ears, mycelium reaches the floral parts and becomes activated.

Thousands of smut spores are produced in smut sori on the floral axis.

Lec 14

COCONUT

BASAL STEM ROT / THANJAVUR WILT

CAUSAL ORGANISM *: Ganoderma lucidum*

SYMPTOM

1.The outer leaves wither and droop but remain hanging for a long time around the stem.

2.The tree becomes unproductive. The new leaves emerged will be smaller in size.

3. These smaller leaves wither leading to death of the plant. On the stem reddish brown discolouration develops by exudation of a brown viscous gummy substance.

4.The sporophores of G. lucidum appears as brackets at the base of the trunk.

RICE

Sheath blight

Causal organism: *Thanatephorus sp*

Symptoms:

1.The infection starts as elliptic or oval greenish grey spots on leaf sheaths near the water level.

.The spots enlarge to 2-3 cm length and spread to upper leaf sheath and leaf blades.

3.The lesions are large, oblong or irregularly elongated with grayish white center and brown margin.

In advanced stages, inside the culms and on leaf sheaths large number of brown spherical sclerotia are formed.

TEA

TEA BLISTER BLIGHT

CAUSAL ORGANISM *Exobasidium vexans*

SYMPTOM

1.Initially small circular yellow colored translucent spots (shiny) can be seen on the upper surface of the leaf..

2. These spots enlarge in size with the shallow depression in the centre, it slowly projects downward as an outgrowth or blisters.

3. Finally, defoliation takes place.

PATHOGEN

Pathogen produces both sexual and asexual spores respectively basidia and conidia.

Early infections are caused by conidial stage. In the later stage, drying of leaf produces basidia.

Life cycle:

It is an obligate parasite.

The basidiospore germinates on the young leaves and form germ tube.

After infection results the formation of galls.

Blisters appear after 3 days of infection.

Basidia are hyaline, club shaped thin walled with 2 short sterigmata at the end arise from the hymenial layer.

Each basidium bears 4-8 hyaline and oval to oblong basidiospores.

Lec 15

Important characters of thanatephorus:

It produces metabasidium little wider than the pedicels, ellipsoid with one side flattened rarely obpyriform to obovate spores and multinucleate hyphal cells.

Sclerotial or sterile mycelial state present.

Symptoms:

Large irregular lesion with straw coloured Centre and reddish brown margin appear on the outermost leaf sheath near water level and on the leaves.

Matured plants and seedlings may become blighted.

Small mustard like sclerotia is present on the diseased portion.

Important characters of exobasidium:

Exobasidium has about 50 species, which are parasitic on leaf, short stem and flowers of plants belonging to *Eriaceae* and causing hypertrophy and deformation.

The dikaryotic myceliums devoid of clamp connections grow intercellularly with haustoria.

By the formation of basidia between the epidermal cells in more or less continuous layer on the surface, hence named as exobasidium.

Parasitic species are *E.vexans* (blister blight of tea), *E. japonica* (gall in azalea)

Symptoms:

Small pale or pinkish round spots appear on the young leaves, which enlarge and protrude out into blister lie swellings on the lower surface.

The raised lower portion of the blisters bears a white layer of basidia.

Infected leaves curl, get deformed and fall off.

Disease also occurs on buds, petioles and tender stems.

Lec 16

Plant Bacteria

- **Bacteria are prokaryotic, unicellular, microscopic, achlorophyllous microorganisms reproduced chiefly by binarry fission**
- **Cells may be Coccus, Bacillus, Spirillum**
- **Most of the phytopathogenic bacteria are gram negative**
- **Most of the plant pathogenic bacteria are rod shaped**
- **Facultative saprophytes**

Structure of a bacterial cell

Flagellum: Hair like appendage

Pili/Fimriae : Short, fine, filamentous

appendages

Capsule: Capsule is a outer slimy /

gummy / viscous layer of the cell

Cell wall: It is a thin, rigid and it allows inward passage of nutrients and outward passage of wastes and digestive enzymes

Cytoplasmic membrane : It is of three layers

Cytoplasm : It comprises of cytoplasmic inclusions – Ribosomes, storage bodies, chromatophores

Nucleus : It is nucleoid as they neither have a distinguished closed nuclear wall nor a mitotic appratus

Pseudomonas

Straight, curved or spiral rigid rods.. Belongs to the family Pseudomonaceae. Flagella is either monotrichous or lophotrichous and non-motile. Pigments are greenish and flourescent and are water soluble. Gramnegative. eg. *Pseudomonas*

Xanthomonas

Flagella is usually monotrichous, pigments are yellow coloured. Water insoluble. Gram-negative.Spherical or straight rods. It has three families, *viz.,* Enterobacteriaceae, Rhizobiaceae and Cornybacteriaceae .

Erwinia -Straight rod, causing anaerobic fermentation of glucose, motile by peritrichous flagella or non motile. **Gram negative*.***

Agrobacterium- Rod shaped, sparsely flagellated or non-motile, grow anaerobically on media containing glucose. ***Gram negative***.

Cornybacterium- Rod or club shaped. It will not actively ferment sucrose anaerobically. **Gram positive.**

Streptomyces

Filamentous bacteria. Belongs to the family Streptomycetaceae. Vegetative mycelium doesn't fragment into bacillary or coccoid form. Gram positive.

Burkholderia Rod shaped,aerobic, **Gram negative**

Ralstonia Rod shaped,aerobic, **Gram negative**

Atrichous	**No flagella**	***Xylella***
Monotrichous	**Single flagellum at one end**	***Xanthomonas***
Cephalotrichous	**Group of flagella at one pole**	***Pseudomonas fluorescens***
Amphitrichous	**One flagellum at each pole**	***Pseudomonas spp.***
Peritrichous	**All portion of its surface**	***Erwinia***

Lophotrichous	**Two/more flagella at one/ both poles**	***Pseudomonas***

1. **Bacterial leaf spot of sesame** : *X. campestris pv. sesami*

Symptoms

The disease appears as water soaked yellow specks in the upper surface of leaf. They enlarge and become angular as restricted by veins and veinlets.

2. **Bacterial leaf spot of pomegranate** : *X.campestris pv. punicae*

Symptoms

Characterised by the appearance of small minute dark coloured irregular spots on the leaves. Several spots may coalesce and cover larger area surrounded by chlorotic halo

Bacterial Blight - *Xanthomonas oryzae pv. oryzae*

Symptoms

Water-soaked to yellowish stripes on leaf blades or starting at leaf tips

then later increase in length and width with a wavy margin

Appearance of bacterial ooze that looks like a milky or opaque dew drop on young lesions early in the morning

Lesions turn yellow to white as the disease advances

Green water-soaked layer along the cut portion or leaf tip of leaves as early symptom

Diagnosis tests

Dipping the cut end of the affected leaves into clean water Bacterial blight or Black arm of cotton: *X. campestris pv. malvacearum*

Symptoms

a. Seedling blight

Circular water soaked lesions are seen on the cotyledons. It spreads to stem and leads to the death of the seedlings.

b. Angular leaf spot-Small water soaked lesions develop on the lower surface of leaves, which later turn angular due to the restriction by veins and vein lets.

c. Vein blight- The infection of veins cause blackening and vein lets gives a typical blighting appearance. On lower surface the bacterial ooze form crust or scales

d. Black arm- On the stem and fruiting branches dark brown - black lesions are formed, which may girdle the stem and branches to cause pre-mature drooping-off of the leaves, cracking of stem and gummosis. The dry black twig hang typically as to give a characteristic black arm symptoms.

e. Boll rot- Water soaked sunken lesions appear on bolls resulting in boll shedding. Lint's stained yellow.

shows the secretion of bacterial ooze

Leaf streak -Xanthomonas oryzae pv. oryzicola

Initially, small, dark-green and water-soaked streaks on interveins from tillering to booting stage

Crown gall of rose

Agrobacterium tumefaciens

Crown gall first appears as small, round, whitish, soft outer growths, on the stem and roots, particularly near the soil line. In addition to forming galls, affected plants may become stunted; they produce small, chlorotic leaves and are more susceptible to adverse environmental conditions, especially winter injury.

Crown gall of apple - *Agrobacterium tumefaciens*

The galls produced are initially soft ,

spherical white latter become hard ,corky and they vary in size.

The affected plants are stunted with chlorotic leaves

Moko Wilt – *Burkholderia solonacearum*

Symptoms

Rapid wilting & collapse of the leaves

Discolouration in vascular region

Blackening of the suckers

Discolouration in fruits

Leaves turn yellow or whitish yellow

Petiole breaks at junction with pseudostem

Rod shaped gram –ve with unipolar flagellum

Scab

Common Scab of Potato

They are like superficial blemishes on tubers and roots and they reduce the yield and deep scabes increase the waste in peeling.

Citrus Canker

Xanthomonas axonopodis pv.citri

Symptoms

Quite similar lesions are produced on leaves, twigs of citrus fruits. The lesions at first appear as small, slightly raised, round, light green spots. Later they become greyish white, rupture, and appear corky with brown, sunken centres. Severe infections of leaves, twigs and branches debilitate the tree while severely infected fruit appear scabbled and deformed

Soft rot

Soft rot of vegetables

Erwinia sp

Pseudomonas sp

The affected area becomes soft and mushy while its surface becomes discoloured and depressed. The entire content have changed to a turbid liquid and produce a foul odor

Bacterial soft rot of *carrot-Erwinia carotovora pv .carotovora*

Symptoms

The parenchymatous tissues of the roots decay very rapidly. The middle lamella is destroyed and the cell collapse into slimy mass of putrified tissues due the pectolytic enzymes produced by the bacteria. This may be accompanied by foul odour.

Brown ring rot of potato- *Pseudomonas solanacearum*

Symptoms

Yellowing, stunting and wilting of plants. Leaflets become flaccid. If the stem is split open and examined, browning of vascular bundles are seen. This browning is often visible from the surface of infected cell as dark streaks. Dark brown discolouration is seen at eyebuds of affected tubers. When the infected tubers are cut open and examined, a brown ring is seen due to vascular discolouration. So the disease is called as Ring disease or Bangle disease.

Bacterial wilt of tomato/ brinjal- *Pseudomonas solanacearum*

Symptoms

Yellowing of foliage, wilting and stunting of plants followed by bacterial ooze, vascular browning and finally death of the plant.