MODULE -1

PLANT PATHOLOGY

- Plant pathology also known as Phytopathology, is the study of plant disease.

Word meaning

- Word is originated from Greek word, *Pathos* and *Logos*, pathos means suffering and logos means study.
- So phytopathology means " The study of the suffering plants".

- **FATHER OF PLANT PATHOLOGY**: **Heinrich Anton De Bary** (German Botanist).
    - He is the founder of modern mycology and plant pathology.
- **FATHER OF INDIAN PLANT PATHOLOGY**: **Edwin John Butler** (Irish Researcher).
    - Founder of mycology and plant pathology in India.

Definition

Plant pathology is that branch of agriculture, botanical or biology science which deals with the study of;

- Cause of the disease
- Resulting losses
- Control of plant diseases

ENTRI

Objectives of plant pathology

- ✓ Study of origin, causes or reason, study of living and non living organisms, other causes of disease or disorder in plants. (**Ethiology-** study of causal organism).
- ✓ Study of mechanism of disease development (**Pathogenesis**).
- ✓ Study the spread of the pathogens within the crop fields (**Epidemiology**).
- ✓ To provide suitable methods for controlling the diseases in order to minimize the loss in the yield of the crop (**Control of diseases**).
- ✓ **Main objective**: better crop production through economic disease management.

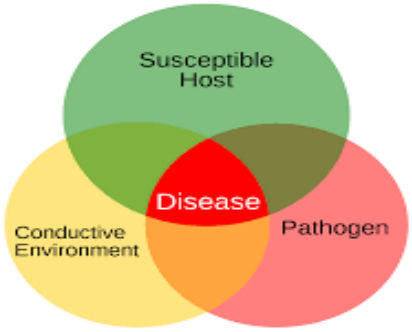
WHAT IS DISEASE?

- ✶ Disease is a harmful deviation from normal functioning of physiological process.
- ✶ It adversely affects on plant growth, health, reproduction and economic value.
- ✶ It results from continuous irritation of plants.

DISEASE TRIANGLE

Conditions for diseases

- **Host should be susceptible.**
- **Pathogen should be virulent**.
- **Environment should be favourable**.



HOST FACTORS

- All plants can be considered as hosts.
- Age- affects disease development depending on plant-pathogen interaction.
- There are different levels of susceptibility, which include

  Immune- cannot be infected.
  Susceptible- can be infected.
  Resistant- may or may not be infected.

PATHOGEN FACTOR

- Amount of inoculum
- Pathogen genetics
- Virulence of the pathogen
- Type of reproduction
- Ecology and mode of spread (air, soil, seed)

ENIVIRONMENTAL FACTORS

- ✶ Moisture
- ✶ Temperature
- ✶ Effects of human culture practices (monoculture, introduction of new pathogens, seed quality)

CLASSIFICATION OF DISEASES

1. Based on the **parts affected**
2. Based upon **the nature of their occurrences**
3. Based on **the mode of transmission**
4. Based on **causal agents**

SI. NO.	Classification of diseases based on;	Different types
1	PARTS AFFECTED	✶ Localized diseases: diseases found in a particular part of the plant. ✶ Systemic diseases: diseases found on the entire plant part of the plant.
2	THE NATURE OF THEIR OCCURRENCES	✶ Epidemic diseases: diseases which occurs in large area like as a country (e.g., leaf spot of rice, blast disease of paddy) ✶ Endemic diseases: diseases that are restricted to particular area (e.g., black wort disease of potato). ✶ Sporadic diseases: diseases that occurs occasionally at very irregular intervals in isolated localities (e.g, angular leaf spot of cotton, blotch disease of cucumber). ✶ Pandemic diseases: the disease which occurs all over the world (e.g., late blight of potato).
3	MODE OF TRANSMISSION	✶ Soil- borne diseases: the diseases caused and spread by soil pathogens. ✶ Air-borne diseases: pathogens spread diseases through wind. ✶ Seed borne diseases: the diseases caused by some pathogens which survive in a dormant or active state inside seeds and other parts that propagates.
4	CAUSAL AGENTS	✶ Non infectious (non-parasitic or physiological) diseases: these diseases are not caused by the pathogens, diseases is caused by disturbances in the plant body due to lack of inherent qualities improper environmental conditions of soil and air (e.g., tip rot or necrosis of mango). ✶ Infectious diseases: diseases caused by pathogenic organisms under a set of

		environmental conditions. Association of a definite pathogen is essential for the disease(e.g., for disease causing pathogens are virus, bacteria, nematodes, fungi etc.).

BIOTIC AND ABIOTIC FACTORS AND VARIOUS SYMPTOMS OF PLANT DISEASES

Plant diseases are the sum total of abnormal changes in the physiological processes brought about by any biotic or abiotic factors.

- ✶ Abiotic factors include all environmental factors
- ✶ Biotic factors include all microbes and parasitic plants.

A. ABIOTIC FACTORS

Refered to as non living factors and it includes

- Nutritional abnormalities
- Pesticide exposure
- Environmental pollutants
- Extreme weather conditions
- Lightning injury
- pH

a. Nutritional abnormalities

They are of two types:

- Nutrient deficiency
- Mineral toxicity

- ➢ In most of cases plant nutritional abnormalities is seen by discoloration of foliage.
- ➢ Common discoloration symptoms include: yellowing & chlorosis.

ENTRI

- Plant requires both macronutrients and micronutrients for their growth
- Deficiency or lack of any of these essential nutrients results in disease symptoms in the plants.

S.I NO	**NUTRIENTS**	**DEFICIENCY SYMPTOMS**:
1	Boron	Discoloration of leaf buds, breaking and dropping of buds.
2	Sulphur	Leaves light green, veins pale green, no spots.
3	Manganese	Leaves are pale in color, veins and venules are dark green and reticulate.
4	Zinc	Leaves pale, narrow and short veins, dark spots on leaves and edges.
5	Magnesium	Paleness for leaf edges, edges have cup shaped folds.
6	Phosphorus	Dark green and short leaves, bronze color under the leaf.
7	Calcium	Plant dark green, tender leaves pale, drying starts from the tips.
8	Iron	Leaves pale, no spots, major veins green.
9	Copper	Pale pink between veins, wilt and drop.
10	Molybdenum	Leaves light green/lemon yellow/orange, spots on whole leaf except veins, sticky secretions from under the leaf.
11	Potassium	Small spots on the tips, edges of pale leaves, spots turns rusty and folds at tips.
12	Nitrogen	Stunted growth, extremely pale color, upright leaves with light green/ yellow color.

Mineral toxicity :

- Presence of excessive available amount of certain minerals in the soil can lead to mineral toxicity to the plants.
- The extent of injury depends on the mineral, its concentrations and the species of the plant.

b. Pesticide exposure

- Some pesticides if improperly used, can cause serious damage to plants.
- The most common chemical injury to plants is due to soil residues or spraying herbicides.
  - E.g., 2,4-D damage to beans and tomatoes.
  - Glyphosate (round up) damage to fruit trees.

- The common symptoms of herbicide exposure are curling and cupping.

c. Environmental pollutants

- High levels of pollutant gases or poisonous gases can cause disease on plants (E.g., fluoride gas).
- Chemicals such as O3, SO2, NO2 released by factories power plants and automobiles exhausts can accumulate in the atmosphere and can cause damage to plants.
- Ozone damage appears in the form of chlorosis, spots and bleaching of young leaves.

d. Extreme weather conditions

Extreme weather can lead to plant injury

- **Cold injury:** low temperature (frost and freeze) can damage the exposed or sensitive organs or may kill the entire plant.
- **Heat injury:** exposure to high temperature may cause symptoms of scorching and scalding.
- **High / low soil moisture:** excessive watering, poor drainage or flooding may cause plants to turn yellow and be stunted.

At the other extreme, low moisture or drought conditions can lead to poor development, wilting and death of plants.

- **High/ low light intensity:** high light intensity is usually not a problem but low light intensity condition especially for indoor plants can lead to Etiolation (tissue are yellowish).

B. BIOTIC FACTORS

Diseases caused by living factors.

SI.NO.	Example for biotic factors	Features
1.	Fungi	• Largest pathogen group. • More than 8000 pathogenic species. • Vegetative growth through production of hyphae. • Reproduce via spores.
2.	Bacteria	• About 200 pathogenic species. • Seen with a light microscope. • Simple and unicellular. • Reproduce by binay fission.
3.	Viruses	• Can only seen with the help of electron microscope. • Simple body structure nucleic acid with a protein coat. • Reproduce by taking over host reproductive machinery. • Often associated with insect vector.

4.	Nematodes	• Parasitic worm. • Very complex compared to other pathogens. • Seen only with a light microscope. • Reproduce by eggs.
5.	Phytoplasmas	• A prokaryotic organism that lack a cell wall and survive in the phloem of plants. • Round or elongate. • Only seen with electron microscope. • Reproduce by binary fission.

SIGNS AND SYMPTOMS

- A sign of plant disease is physical evidence of the pathogen.
  e.g., fungal fruiting bodies are sign of disease.
- A symptom of plant disease is a visible effect of disease on the plant.
- Symptoms may include a detectable change in color, shape or function of the plant as it responds to the pathogen.

SI. NO.	DISEASE	DISEASE SIGN	DISEASE SYMPTOMS
1.	**Fungal**	• Leaf rust • Stem rust • Sclerotina • Mildews	• Anthracnose • Leaf spot • Chlorosis • Damping off of seedlings
2.	**Bacterial**	• Bacterial ooze • Water soaked lesions	• Leaf spots and fruit spots • Canker • Crown gall

3.	**viral**	None the viruses themselves can't be seen	• Mosaic leaf pattern • Crinkled leaves • Yellowed leaves • Plant stunding

COMMON DISEASE SYMPTOM

1. MILDEWS

- In this type of symptom, growth of pathogen remains restricted on the surface of the host tissue.
- Mildews may be Downy Mildews and Powdery Mildews. In downy mildews the pathogen produces a cottony mycelial growth affecting host epidermis.
- In Powdery Mildews they produce a powdery appearance of the host surface.

2. RUST

Rusty appearance are relatively small pustules of spores.

1. Autoecious rust: complete its life cycle in same host. eg; Linseed rust

2. Heteroecious rust: the rust which requires alternate hosts or completes their life cycle more than one host. E.g.,wheat rust

Colour of rusts may be Orange, red, brown, yellow, white or black.

3. WHITE BLISTERS

● White Rusts:- White blister like pustules appearing on infected host tissue break open exposing powdery masses of spores.

White rusts resemble rusts by pustule formation and powdery masses of spores, but differ in White colour of pustules

4. SMUT

Sooty or charcoal like powder. Plants shows a black or purplish black dusty mass composed of the fungus spores particularly in ovulary part of the floral organs.

● When the spore masses is covered by a reasonably tough covering it is known as Covered Smut.

● When covered by a brittle covering-Loose Smut.

● When the spore masses have fishy smell-Stinking Smut.

5. ROOT- ROT

- Illustrated by decay of root crops and destruction of woody roots of forest trees.
- In the root-rot the tap root and secondary roots may rot owing to fungal attack resulting in the sudden death of affected plant.

6. BLIGHT

● A condition developed due to the rapid killing of foliage, biomass etc. by pathogens.

● Burnt like appearance on plant parts.

● The killed tissue is often transformed into a slimy mass which emits pungent odour.

7. BLAST

It is the sudden death of young buds, inflorescence, or young fruits due to water shortage.

8. WILTING

● A flaccid or drooping condition of leaves, shoots or other parts is usually due to a diseased Vascular system.

● The wilting may be temporary, the plants recovering at night, it may be permanent and progress to death of the parts involved.

● Vascular pathogens particularly *Verticillium* and *Fusarium* also known as Wilt fungi often cause discolouration of xylem due to accumulation of Melanins or related materials which are forerunners of cell death and necrosis.

9. CANKER

- It is a sunken necrotic lesion developed in the cortical tissues of stems, fruits or leaves.
- Or it can be dead area in the bark or cortex of stem of woody plants.

Eg:- Pink disease of Rubber, Citrus canker-*Xanthomonas*

10. YELLOWING

- The yellowing of parts containing Chlorophyll.
- It may be Confined to Spots, Rings, or Streaks in Leaves, Stems, or Fruits or it may be Generalized.

11. SCORCH OR BURN

● A term is used to describe the rapid death and browning of large indefinite areas of leaves or fruits.

● Drought, Sunburn, Spray injury, Freezing, are the Common causes of Scorch.

12. DIE-BACK

● It is a symptom resulting from the dying of twigs or branches from the tip towards the base.

13. SPOTS

● Common symptom in many diseases in which more or less Circular diseased areas develop. Spotting is very common on leaves.

● Often the affected tissue dies, turns brown and dries out. Frequently the name of the affected organ is coupled with the term Spot as Leaf-Spot, Fruit-spot, Stem-spot, or the colour of the lesion is made the Qualifying Word as in Brown-Spot, Black-Spot and so on.

14. SCAB

● Here the pathogen produces a Roughened or Crust-like lesion.

15. ROTS

- It is a condition in which dead tissues are in a more or less advanced stage of disintegration under influence of Various Enzymes which decompose Cellulose, lignin and other associated substances of the plant tissue.
- Basically two type of Rots are Recognized:
  Dry rots & Soft rots
  - ➢ In Dry rots no Exudation of Sap takes place from infected plant parts,
  - ➢ But in Soft rots, there is Sap exudation from affected Parts. Rots may also be grouped according to the Special structures or Organs Involved:- Root-rots, Stem-rots, bud-rots, Fruit-rots

16. ANTHRACNOSE

● Elongate, more or less angular spots appear on the veins on the lower side of the leaf.

● Spreading into Surrounding tissue and eventually appearing on the opposite sides.

● Petioles, Stem, and often fruits may be affected.

17. GUMMOSIS

•The oozing of gum from Wounds or other openings in the bark of diseased tree is common in Citrus and Stone-Fruit trees.

18. NECROSIS

- Death or killing of the host tissues induced by the attack of a pathogen is called necrosis.
- It may be caused by rots, blights, wilts, die-back and cankers.
- The causal organism may be a fungus or a bacterium

19. CHLOROSIS

- Here a lighter green colour than normal is produced due to Partial failure of Chlorophyll to develop.
- Yellowing of leaves occurs.

20. VEIN CLEARING

- Common symptom of Virus Infection.
- The green Colour fails to develop along the Veins.
- They may appear translucent.

21. ETIOLATION

- A syndrome involving lack of chlorophyll development and abnormally elongated stem growth usually results from growth in the dark, though certain pathogens or Malnutrition may also produce it.

22. DAMPING-OFF

- The rapid rotting of the stems of Seedlings the ground level So that top fall Over.

23. PUCKERING

- A symptom exhibited by leaves where the veins do not grow commensurately with the interveinal areas.

- So that the leaf appears as it might if the veins were threads that had been through the petiole.
- This effect may be produced by a failure of the veins to grow properly as in certain virus diseases.
- It may result from an outgrowth of interveinal tissue as in the peach leaf curl.

24. PHYLLODY

- It is the abnormal development of floral parts in to leafy structures.
- it is generally caused by *phytoplasma* or *virus infections*.

25. SCLEROTIA

A compact, often hard, mass of dormant fungus mycelium.

26. HYPERPLASIA

It is the abnormal increase in size of organ due to an increase in number of cells of organ(due to cell division).

27. HYPERTROPHY

Increased size of organs due to increased size of cells.

HISTORY OF PLANT PATHOLOGY

IMPORTANT PHASES:

- ANCIENT PERIOD
- DARK PERIOD
- PRE-MODERN PERIOD
- MODERN PERIOD

ANCIENT PERIOD	
THEOPHRASTUS	• Greek philosopher. • First to study and write about the diseases of trees,cereals and legumes. • Recorded his some observations on plant diseases in his book "ENQUIRY INTO PLANTS". • Observations are not based on experimentations.
DARK PERIOD	No increase in the knowledge of plant pathology so it is known as dark period
PRE-MODERN PERIOD	

ANTON VAN LEEUWENHOEK	• Dutch • developed the microscope. • He described bacteria with this microscope. • "Father of Microbiology"
PIER ANTONIO MICHELI	• Italian botanist. • Father of Mycology. • The first person who observed fungal spores and conducted many spore germination studies. • He published a book "NOVA PLANTARUM GENERA", includes descriptions of fungal species (1729).
TILLET	• French Botanist. • In 1755 Published paper on **BUNT OR STINKING SMUT OF WHEAT.** • Great grandfather of phytopathology. • Through his experiments he proved that wheat seeds that contained black powder on their surface produces more diseased plants than normal ones. • Reported the chemical treatments of seeds.
MODERN PERIOD	
BENEDICT PREVOST	• French. • He proved that diseases are caused by microorganisms. • Discovered the life cycle of wheat bunt fungus(Tilletia caries). • He showed that the solution containing copper sulfate prevents the germination of bunt spores. • He mentioned the fungicidal and fungistatic properties of chemical treatments.

ROBERT KOCH	• Established the Germ Theory. • Diseases are caused by the presence and action of specific microorganisms. • Established the principles of pure culture technique. • Described the theory called "KOCH'S POSTULATES" **KOCH'S POSTULATES** 1. The microorganism must be identified in all individuals affected by the disease, but not in healthy individuals. 2. The microorganism can be isolated from the diseased individual and grown in pure culture. 3. When introduced into a healthy individual, the cultured microorganism should cause disease. 4. The microorganism must then be re-isolated from the experimental host, and found to be identical to the original microorganism.
E.M FRIESs	• Published Systema Mycologicum for naming fungi. • Linnaeus of Mycology.
J.G KUHN **.He**	• published first textbook in plant pathology- **THE DISEASES OF CULTIVATED CROPS, THEIR CAUSES AND THEIR CONTROL**
IRISH FAMINE	• In 1845, the potato crop in Ireland was completely wiped out by late blight disease. • This caused great famine in 1846. • This resulted in the death of hundreds of thousands of people.

PIERRE-MARIE-ALEXIS MILLARDET(P.A MILLARDED	• Discovered **Bordeaux mixture** for the control of downy mildew of grapevine.
MARTINUS BEJERINCK	• **Founder and father of virology.** • he was the first to use the term "Virus" Proved that the virus inciting tobacco mosaic is not a microorganism. • He believed it to be contagium vivum Fluiddum (infectious living fluid)
ANTON De BARY	• Germany • He was the founder and father of modern mycology. • He was the founder of modern plant pathology. • In 1863,he studied the epidemics of late blight. • And renamed the causal organism as Phytophthora infestans. • He discovered heteroecious nature of rust fungi. • He wrote a book named "Morphology and Physiology of Fungi, Lichens and Myxomycetes".
EDWIN JOHN BUTLER (E.J BUTLER)	• First empirical Mycologist in India. • Father of Modern Plant Pathology • Father of Indian Mycology. • He worked at IARI. • Published a book named as Fungi and diseases in plants. • He recorded the downy mildew on maize for the first time in India.

T.S SADASIVAN	• Started the studies on biochemistry of host-parasite relationship. • Contributed to the concept of Vivotoxins.
R.S SINGH	• Wrote a famous book- Plant Diseases

- FATHER OF PHYTOBACTERIOLOGY- **E.F SMITH**
- FATHER OF SEED PATHOLOGY- **PAUL NEERGAARD**
- FATHER OF FOREST PATHOLOGY- **ROBERT HARTIG**
- FATHER OF NEMATOLOGY-**NATHAN AUGUSTUS**

IMPORTANT EVENTS IN PLANT PATHOLOGY:

- 1845-1846- LATE BLIGHT OF POTATO/IRISH FAMINE
- 1869-COFFEE RUST IN SRI LANKA
- 1918-1919- BROWN LEAF SPOT OF RICE IN DELTA OF KRISHNA & GODAVARI RIVERS
- 1938-1939- RED ROT OF SUGARCANE
- 1943- BENGAL FAMINE/BROWN LEAF SPOT OF RICE
- 1992- COTTON LEAF CURL

INDIAN INFORMATIONS ON PLANT DISEASES:

In India, the informations on plant diseases is available in ancient literatures such as:

1. RIGVEDA
2. ATHARVA VEDA
3. ARTHASHASTRA OF KAUTILYA
4. SUSHRUTA SAMHITA
5. AGNI PURAN
6. VISHNUDHARMOTTARA

VRIKSHA AYURVEDA - SURAPALA

- First book in which a lot of informations on plant diseases is available.
- In this plant diseases were categorized into two;
    A. Internal(probably physiological diseases)
    B. External(probablyinfectious diseases)-caused by the attack of microorganisms.
- Symptoms of plant diseases such as Rust,Downy mildew,and Blight are often mentioned in the Bible.

THE PROCESS OF INFECTION IN PLANTS

PARASITISM AND PATHOGENICITY

Parasite : An organism that lives on or in some other organism and obtains its food from the latter is called a Parasite.

Parasitism: The removal of food by a parasite from its host is called Parasitism.

TYPES OF PARASITES

1. **Biotroph**: An organism that can live and multiply only on another living organism.

   Eg; mildews,rust,smut fungi,virus,bacteria etc.

2. **Semi biotroph**: The non obligate parasites that lives most of the time or most of their lifecycle as parasites but, under certain conditions,may grow saprophytically.

3. **Necrotrophs**: A parasite is a necrotroph when it kills the host tissues and then lives saprophytically.

PATHOGENICITY AND PATHOGENESIS

- **Pathogenicity**: Ability of the parasite or pathogen to interfere with one or more of the essential functions of the host plant,causing 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 syndrome.

HOST RANGE OF PATHOGEN

● Pathogens differ with respect to the kinds of plants that they can attack, with respect to the organs and tissues that they can infect, and with respect to the age of the organ or tissue of the plant on which they grow.

● Some pathogens are restricted to a single species, others to one genus of plants.

● Some pathogens grow especially on roots, others on stem or leaves.

DEVELOPMENT OF DISEASE IN PLANTS

Disease triangle

Conditions for disease

➢ Susceptible host

➢ Virulent pathogen

➢ Favourable environment

DISEASE TETRAHEDRON

STAGES OF DISEASE DEVELOPMENT/THE DISEASE CYCLE

- The development of an infectious plant disease is a series of more or less distinct events occurs in succession and leads to the development and perpetuation of the disease and the pathogen.
- This chain of events is called a **disease cycle**.

EVENTS IN DISEASE CYCLE

1. **Inoculation**
2. **Penetration**
3. **Infection**
4. **Invasion or colonisation**
5. **Growth and reproduction**
6. **Dissemination**
7. **Survival of the pathogen**

1. INOCULATION

❖ Inoculum: The infective pathogen propagules coming in contact with the host constitutes the inoculum.

❖ Inoculation is the initial contact of the pathogen with the site of the plant where infection is possible.

❖ In fungi, the inoculum may include the spores, sclerotia (compact mass of mycelium)or fragments of mycelium.

❖ In bacteria, virus, phytoplasma, protozoa etc. the inoculum is always whole individual of respective organisms.

TYPES OF INOCULUM

1. Primary inoculums: An inoculum that survives dormant in the winter or summer and causes the original infections in the spring or autumn is called a primary inoculum, and the infections it causes are called Primary infections.(sclerotia, mycelium)

2. Secondary inoculum : An inoculum produced from primary infections is called a secondary inoculum and it, in turn, causes Secondary infections.(conidia, zoospores, uredospores).

2. PENETRATION THE PROCESS BY WHICH THE PATHOGEN ENTERS IN TO ITS HOST

The penetration process is divided into

1. Pre- penetration process
2. Penetration
3. Post -penetration process

a. PRE-PENETRATION

● Almost all fungi,bacteria, and parasitic higher plants, must be first attached to the host surfaces.
● This attachment takes place through their adhesive materials which are composed of water insoluble polysaccharides.
● Pathogens such as phytoplasmas, viruses are placed directly in to the cells of the plants by their vectors.
● Presence of moisture on host surface helps in attachment.

Fungal pre penetration;
In fungi pre penetration occurs by spore germination, conidia and zoospores germinate immediately, whereas resting spores of fungi germinate soon after dormancy. (Eg; Asexual spores: sclerotia, chlamydospores Sexual spores: teliospores, oospores etc.)

Infection structures;
● germ tube
● appressorium
● infection hyphae
● haustoria
● rhizomorphs

Pre penetration in bacteria;
Multiplication in the presence of moisture or host exudates.
Eg; agrobacterium, erwinia, pseudomonas, xanthomonas

Pre penetration process in nematodes;
It occurs by the hatching of eggs.

Pre penetration process in parasitic plants;
Seed germination and formation of haustoria.

b. PENETRATION PROCESS

- Fungi may penetrate in either indirect or direct penetration.
- Bacteria, mostly enter through wounds and sometimes by natural openings.
- Viruses, viroids, phytoplasmas etc. by mechanical means (wounds)and by vectors.

Direct and indirect penetration direct penetration;
Penetration occurs through Appressorium, Germ tube, Haustoria (eg; powdery mildew), Infection cushion.

Indirect penetration;
Penetration through wounds and natural openings like Stomata, Hydathode, Lenticels, Nectrothodes.

Penetration through wounds examples:

- Hail, Frost, Insect feeding, Cultivation, Heat scorching, Traffic damages.
- Pathogen first multiply on wounds in the presence of moisture and then penetrate host cell by
  - *Directly*
  - *Haustoria*

- *Enzymes or Toxins*

3. INFECTION

- It is the process by which pathogen establish contact with susceptible cell or tissue of the host and procure nutrients from them.
- Successful infection results in the appearance of symptoms, on the host plants, some infection remain latent.
- Symptoms may be appears soon 2-4 days after inoculation or as late 2-3 year after inoculation.

Infection process is affected by various factors;

➔ Resistance & Susceptibility of the host

➔ Aggressiveness Virulence of the pathogen

➔ Environmental factors

➔ Host nutrition & pH

➔ Incubation period (depends upon host-pathogen combination, stage of host and environment etc.)

4. INVASION OR COLONIZATION

- Invasion is the spread of the pathogen in the host. Most fungi spread in to all the tissues of the plant organs.
- The infect either by growing directly through cell as intracellular mycelium or by growing between the cell as an intercellular mycelium.

Different pathogens invade their host as;

- Ectoparasites: mycelium lies superficially on the surface of the infected part with haustoria entering the epidermal cells. Eg; Powdery mildew
- Endoparasites: some fungi are present inside the host, but they produce external mycelium. Eg; Wilts

- Subcuticular pathogens Eg: Scab(apple)
- Sub epidermal pathogens: Eg: Wheat rust
- Endo-Ecto parasites : Canker (potato).

5. GROWTH AND REPRODUCTION

➢ Different pathogens grow intercellularly & intracellularly inside their host.

➢ Growth and reproduction rate depends upon invasion behaviour of the pathogen.

➢ Methods of reproduction

1. Asexual
2. Sexual
3. Replication in case of majority of sub-microscopic pathogens.

6. *DISSEMINATION OF THE PATHOGEN*

- ➢ Dispersal means spread of pathogen propagules from one plant to the another or one area to another for short as well as long distance.
- ➢ Two types of dissemination are present and they are,
  - Passive/Indirect -with the help of Water,Wind,Insects,Human beings,Animals
  - Active/Direct -move on own power Fungi -spores expelled forcibly

Agents of dissemination

wind - anemochory
Water- hydrochory
Animal- zoochory
Human- anthropochor

7. SURVIVAL OF THE PATHOGEN

- ✓ Plant pathogens can survive in the absence host.
- ✓ They have evolved several mechanism to survive in too cold and dry summer.

Pathogens survives on ;

- In infected crop debris
- In seed
- In soil
- In propagating material
- Infected material on host plants
- On growing plants
- As dormant structures (eg: sclerotia)

Subsidiary hosts

➔ Alternate host *Puccinia graminis tritici* which causes stem rust of wheat attack and survives on barberry, the only other species it affects other than wheat. It is essential for completing its life cycle, so barberry is known as alternate host.

➔ Collateral host (Alternaria solani-affects solanaceae family) It is the host helps in the survival of the parasite,as well as these hosts are belongs to the same family.

PLANT DEFENCE MECHANISMS (STRUCTURAL AND BIOCHEMICAL DEFENCE SYSTEMS)

PLANT DEFENCE MECHANISM

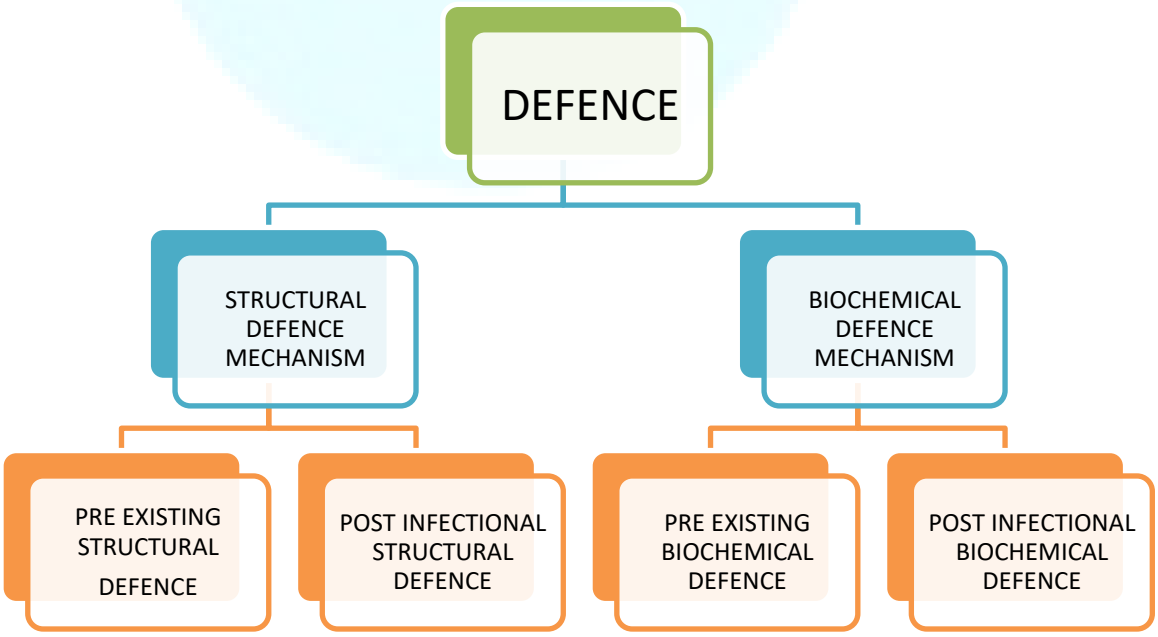
● Each plant may be affected by hundreds and thousands of different kinds of pathogens.

● All the host plants have developed some inbuilt mechanism by which they are enable to survive from the pathogen invasion.

● The resistance developed by the host against a pathogen is its capacity to develop measures to escape from injuries effects of the pathogen, and this can be called as the Defence Mechanism shown by the host plants.

● The defence mechanism developed in plants can be grouped into two categories, and they are

1. Structural defence
2. Biochemical defence



1. STRUCTURAL DEFENCE

- In plants some structures are already present to defend the attack.
- while in others, the structures to defend the host develops after the infection.
- And these kind defences are of two types,
    a. **Pre-existing structural defense**
    b. **Post infectional structural defence or Induced defence**

a. Pre-Existing Structural Defense

1. Wax and Cuticle

● Cutin and wax are non cellular substances that forms the outermost covering of epidermal cells.

● The wax on the leaf surface cannot retain the water, therefore the germination of fungal spores and multiplication of bacteria will be checked.

2. Cuticle Thickness

● The thickness of cuticle act as a defence structure in host plants.

● The cuticle thickness obstructs the path of pathogen.

● A thick cuticle checks the exit of the pathogen from inside the host, thus reducing the secondary infection.

3. Epidermis

● The thickness or toughness of epidermal cells make direct penetration by fungal pathogen difficult or impossible.

● The lignification and silicification of the epidermis are also responsible in these kind of defence mechanisms.

4. Structure of natural openings

- Stomata
- Lenticels

The plants have structural specificity for these kind of openings, in plants these variations in the structures and cells will results the defence from pathogens.

b. Post infectional structural defence/Induced defence

- Pathogen penetration to the host surface induces the structural defence mechanism in the host cells
- These may be regarded as:
  - Histological defence barriers (cork layer, abscission layers and tyloses formation)
  - Cellular defence structures

Cork layer formation

- The entry of several pathogens is checked by the formation of several layers of cork in the host plant beyond the point of infection.
- This happens as a result of stimulation of host cells by substances secreted by the pathogens.
- The cork cells checks the flow of nutrients and water from the healthy cells from infected area

Abscission layers

- Abscission layers are generally formed on young leaves following infection by the pathogens.
- After infection, a few layer of cells around the infected spots swell and become thin walled, because of the dissolution of pectic materials of the middle lamella.
- Then the central part of the leaf becomes completely cut off from the rest of the leaf.
- Thus the plant discards the infected area of leaf and protects the rest of the leaf tissue from invasion of pathogens.

Tyloses formation

- Several plants produces tyloses within the vessels,during the invasion of pathogen.
- The tyloses clog the vessel and thus ascent of sap is checked and wilting may be caused.

Gum deposition

● Plants produce a variety of gummy substances around lesions or spots as a result of infection.

● These gummy substances inhibit the progress of the pathogen.

CELLULAR DEFENCE STRUCTURES

1. Hyphal sheathing

2. Necrosis or hypersensitive defence

● The host nucleus first moves towards the pathogen and then protoplasm of the host comes in contact with the pathogen.

● The nucleus soon disintegrates into brown granules which first accumulate around the pathogen, later dispersing throughout the host cytoplasm.

● Then the cell membrane swells and finally the cell bursts and dies.

● As a result, the pathogen fails to grow beyond the necrotic or dead cells and the further growth of the pathogen is stopped.

2. BIOCHEMICAL DEFENCE

● The physiological or biochemical defence are formed as a result of the reactions of the protoplasm of the host cells.

● These biochemical defence are grouped into two depending upon the time of their production.

1. Pre existing biochemical defence

2. Post infectional biochemical defence

Pre-existing biochemical defence

1. Release of inhibitors

● The host plant exudate certain metabolic products outside either through leaves or through the roots.

● These are amino acids, Sugars,enzymes, alkaloids, nucleotides,growth factors and toxins.

● In these exudates micro organisms grows and they are called microflora and fauna or rhizosphere and phyllosphere.

● The exudates also contain certain *unfavourable phytotoxins* which directly interfere with the growth of the pathogens.

● The microflora and fauna are antagonistic to pathogen and produce certain antibiotics which resist or kill the pathogen.

2. Presence of inhibitors in the cell

● In several resistant varieties pre-formed toxic substances are produced by the host to resist the pathogen.

● *Chlorogenic acid* is a very important toxin found in a variety of plants which resist their pathogens.

● The action of chlorogenic acid lies in its stimulation to produce cork cambium immediately after the infection.

3. Absence of nutrients and stimulants

● Several pathogens are host specific

● Such host produces certain essential food and stimulants

● Those plants which do not produce such foods are resistant and the pathogen cannot infect them.

Post infectional or induced biochemical defence

1. Formation of toxin after infection

● Chemicals like phenolic compounds, proteins, enzymes etc. are produced from the host after the infection.

● These compounds shows fungicidal, fungistatic or bacterial properties and these toxic substances act against the pathogen.

a. Phenolic compounds

- These compounds are the most important compounds that are formed in hosts due to pathogenic infection.
- The most important phenolic compounds are chlorogenic acid, caffeic acid, ferulic acid and oxidation products of hydroxythreonine, hydroquinone.
- Phenolics flow continuously from adjacent tissue to the infection site to retard the development of disease.

b. Phytoalexins

- They are the common chemical substances produced in the host plant interaction.
- They are phenolic compounds which are produced in antiparasitic response.
- In literal sense '*alexin*' means to ward-off.

- Phytoalexin synthesis parallels the mechanism of defence through antibodies in animal system.
- Their production is induced by any physical or chemical injury and fungi, bacteria etc.
- Phytoalexin synthesis can be found in families like Leguminosae, Solanaceae, Malvaceae, Apiaceae, Asteraceae etc.
- Phytoalexins are produced by healthy cells adjacent to damaged or necrotic cells.
- They are produced in response to materials diffusing from damaged cells.
- Phytoalexin production is stimulated in host by the presence of certain pathogenic substance called *Elicitors.*
- Examples of elicitors are glucan and glycoprotein in fungi
- The common phytoalexins found in plants are *Orchinol, Phaseolin, Pisatin, Isocoumarin, Medicarpin*
- Muller and Borger used this term for the first time.

c. Synthesis of enzymes and proteins

● The infection of a host by a pathogen induces the host to produce certain enzymes for resistance.

● The phenol oxidising enzymes of potato make the plant resistant to late blight disease.

Substance of the host that resist the enzymes of pathogen

● After the penetration the pathogen dissolves the middle lamella of the integral cells.

● This is done by the enzymes called pectinolytic enzymes.

● Several plants produce certain substance which may reduce or stop the enzymatic cleavage of pectic compounds. The presence of polyvalent cations reduces the enzymatic activity and thus the splitting of pectin is prevented.

Growth hormones

- **IAA** is found to increase resistance in plants.
- **Kinetin** is also helpful in maintaining disease resistance in plants.

Host cell resistance

● Accumulation of defence related substance near the cell wall forming insoluble structures.

Eg; Callose, Glycoprotein rich in Hydroxyproline, Lignin, Suberin and Silicon and Calcium like minerals.

CLASSIFICATION OF TOXINS

According to the source of origin, toxins are divided into 3 broad classes namely

1. **Pathotoxins**
2. **Phytotoxins**
3. **Vivotoxins**

1. Pathotoxin

● These are the toxins which play a major role in disease production and produce all or most of the symptoms characteristic of the disease in susceptible plants.

● Most of these toxins are produced by pathogens during pathogenesis.

Eg; Victorin

2. Phytotoxin

- These are the substances produced in the host plant due to host-pathogen interactions for which a causal role in disease is merely suspected rather than established.

Eg; Alternaric acid, Piricularin

3. Vivotoxins

- These are the substances produced in the infected host by the pathogen and or its host which functions in the production of the disease, but is not itself the initial inciting agent of the disease.

Eg; Fusaric acid

DISEASE MANAGEMENT-CHEMICAL,BIOLOGICAL, AND QUARANTINE MEASURES

Methods of control of plant diseases

Methods of plant disease control have been categorized into two:

1. PROPHYLAXIS OR PREVENTION
2. IMMUNIZATION OR CURATIVE

- Prophylaxis is the protection of the host from exposure to the pathogen,from infection or from environmental or any other such factors favourable to disease development.
- Immunisation refers to improvement of resistance of the host to infection and to disease development.

Fundamental Principles of Disease Management

1. AVOIDANCE
2. EXCLUSION
3. ERADICATION
4. PROTECTION
5. IMMUNIZATION
6. THERAPY

1. AVOIDANCE

- It involves tactics that prevent contact between the host and

the pathogen.

- The selection of geographic area,selection of a proper field,planting time and disease escaping varieties play an important role in avoiding the disease.

2. EXCLUSION

- It means preventing the entrance and establishment of pathogens in uninfected crops in a particular area.
- It can be achieved using certified seeds or plants,growing crops in regions unfavourable for the pathogen, and quarantine measures are some means of preventing the spread of pathogens.

a) Seed treatment

- Seeds ,tubers,grafts,bulbs,and other propagating materials can be given heat,gas or chemical treatment to keep them free from pathogens.

b) Inspection and Certification

- The seeds are inspected periodically and necessary precautions are taken to remove the diseased plants,the crop is then certified as disease free.
- This practice helps to prevent the inter and intra regional spread of seed-borne diseases.

c) QUARANTINE REGULATION

- It can be defined as a legal restriction on the movement of agricultural commodities for the purpose of exclusion,prevention, or delay in the spread of plant pests and disease in uninfected areas.
- Quarantine measures are of three types:

  1.Domestic

  2.Internal

  3.Total embargoes.
- The quarantine laws were first enacted in the USA in 1912 and are known as FEDERAL QUARANTINE ACTS.

➢ In India ,the Destructive Insect and Pest Act was passed in 1914.

➢ Seed Act(1996),New Policy on Seed Development(1998), National

Seed Policy(2002),Insecticides Act(1968),Biodiversity Act(2002),Protection and Plant Varieties and Farmers Right(PPVFR-2001).

- In India,there are 16 quarantine stations operating under the Directorate of Plant Protection and Quarantine-8 at scaports,6 at airports,and two on land frontiers.

The research material is examined by these agencies:

- The National Bureau of Plant Genetic Resources,New Delhi (agricultural and horticultural crops).
- The Forest Research Institute,Dehradun(forest plants)
- Botanical Survey of India,Kolkata (economically important plants)
- NBPGR(tropical plants and post-entry quarantine checking of imported plant materials)
    - Golden Nematode (*Heterodera rostochiensis*), Wart (*Synchytrium endobioticum*).

3. ERADICATION

It involves elimination of a pathogen once it has become established on a plant or in a field.it can be accomplished by:

- Removal of diseased plants or parts
- Sanitation
- Rotation of susceptible with non-susceptible crops to starve out the pathogen
- Disinfection usually by chemicals,sometimes by heat treatment
- Soil treatments
- Biological control

a).Sanitation

- Many plant pathogens over-winter or over-summer on the remnants of previous year's crop in the soil, wild perennial hosts or weeds and seeds.
- They serve as a source of primary inoculum.
- The inoculum is transmitted to the hosts by various agencies such as wind, water, insects, manure of livestock and agricultural implements.

b). Roguing

- Removal and Destruction of Diseased Plant Organs, eradication of alternate and collateral hosts and sanitation of Fields. Eg; Katte disease of cardamom,Panama disease of Banana

c).Crop rotation

- Crop rotation is essential for controlling soil borne diseases and pathogens.

d).Soil treatment

- It involves the use of chemicals,heat energy,flooding and fumigation with chemicals.

e).Heat or chemical treatment of diseased plants

- Thermotherapy

CHEMICAL CONTROL

Types of chemical fungicides:

A) PROTECTANTS
B) ERADICANTS
C) THERAPEUTANTS

Fungicides

1. Inorganic copper compounds
2. Organic sulfur compounds and sulfur sprays
3. Inorganic mercury compounds
4. Quinone and phenolic fungicides
5. Benzene compounds
6. Antibiotics
7. Soil fumigants
8. Oils

Inorganic copper compounds

1. **BORDEAUX MIXTURE**

- 1882-Prof. Millardet
- Bordeaux university France
- Published in 1885 and
- used in 1887
- Used in grapes

- Bordeaux mixture can be prepared using differing proportions of the components.
- In preparing it, the $CuSO_4$ and the lime are dissolved separately in water and then mixed.
- Calcium oxide (burnt lime) and calcium hydroxide (slaked lime) give the same end result, since an excess of water is used in the preparation.
- Bordeaux mixture—a combination of copper sulfate, lime, and water—is an effective fungicide.
- These natural minerals, when mixed in the correct order, provide long-lasting protection to plants against diseases.
- 1% Bordeaux mixture = 1:1:100
- "1" representing 1 kg $CuSO_4$ (pentahydrated), the second representing 1 kg hydrated lime, and the 100 representing 100 litres (100 kg) water.

2. **BORDEAUX PASTE**

- It contains same components of bordeaux mixture but it is in the form of paste.

3. **BURGUNDY MIXTURE**

- (Soda Bordeaux Mixture)
- Mason – 1887
- Burgundy in France

- Sodium Carbonate (Na2CO3) used in place of lime

4. CHESTNUT COMPOUND

- Bewley – 1921
- Copper sulphate (CuSO4. 5 H2O) = 2 parts
- Ammonium carbonate (NH4)2CO3) = 11 parts
- Used for Damping off.

5. CHAUBATTIA PASTE

- Singh -1943
- The paste is prepared by mixing copper carbonate (800g)and red lead(800g) in one litre of lanolin or raw linseed oil.
- Used against pink disease, stem canker.

6. SULPHUR DUST

- S - dust should be very fine
- Particle size- 200-300 mesh or 47-74 µ
- Natural 'S' from ores is grounded & used
- Used against powdery mildews

ORGANIC SULPHUR COMPOUNDS

1. ZIRAM

- Zinc Diethyl dithiocarbamate
- T. N. – Corozate, Cuman, Zirberk, Zerlate
- Used as spray- 0.15-0.25%

2. FERBAM

- Ferric dimethyl dithiocarbamate
- T. N. – Fermate,Karbarn, Ferberk, Coromet
- Dose - 0.1 - 0.3% as foliar spray
- Used to correct Iron deficiency

3. THIRAM

- Tetramethyl thiuram disulphide
- Other trade names Arasan, Hexatier, TMTD, Thylate, Thiride

- Used for seed treatment of wheat,rice,gram,peas etc.
- Used as an activator in the production of synthetic rubber

4. **ZINEB**

- Zinc ethylene bisdithiocarbamate
- T. N. – Indofil Z- 78, Lonacol, Parzate C, Dupont
- Used as foliar spray for blast and blight of rice

5. **MANEB**

- Mengnese ethylene bisdithiocarbamate
- Not available in India
- In India- Dithane M-45 (Maneb 78% + Zinc 2%)

6. **NABAM**

- Disodium ethylene bisdithiocarbamate
- Dithane-14
- T. N. – Vapam, Chemvape

7. **Phenols**

- Chiefly applied to textiles and woods as preservative fungicides.
- Important phenolic compounds-derivatives of cersol and O-phenyl phenol.

Heterocyclic nitrogen compounds

a. Captan -Kittleson's killer
b. Used against rusts,mildews etc.
c. Captafol or difolatan-similar to captan used against late blight
d. Flopet
e. Glyodin

Benzene compounds

1. Chloroneb
2. Pentachloronitrobenzene (PCNB)
3. DDexon
4. Dinocap -Karathane

Soil Fumigants

1. Formalin
   - Formaldehyde drench
   - Control of damping off and blight
   - 37-40% solution in water is used.
2. **Carbon Disulphide**
   - Checks the growth of nematodes
   - Other important soil fumigants are Chloropicrin,Vapam,Methyl bromide,Dazomet

ANTIBIOTICS

- Streptomycin
- Cycloheximide
- Aureofungin
- Blasticidins
- Griseofulvin
- Tetracycline
- Nystatin
- Bulbiformin
- Agrimycin -100

BIOLOGICAL CONTROL METHODS

- The term biological control implies the control of a disease through some biological agency,and the term biological agency means a living microorganism or macroorganism other than the diseased or damaged plant acting as host and the pathogen or pest causing the disease or damage.
- Biological control of plant disease may be defined as any condition or practice whereby survival or activity of a pathogen is reduced through the agency of any other living organism with the result that there is a reduction in the incidence of the disease caused by the pathogen-GARRETT
- According to Agrios around thirty microorganisms have been registered and they were used in biological control.
- *Gliocladium virens* sold as GlioGard for control of seedling disease.
- *Trichoderma harzianum* sold as F-stop for the control of soil borne disease.

- *Trichoderma harzianum/Trichoderma polysporum* sold as BINAB-T for the control of wood decays.
- *Agrobacterium tumefaciens,P.fluorescens* sold as Dagger G for use against *Pythium* and *Rhizoctonia* species.
- *Bacillus subtilis* sold as Kodiak and utilized as seed treatment.

Mechanisms of Pseudomonas species in disease suppression

- Production of siderophores which remove iron from the soil environment and make it unavailable to pathogens.
- Antibiosis- various antibiotics have been reported to be produced by them.
- Induction of resistance
- Competitive root colonization

Mycorrhizal fungi as biocontrol agents

- They have received considerable attention in recent years. Several mechanisms have been postulated.These are:
  - Creating mechanical barrier for the pathogen to penetrate.
  - Inducing thickening of cell walls through lignification and production of other polysaccharides.
  - Stimulation of host root to accumulate metabolites
  - Stimulating flavanolic wall infusions.
  - Stimulating microbial activity in the root zone
  - Producing antibacterial and antifungal antibiotics
  - Increasing concentrations of dihydroxy phenols in roots

Soil Amendments

- The organic amendments increase the activity of saprophytic organisms,which results in the abundant liberation of CO2 as a result of the respiratory activity of the microbes.
- The pathogens sensitive to CO2 are inhibited.
- Due to the rapid multiplication of microbes in the soil, the available nitrogen in the soil is rapidly utilized by the fast growing saprophytes,this results in acute nitrogen scarcity which adversely affects the growth of the pathogens.

Hyperparasitism

- Certain fungi and bacteria are parasitic on plant pathogens.
- Many fungi are known to parasitize phytopathogenic nematodes.

Entomogenous fungi

- There are several fungi which are capable of growing in the bodies of insects thus destroying them.
  Eg; Entomophthora

4.PROTECTION

- It is the use of some protective barrier between the susceptible part of the suspect or host and the pathogen.
- In most cases, a protective spray or dust applied to the plant in advance of the arrival of the fungus spores.
- Sometimes it is achieved by killing insects or other inoculating agents.
- The principle of protective fungicides is to disrupt the natural sequence of infection.
- The fungicides act on the leaf surface to kill the newly germinated spores.

Safeners

- A safener is defined as a chemical that reduces the phytotoxicity of another chemical.
  Eg: Copper sulfate is phytotoxic but with the addition of lime its toxicity is reduced.
- Glyceride oils act as good safeners for copper sprays by providing a film around each particle.

Carriers

- When the fungicide is used as a dust, the active ingredient is generally diluted with finely divided powder is called a carrier.

Spreaders

- Materials which are added to spray mixture to establish improved contact between the fungicides and the sprayed surface are known as spreaders.
  Eg;Mineral oils,Glyceride oils,Terpene oils,Sulphated alcohols,Sopamines

Stickers

- Materials added to spray or dust which improve its adherence to plant surfaces are known as stickers.
  Eg; Starch,Gum arabic and Dextriens

5.IMMUNIZATION/DISEASE RESISTANCE

- Disease resistant and tolerant varieties are the cheapest,easiest and most efficient way to reduce disease losses.
- Varieties should be selected that possess resistance or tolerance to one to one or more disease organisms.
- For some diseases,such as the soil borne vascular wilts and viruses the use of resistant varieties is the only means of ensuring control.

THERAPY

- It is used on individual plants and can not be used on a large scale.
- It is achieved by inoculating or treating the plant with something that will inactivate the pathogen.
- Chemotherapy is the use of chemicals to inactivate the pathogen,whereas heat is sometimes used to inactivate the pathogen.
- Chemotherapy is the use of chemicals to inactivate the pathogen,whereas heat is sometimes used to inactivate or inhibit virus development in infected plant tissues so that newly developing tissues will be free from pathogen.
- Thermotherapy involves the exposure of diseased plants or parts of them to hot water or high air temperature for different periods of time.
- Loose smut of wheat is controlled by treating the seeds with hot water,but growing resistant varieties is a simpler method of control.
- Hot water treatment has ben used to kill nematodes in bulbs,corms,tubers and fleshy roots while they are in a dormant conditions.

ENTRI

COMMON DISEASES OF CROPS IN KERALA- PADDY

1. RICE BLAST/ ROTTEN NECK/ RICH MAN'S DISEASE

Causal organism

Anamorph: ***Pyricularia oryzae*** or ***Pyricularia grisea***

Teleomorph: ***Magnaporthe oryzae*** or ***Magnaporthe grisea***

Symptoms

- Blast means burned appearance.
- The fungus attacks the crop at all stages of crop growth
- Symptoms appears on leaves, neck, nodes and glumes.
- Common symptom is the golden or spindle shaped lesions on leaves.
- On leaves lesions appears as bluish green spots which enlarge under moist condition to spindle shaped spot with grey Centre with dark brown margins
- Black lesions of appears on nodes.
- Affected nodes may break up and all the parts above the infected node will die
- Neck region of panicle were attacked by fungus and the lesions turn to Brownish-black which is referred to as rotten neck or panicle blast or neck rot

Control measures

- Direct foliar spray of copper fungicides and organo-mercuric fungicides. eg; Hinosan, Biotox, Bordeaux mixture etc.
- Application of antibiotics such as blastin, blasticidin etc
- Use of disease resistant varieties like IR 20,ADT 39,ASD 18 and IR64.
- Treat the seeds with Captan or Thiram or Carbendazim or Tricyclazole at 2 g/kg.
- Field sanitation and destruction of collateral hosts.

2. SHEATH BLIGHT

Causal organism: *Rhizoctonia solani*

Symptoms

- On the lower leaves sheath oval, oblong or irregular greenish grey spots appears later it becomes greyish white with brown margin.
- Under favourable conditions it spreads to the leaves also and irregular greenish grey lesions with dark brown margins develop on leaves.
- In humid conditions white mycelial growth and later brown sclerotia of the fungus is seen on the affected area.

Control measures

- Use of antibiotic like validamycin.
- Apply organic amendments like neem cake and avoid flow of irrigation water from infected fields to healthy fields.
- Deep ploughing in summer and burning of stubbles.
- Spray Carbendazim, carboxin, flusilazole etc
- Soil application of *P.fluorescens* after 30 days of transplanting.
- Foliar spray *P.fluorescens* at 0.2% at boot leaf stage and 10 days later

3. BROWN SPOT

Causal organism: *Cochliobolus miyabeanus* is also known as *Helminthosporium oryzae*

Symptoms

- On the leaves small definite spots of oval or oblong shape and dark brown colour are formed.
- On susceptible varieties spots are larger in size and are having light brown or grey center with dark reddish brown margin.
- The symptoms also appear on the glumes as black oval or oblong spots or whole surface of the grain turn black and velvety.

Control measures

- Use of antibiotic aureofungin, nystatin.
- As disease is seed borne, Use disease free seeds.
- Removal of alternate & collateral hosts.
- The use of resistant varieties is the most economical means of control.
- seed soak / seed treatment with Captan or Thiram at 2.0g /kg of seed.
- Since the fungus is seed transmitted, a hot water seed treatment (53-54°C) for 10-12 minutes may be effective before sowing.

4. SHEATH ROT

Causal organism: ***Sarocladium oryzae***

Symptoms

- The fungus infects the leaf sheath enclosing the panicle causing oblong or irregular brown spots which later develop into a lesion with dark brown margin and grey center.
- The young panicle remains inside the sheath.
- White powdery growth of fungus can seen on the rotten sheath.
- The grains becomes chaffy.

Control measures

- Certified seeds should use.
- Use wider planting distance.
- Apply potassium, calcium sulphate, zinc fertilizers at tillering stage.
- Foliar spraying with Benomyl and copper oxychloride is also effective.
- Field sanitation

4. FOOT ROT

Causal organism: ***Fusarium moniliforme***

Symptoms

- Infected plants are taller than normal plants in seedbed and field.
- Thin plants with yellowish green leaves and pale green leaves.
- Drying of leaves and leaf sheath discolouration of lower nodes and adventitious root formation are the major symptom.
- Partially filled grains, sterile, or empty grains for surviving plant at maturity.

Control measures

- Clean seeds should be used to minimize the occurrence of the disease.
- Salt water can be used to separate lightweight, infected seeds from seed lots and thereby reduce seed borne inoculum.
- Seed treatment using fungicides such as thiram, thiophanate-methyl, or benomyl is effective before planting.

5. FALSE SMUT

Causal organism: ***Ustilaginoidea virens***

Symptoms

- The symptoms arises after flowering.
- Infected grains transforms in to yellow to orange spore balls, later it turns in to dark green or black.
- Growth of velvety spores that enclose floral parts.

Control measures

- Apply captan, captafol, fentin hydroxide, and mancozeb can inhibit conidial germination.
- At tillering and pre flowering stages, spraying of carbendazim fungicide and copper base fungicide can effectively control the disease.
- Proper Destruction of straw and stubble.
- Seed treatment with carbendazim 2.0g/kg of seeds.
- Control insect pests.

6. NARROW BROWN SPOT

Causative organism: ***Cercospora oryzae***

Symptoms:

- Numerous narrow linear brown spots appears on leaves.

7. STACK BURN

Causative organism: ***Alternaria padwickii***

Symptoms:

- ✶ Presence of large oval or circular dark brown lesions with narrow distinct margins in leaves.
- ✶ On the affected grains pale brown to whitish spots with dark brown margin bearing black dot in the centre are formed.

8. LEAF SCALD

Causative organism: ***Rhynchosporium oryzae***

Symptoms:

- ✶ Lesions with typical zonation with dark coloured wavy lines at the leaf tips then spreads to the leaf blade.

9. UBBATTA

Causative organism: *Ephelis oryzae*

Symptoms:

- ✶ Whole panicle transforms into a cylindrical rod covered with white mycelia later they become hard bearing many black dots.

10. BACTERIAL LEAF BLIGHT

Causal organism : ***Xanthomonas oryzae*** or ***Xanthomonas campestris***

Rod shaped,gram negative,non capsulated and non spore forming aerobic bacterium.

Symptoms

- Seedling wilt or kresek symptom.
- 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 dewdrop on young lesions early in the morning.
- Occasionally the linear lesions may develop anywhere on the leaf lamina or along the midrib with or without marginal stripes.

Control measures

- Use of resistant varieties
- Chlorination of irrigation water.
- Dipping of the seeds for 8 hours in water solution of 0.1% ceresan wet and streptomycin.
- Spraying with agrimycin and copper oxy-chloride.
- Burning of the straw stubble of infected plants to kill the bacterium.

11. TUNGRO DISEASE

Causal organism: Rice tungro disease is caused by the combination of two viruses, which are transmitted by green leafhoppers. (***Nephotettix virescens***)

The disease complex is associated with **rice tungro bacilliform virus** (**RTBV)** and **rice tungro spherical virus (RTSV).**

Symptoms

- Plants affected by tungro exhibit stunted growth.
- Their leaves become yellow or orange-yellow,and rusty spots appears.
- Discoloration occurs from leaf tip to the entire leaf blade.
- Delayed flowering, - panicles small and not completely exerted.
- Most panicles sterile or partially filled grains.
- Tungro virus disease affects all growth stages of the rice plant specifically the

vegetative stage.

Control measures

- Light traps can used to control the growth of leafhoppers.
- Planting of resistant varieties like IR 36,IR 50,ADT 37,Ponmani Surekha,Vikram Arya,IR 36 and white ponni is the most economical means of managing the disease.
- Apply neem cake 12.5 kg/20 cent nursery.
- Destruction of weed hosts on bunds.
- Leaf yellowing can be minimized by spraying 2% urea mixed with Mancozeb at 2.5 gm/lit.
- Insecticides like Fenthion can be used to control the growth of the vectors.

COMMON DISEASES OF PADDY

BLAST - *Pyricularia oryzae or Magnaporthe grisea*

SHEATH BLIGHT - *Rhizoctonia solani*

BROWN SPOT - *Helminthosporium oryzae*

SHEATH ROT - *Sarocladium oryzae*

FOOT ROT - *Fusarium moniliforme*

FALSE SMUT - *Ustilaginoidea virens*

BACTERIAL LEAF BLIGHT - *Xanthomonas oryzae* or *X.campestris*

TUNGRO - Rice tungro virus (RTBV and RTSV)

COMMON DISEASES OF CROPS IN KERALA- COCONUT & ARECANUT

DISEASES OF COCONUT(*Cocos nucifera*)

1. **ROOT WILT** - ***Phytoplasma***
2. **STEM BLEEDING** - ***Thielaviopsis paradoxa***
3. **BUD ROT** - ***Phytophthora palmivora***
4. **LEAF ROT** - ***Colletotrichum gloeosporioides, Exserohilum rostratum & Fusarium sp.***
5. **GREY BLIGHT** - ***Pestalotia palmarum***
6. **THANJAVUR WILT** - ***Ganoderma lucidum & Ganoderma applanatum***

1. ROOT WILT/ KERALA WILT

Causative organism: - ***Phytoplasma***

Symptoms:

- Flaccidity of leaf let's
- Abnormal shedding of buttons and immature nuts present
- Reduction of leaf size.
- Abnormal bending or Ribbing of leaflets occurs.
- Yellowing of older leaves, necrosis of leaflets and decay of root system are other important symptoms.

Control measures

- Cut and remove disease advanced, uneconomical palms yielding less than 10 nuts per palm per year
- Adopt suitable inter/mixed cropping in coconut gardens.
- Provide adequate drainage facilities.
- Apply green manure and neem cake.
- Apply fertilizer such as urea, potash etc
- Magnesium van supplied to manage insect vectors

2. STEM BLEEDING

Causative organism: ***Thielaviopsis paradoxa***

Symptoms

- Dark reddish brown liquid exudes from the growth cracks present on the stem bark.
- The presence of characteristic dark brown patches at the basal portion of the trunk.
- These lesions spread to other parts of the stem.
- The tissues below the infected portion shows decaying.
- In advanced stage the tissue become black and fibrous.
- Symptoms on the crown is premature yellowing of leaves of the outer whorl, followed by drooping and drying.
- Trunk gradually tapers towards the apex.

3. BUD ROT

Causative organism: ***Phytophthora palmivora***

Symptoms

- Initial symptom of diseases is the yellowing of spindle leaves.
- Later spindle loses its green color and turns brown and get drooping.
- Tender leaves tissue and leaf sheath show water soaked lesions, later turns to brown.
- In severe stage, spindle can be drawn out of the crown with slight pull.
- Entire crown degenerate and turn to slimy mass and emitting foul smell.
- Later entire crown falls leaving only barren stem.

Control measures

- Destroy the chiseled materials by burning.
- Avoid mechanical injury to trunk.
- Apply 5kg neem cake containing the antagonistic fungi, *Trichoderma* culture.
- Provide adequate irrigation.
- Chisel out completely the affected tissues and paint the wound with tridemorph 5% or Bordeaux paste.

- Apply coal tar after 1-2 days on the treated portion.

4. LEAF ROT

Causative organism: ***Colletotrichum gloeosporioides, Exserohilum rostratum &Fusarium sp.***

Symptoms:

- The disease appears as minute water soaked lesions on the emerging spindle leaf.
- Similar symptoms are also noticed on the distal end of younger leaves later these lesions coalesce leading to extensive rotting of tissue.
- The tips of the rotten leaflets get cemented together while the base remains open.
- The rotten portions dry up turn black and are blown away by wind.
- The basal portion of leaflets may be devoid of symptoms, which gives a 'fan' shaped appearance when the leaf unfurls.

Control measures

- Remove the rotten portion.
- Pour fungicide solutions of 2ml Hexaconazole or Mancozeb 3g in 300ml water per palm to the base of spindle leaves
- Spray 1% Bordeaux mixture at crown and leaves
- Use *pseudomonas fleurascens*

5. GREY BLIGHT

Causative organism: ***Pestalotia palmarum***

Symptoms:

- The initial symptoms appears as yellowish brown spots with grey brown margins as the disease advances it becomes greyish white.
- Symptoms are noticed in leaflets of outer whorl and give a blighted appearance
- In advanced stage tip and margins of the leaflets dry and shrivel giving a burnt appearance

Control measures:

- Remove the severely affected older leaves and burn.
- Spray the trees with 1% Bordeaux mixture or propiconazole
- 0.3%.
- Regular application of *potassium chloride* helps to reduce the disease.

6.TANJORE WILT

Causative organism: ***Ganoderma lucidum & Ganoderma applanatum***

Symptoms:

- Initial symptoms of Tanjore wilt (Ganoderma wilt) start with yellowing and drooping of the outer whorl of leaves.
- Later exudation of reddish brown liquid through cracks at the base of the trunk and oozing spread upwards.
- The bark turns brittle and often gets peeled off in flakes, leaving open cracks and crevices.
- The internal tissues get discoloured, disintegrated and emitting a bad smell.
- Bracket formation at the base of the trunk during rainy season.
- Ultimately the palm dies off.

Control measures:

- Apply *Pseudomonas fleurascens* and *Trichoderma viride*.
- Apply phosphobacteria and azotobacter.
- Apply organic manure and neem cake.
- Avoid flood irrigation in order to prevent spread of pathogen

DISEASES OF ARECANUT (*Areca catechu*)

1.**MAHALI -*Phytophthora arecae***

2.BUD ROT -*Phytophthora arecae*

3.FOOT ROT -*Ganoderma lucidum*

4.YELLOW LEAF DISEASE -Phytoplasma

5.INFLORESCENCE DIEBACK -*Colletotrichum gloeosporioides*

1.MAHALI / KOLEROGA/FRUIT ROT

Causative organism: ***Phytophthora arecae***

Symptoms:

- Rotting and excessive shedding of immature nuts.
- Nuts show large vacuoles and dark brown radial strands.
- Affected nuts fall off and show the white mycelial growth of the fungus.

Control measures:

- Remove and burn the affected nuts
- Apply 1% Bordeaux mixture.
- Cover the bunches with polythene bags.

2.BUD ROT

Causative organism: ***Phytophthora arecae***

Symptoms:

- Spindle leaf colour changes from green to yellow and then brown.
- The leaves rot and the growing bud rots causing death of the palm.
- The outer leaves droop off one by one leaving a bare stem.

Control measures

- Remove and destroy the affected spindle and leaves.
- Bordeaux mixture application is recommended.

3.FOOT ROT/ANABE ROGA

Causative organism: ***Ganoderma lucidum***

Symptoms:

- The leaflets in the outer whorles becomes yellow and spreads to the whole leaf and the leaves drooping down covering the stem.
- Subsequently all the leaves droop, dry up and fall off, leaving the stem alone
- Stem becomes brittle.
- The base of the stem shows brown discoloration and oozing of dark fluid.
- Bracket shaped fructifications called 'anabe' appears at the base of the trunk.
- Roots become discoloured, brittle and dried.

Control measures:

- Destruction of infected trees.
- Maintaining optimal plant population without overcrowding.
- Providing good drainage facility and fertilizers and manures.
- Digging trenches to avoid root contact from diseased to healthy.
- Drench 1% Bordeaux mixture at frequent intervals.

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4.YELLOW LEAF DISEASE

Causative organism : phytoplasma

Symptoms

- Yellowing of tips of leaflets .
- Brown necrotic streaks appears parallel to veins in unfolded leaves.
- The yellowing extends to the lamina.

- Tips of the chlorotic leaves dry up,In advanced stage all the leaves become yellow.
- Finally the crown leaves fall off leaving of a bare trunk.

Control measures

- Maintain the garden properly to keep affected palms in a healthy Condition by adopting recommended manurial, cultural, plant protection and other practices.
- Improve the drainage system in the field.

5.INFLORESCENCE DIE BACK

Causative organism: ***Colletotrichum gloeosporioides***

Symptoms

- Disease appears on rachillae of the male flowers and then in the main rachis as brownish patches which soon spread from tip downwards covering the entire rachis causing wilting.
- The female flowers of the infected rachis shed and the whole inflorescence show 'dieback' symptom.
- The fruiting bodies of the fungus,(conidia) appear as concentric rings in the discolored areas.

Control measures

- Remove affected inflorescence immediately.
- Spray zineb and mancozeb to the female inflorescence.
- Use Aureofungin.

COMMON DISEASES CROPS IN KERALA-PEPPER,GINGER,CARDAMOMUM

DISEASES OF PEPPER

1. **FOOT ROT/QUICK WILT** - ***Phytophthora capsici***
2. **ANTHRACNOSE OF PEPPER** - ***Colletotrichum gloeosporioides***
3. **BASAL WILT** - ***Sclerotium rolfsii***
4. **LEAF ROT AND BLIGHT** - ***Rhizoctonia solani***

1. FOOT ROT/QUICK WILT CAUSATIVE ORGANISM

Causative organism: ***Phytophthora capsici***

Symptoms:

- Black spots appear on the leaves and they have a characteristic fine fibre like projections which rapidly enlarges and causes defoliation.
- The stem near the ground level get infected and the rotting and death of vine occurs within 2-3 weeks.
- The affected portion emits bad odour.
- The necrosis progress downwards to the underground stem and to the root system.
- The infection starts at main root or at feeder root, the leaves become yellow and defoliate.

Control measures:

- Phytosanitation.
- Soil drenching with 1% Bordeaux mixture after removal of the affected plant.
- Spraying with 1% Bordeaux mixture .
- Soil application of neem cake and ***Trichoderma viride*** or *P. fluorescens*

2.ANTHRACNOSE OF PEPPER / POLLU DISEASE

Causative organism: ***Colletotrichum gloeosporioides***

Symptoms:

- Symptoms appear in leaves and stem.
- Circular or irregular grey spots appear in the leaves.
- Concentric rings of acervuli appear on upper surface of the leaves.
- On the stem the infection appear at the tips spreads downwards and kill the entire vine.
- Berry becomes brown in colour and extends downwards from upper portion,and become chaffy.

Control measures:

- Soil drenching with 1% Bordeaux mixture after removal of the affected plant.
- Spraying with 1% Bordeaux mixture .

3.BASAL WILT CAUSAL ORGANISM

Causative organism: ***Sclerotium rolfsii***

Symptoms:

- Grayish lesions appear on stems and leaves.
- On the leaves white mycelium is seen and this mycelial threads later surround the stem resulting in drooping of leaves.
- Small whitish to cream coloured grain like sclerotial bodies appear on the mature lesions.

Control measures:

- Phytosanitation.
- The affected portions and the defoliated leaves are cutted and destroyed, also the remaining cuttings should be sprayed with carbendazim or 1% bordeaux mixture.

4.LEAF ROT AND BLIGHT

Causative organism: ***Rhizoctonia solani***

Symptoms:

- Greyish sunken spots and mycelial threads appear on the leaves and the infected leaves are attached to one another with the mycelial threads.
- On stems, the infection occurs as dark brown lesions which spread both upwards and downwards.

DISEASES OF GINGER

1.RHIZOME ROT/SOFT ROT- ***Pythium aphanidermatum/ P. vexans /P. myriotylum***

2.BACTERIAL WILT - ***Ralstonia solanacearum***

3.LEAF SPOT - ***Phyllosticta zingiberi***

1. RHIZOME ROT/SOFT ROT

Causal organism: ***Pythium aphanidermatum/ P. vexans / P. myriotylum***

Symptoms:

- The infection starts at the collar region of the pseudostems and progresses upwards as well as downwards then it becomes water soaked and the rotting spreads to the rhizome resulting in soft rot.
- In early stages of the disease, the middle portion of the leaves remain green while the margins become yellow.
- The yellowing spreads to all leaves of the plant and followed by drooping, withering and drying of pseudostem.

Control measures:

- Treatment of seed rhizomes with mancozeb.

- Cultural practices such as selection of well drained soils for planting is important for managing the disease.
- Seed rhizomes are to be selected from disease free gardens, since the disease is also seed borne.

2.BACTERIAL WILT

Causative organism: *Ralstonia solanacearum*

Symptoms:

- Water soaked spots appear at the collar region of the pseudostem.
- The first symptom is mild drooping and curling of leaf margins of the lower leaves which spreads upwards.
- Later, the plants exhibit severe yellowing and wilting symptoms.
- The vascular tissues of the affected pseudostems show dark streaks.
- The affected pseudostem and rhizome when pressed gently extrudes milky ooze from the vascular strands.

Control measures:

- The cultural practices adopted for managing soft rot are also to be adopted for bacterial wilt.
- The seed rhizomes may be treated with streptocycline
- Once the disease is noticed in the field all beds should be drenched with Bordeaux mixture 1% or copper oxychloride 0.2%.

3.LEAF SPOT

Causative organism: *Phyllosticta zingiberi*

Symptoms:

- The disease starts as water soaked spot and later turns as a white spot surrounded by dark brown margins.
- The lesions enlarge and adjacent lesions becomes necrotic areas.

Control measures:

- The disease can be controlled by spraying Copper oxychloride 0.25 % or Mancozeb 0.2%.

DISEASES OF CARDAMOM

1.**KATTE DISEASE(MOSAIC/MARBLE DISEASE) - CDMV**

2.AZUKAL DISEASE/CAPSULE ROT -*Phytophthora parasitica/ Phytophthora palmivora*

3.CLUMP ROT/RHIZOME ROT -*Pythium vexans, Fusarium oxysporum, Rhizoctonia solani*

4.CHENTHAL DISEASE - *Colletotrichum gloeosporioides*

1.KATTE DISEASE(MOSAIC/MARBLE DISEASE) - CDMV

Causal organism: Cardamom mosaic virus (CDMV)

Symptoms:

- General chlorosis of young leaves.
- In advanced stage the whole plant shows mosaic symptom.
- Rhizome shrivels and plants dies.
- If young clumps are attached they die before flowering.
- Vector: *Pentalonia nigronervosa*

Control measures:

- Use only healthy seedlings raised from Katte free plants.

- Practise regular roughing.
- Collection and removal of infected clumps along with rhizomes and burning.
- Raising of nursery in diseases free areas.
- Spray with *dimethoate (or) Methyl dematan (or) Phosphamidon* to kill the vector.

2.AZUKAL DISEASE/CAPSULE ROT

Causal organism: ***Phytophthora parasitica/ Phytophthora palmivora***

Symptoms:

- Large circular, irregular, water soaked spots with black colour appear on leaves.
- Grey patches of irregular spots with brown margin are seen at the base of the leaf sheath.
- The infection spreads to the underground plants and the rhizomes become rots.
- Small light brown lesions appear in the green tender fruits which fall of in 3-6 days leaving the small fruit stalk. The tip of inflorescence also rot.

Control measures:

- Removal and burning of infected plants.
- Avoid moving of rhizomes from diseased areas to healthy area for planting.
- Provide proper drainage.
- Three sprays with Bordeaux mixture 1%.

3.CLUMP ROT/RHIZOME ROT

Causative organism: ***Pythium vexans, Fusarium oxysporum, Rhizoctonia solani***

Symptoms:

- Infected leaves become pale, yellow and ultimately the young leaves die.
- Older leaves die prematurely and new shoots that arise are weak, decay and the rhizomes rot at the base of the stem.
- The diseased shoot can be pulled out easily.

Control measures:

- Destruction of diseased clumps.
- Providing proper drainage.
- Changing the nursery site.
- Drenching the nursery beds with Copper oxychloride 0.25% or Bordeaux mixture 0.5%.

4.CHENTHAL DISEASE

Causal organism: ***Colletotrichum gloeosporioides***

Symptoms:

- Elongated, water soaked lesions of varying size appear on the upper surface of the leaf.
- New shoots which develop are reduced in size.

● Flowers fail to develop.

● The inflorescence dry up stating from tip downwards. The affected garden shows burnt appearance.

COMMON DISEASES OF CROPS IN KERALA- RUBBER, TEA & COFFEE

DISEASES OF RUBBER (*Hevea brasiliansis*)

1.**Abnormal leaf fall – *Phytophthora palmivora, P.meadii***

2.Powdery mildew- *Odium heveae*

3.Pink diseases- *Corticium salmonicolor*

4.Birds eye spot- *Drechslera heveae*

5.Leaf spot- *Corynespora cassiicola*

1.ABNORMAL LEAF FALL

Causative organism: *Phytophthora palmivora, P.meadii*

Symptoms:

- Affected fruit rot
- On leaves dull grey, circular spots appear which enlarge and become irregular.
- The petiole exhibit sunken spot.
- The affected leaf form a thick carpet of rotting foliage which emits bad smell.

2.POWDERY MILDEW

Causative organism: ***Odium heveae***

Symptoms:

- White powdery fungal growth appears on young leaves and also on matured leaves.
- Infected leaves curl, crinkle, role inwards and fall off leaving the petiole attached to the tree giving a broom stick appearance.

- The infected flowers and tender fruits shed.

Control measures:

- Plant resistant cultivars.
- Prune or stake plants to improve air circulation.
- Remove diseased foliage from the plant and clean up fallen debris on the ground.
- Use a thick layer of mulch or organic compost to cover the soil after you have raked and cleaned it well.
- Milk sprays, made with 40% milk and 60% water, are an effective home remedy for use on a wide range of plants.
- Wash foliage occasionally to disrupt the daily spore-releasing cycle.
- Water in the morning, so plants have a chance to dry during the day.
- Use a slow-release, organic fertilizer on crops and avoid excess nitrogen.

3. PINK DISEASES

Causative organism: ***Corticium salmonicolor***

Symptoms:

- Young twigs and branches are affected
- presence of white mycelium which is like spider's web, followed by pink bark necrosis.
- The fungal growth encircled the stem, penetrates the bark and cortical tissues which eventually decay.
- The bark spits off
- Release of latex that turn black on the surface of the cracked infected bark.

Control measures:

- Affected parts should be pasted with Bordeaux.

4.BIRDS EYE SPOT

Causative organism: ***Drechslera heveae***

Symptoms:

- Affected rubber leaves have numerously-scattered small, circular spots with transparent centers and distinct brown borders which look like bird's eye.
- Young leaves are blackened and wrinkled, older leaves have necrotic lesions that result formation of shot holes caused due to falling down of tissue.

Control measures:

- Spray with 1% Bordeaux mixture
- Maintain proper nutrition on young plants

5. LEAF SPOT

Causative organism: ***Corynespora cassiicola***

Symptoms:

- Circular spots with brown or papery Centre and with a dark brown ring appear on the young leaves.
- Yellow hallo develop around the ring.
- Short holes occurs.
- Affected leaves drugs up.

Control measures:

- Spray with 1% Bordeaux mixture.

DISEASES OF TEA (*Camellia sinensis*)

1.**BLISTER BLIGHT - *Exobasidium vexans***

2.BLACK ROOT ROT- *Rosellinia arcuata*

3.RED RUST- *Cephaleuros virescens*

4.RED ROOT DISEASE- *Poria hypolateritia*

5.BROWN/ GREY BLIGHT- *Colletotrichum sp, Pestalotiopsis sp.*

1.BLISTER BLIGHT

Causative organism: *Exobasidium vexans*

Symptoms:

- Brown to pink lesions developed on the upper surface of leaves. They become circular, blister like swelling both surface of leaf.
- Lesion color will be deep red.
- The concave symptom is depressed and become white, soft.
- Such type of lesions coalesce together formed a bigger lesion and finally leaves may drop off.

Control measures:

- Removal of infected branches by pruning.
- Field sanitation.
- Soil drench will be made in seedling line. 4 g/m2 plant vax usually 2 times in 2-3 weeks interval.
- After each Plucking, fungicidal (specially Copper fungicides) spray would be done at 10-15 days interval.
- Spraying with Vitavax200 @ 5-10 g/mature plant at 35-40 days interval.

2. BLACK ROOT ROT

Causative organism: ***Rosellinia arcuata***

Symptoms:

- White and star shaped mycelium is present on the stem
- Cancers appears on the collar region

Control measures:

- Removal and destruction of infected plants.
- Clean cultivation without leaves.
- Dig a trench around the infected bush to provide sunlight in the trench which prevent the spread of mycelium

3. RED RUST/ ALGAL LEAF SPOT

Causative organism: ***Cephaleuros virescens***

Symptoms:

- The algae produces microscopes red colored spore like bodies on surface of leaf.
- Most of the growth seen on upper surface
- Oldest infections as greenish-grey and look like lichen

Control measures:

- Removal of infected portions by spraying of Bordeaux mixture .
- Improve nutrient status of soil.
- Apply Nitrogen, Phosphorus, potassium.

ENTRI

DISEASES OF COFFEE (*Coffea arabica*)

1.LEAF RUST- *Hemileia vestatrix*

2.BLACK ROT/ KOLEROGA- *Corticium salmonicolor*

1. LEAF RUST

Causative organism: Hemileia vestatrix

Symptoms:

- Mostly affects on leaves.
- Rust lesions developed as orange yellow spots on lower surface of leaves. Thousands of spots appear on upper surface of leaves.
- The orange yellow spots are followed by black spots followed by necrosis .
- Infected leaves defoliate and branches remain without leaves .
- Shunted growth
- Low yield

2. BLACK ROT/ KOLEROGA

Causative organism: ***Corticium salmonicolor***

Symptoms:

- Dark brown or black decaying leaves, twigs and berries, from which black rot derived.
- Leaves hang down by a strong fungal strand.
- Mycelial threads can be seen on twigs and petiole.
- Sclerotium can be seen all over the affected areas.
- Defoliation and drooping occurs.

Control measures:

- Remove affected portion.
- Spraying 1% Bordeaux mixture.