DISEASES OF FRUITS, PLANTATION AND MEDICINAL AND AROMATIC PLANTS

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LECTURE 1

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic plants

The word 'pathology' has been derived from two Greek words, *pathos= suffering* and *logos*= to study or discourse or to speak. Plant Pathology also called as phytopathology (*phyton*=Plant, *pathos*=suffering/ailments, *logos*=knowledge/science). Many plant pathologists proclaim that plant pathology is a discipline which encompasses both 'art' and 'science'. Art is doing and science is understanding.

Plant Pathology (Phytopathology) deals with the cause, etiology, resulting losses, prevention and management (control) of the plant diseases.

The objectives of the Plant Pathology are the study on:

i. the living entities that cause diseases in plants;
ii. the non-living entities and the environmental conditions that cause disorders in plants;
iii. the mechanisms by which the disease causing agents produce diseases;
iv. the interactions between the disease causing agents and host plant in relation to overall environment; and
v. the method of preventing or management the diseases and reducing the losses/damages caused by diseases

Plant disease:

A simple dictionary meaning of disease is any departure from health, presenting marked symptoms, malady, illness, disorder. A number of definitions have been proposed for a diseases plants by Agrios (1997), Horsfall and Cowling (1977), Julius Kuhn (1858), H M Ward (1896), Butler (1918), Horsfall and Dimond (1959), Singh *et al.*, (1989). Some examples are:

Agrios (1997) has defined disease in plants as a series of invisible and visible responses of plant cells and tissues to a pathogenic micro-organism or environmental factors that result in adverse changes in the form, function, or integrity of the plant and may lead to partial impartment or death of the plants or its parts.

According to Horsfall and Cowling (1977), disease is a malfunctioning process that is caused by continuous irritation. Of course this process may result in some suffering and this produces symptoms. This conception of the disease is accepted by the committee of terminology of the American Phytopathological Society and by the counterpart committee of the British Mycological Society.

In 1858, Julius Kuhn, in Germany, had defined plant disease as disease as abnormal changes in physiological processes which disturb the normal activity of plant organs. A similar definition was given by H M Ward (1896) who defined disease as a condition in which the functions of the organism are improperly discharged or in other words, it is a state which is physiologically abnormal and threatens the life of the being or organ.

E J Butler (1918) had defined disease as variation from normal physiological activity which is sufficiently permanent or extensive to check the performance of natural functions by the plant or completion of its development.

According to American Phytopathological Society (Phytopathology 30:361-368, 1940) disease is a deviation from the normal functioning of physiological processes of sufficient duration or intensity to cause disturbance or cessation of vital activities. The British Mycological Society (Trans. Brit. Mycol. Soc. 33:154-160, 1950) defined disease as a harmful deviation from normal functioning of process.

Singh *et al*., (1989) define the disease as " a sum total of the altered and induced biochemical reaction in the system of plant or plant part brought about by any biotic and abiotic factors (s) or a virus leading to malfunctioning of it physiological processes and ultimately malfunctioning gradually at cellular level and/or morphological level. All these alteration should be such a magnitude that they become threat to normal growth and reproduction of the plants.

An analytical approach to definition of the term 'disease' was made by Horsfall and Dimond (1959) who clarified many misconceptions. According to them disease (i) is not a pathogen, it is caused by a pathogen (ii) is not the symptoms or effects seen on the plant, symptoms result from disease (iii) is not a condition as the condition results from the disease (iv) is not any injury which results from disease as well as from any traumatic cause and (v) cannot be catching or infectious, it is

actually the pathogen which is catching or infectious or transmitted. They defined disease as a malfunctioning process in the plant body due to continuous irritation which results in some suffering. Hence, a disease is a pathological process in plants and animals.

A series of harmful physiological processes caused by continuous irritation of the pant by a primary agent. A harmful deviation from the normal functioning of physiological processes.

Some disease enhances the beauty or value of the plant *viz*, are broken tulips in Holland which were actually due to viral infection but they fetched very high market price because of their beauty. Variegation on crotons (ornamental perennials) is another example.

Disorder: Non-infectious plant diseases due to abiotic causes such as adverse soil and environmental conditions are termed disorders.

Based on occurrence

Endemic disease: The word endemic means 'prevalent in and confined to a particular district or country' and is applied to disease. When a disease is more or less constantly present from year to year in a moderate to severe form in a particular country or part of the earth, it is called as endemic. Eg. Potato wart is endemic to Darjeeling hills

Epidemic or epiphytotic disease: The term epidemic is derived from a Greek word meaning 'among the people' and in true sense applies to those diseases of human being which appear very virulently among a large section of population. To carry the same sense in the case of plant diseases the term epiphytotic has been coined. An epiphytotic disease is one which occurs widely but periodically. It may be present constantly in the locality but assumes severe form only on occasions. Eg cereal rust and powdery mildew.

Sporadic disease: Those diseases which occurs at very irregular intervals and locations and in relatively few instances. Eg leaf blights and wilt.

Pandemic disease: diseases occurring throughout the continent or sub-continent or world resulting in mass mortality e.g., Late blight of potato**.**

Based on number of generation of infection or production of Inoculum

Simple interest disease or Monocyclic diseases or Single cycle disease: This denotes a disease, the increase of which is mathematically analogous to simple interest in money. There is only one generation of disease in the course of one epidemic. A simple interest disease develops from a common source of inoculum, that is, the capital is constant and often there is one generation of infection in a season.

e.g. loose smut of wheat and soil borne disease such as vascular wilts and soil borne smuts.

Compound interest/ polycyclic diseases: This denotes a disease, the increase of which is mathematically analogous to compound interest of money. There are several or many generations of the pathogen in the life of the crop, that is, the capital is increased by the amount of interest. Eg. DM, PM, Rust, Late blight of patato.

Difference between monocyclic and polycyclic disease

Features	**Monocyclic disease**	**Polycyclic disease**
Synonym	Simple interest disease	Compound interest disease
No. of cycles	Pathogen having one cycle per season	Pathogen may complete several to many generations per season
Role of inoculm	There is only primary inoculum which causes infection, no secondary inoculum, so no secondary infection	Primary inoculum give rise to secondary inoculum and secondary infection
Rate of inoculum/disease increase	0.02 units/day	0.1-0.5 units/day
Disease progress curve	Saturation type, $\log_e[1/(1-x)]$	Sigmoid curve, $\log_e(x/1-x)$
Role of inoculum	Initial inoculum play important role	Secondary inoculum and secondary infection play and important role
Epidemic rate	Calculate per year	Calculated per day or per

		week
Mode of spread	Through soil/seed	Through air
Sanitation/fungicide	Sanitation is effective to control the disease	Timely application of fungicide is effective
Management	Through reducing the amount or the efficacy of the primary inoculum	Through reducing primary inoculum and rate of infection
Examples	Vascular wilts, post-harvest diseases, soil borne pathogens, loose smut of wheat, covered smut of barley,	Downy mildew, powdery mildew, rust and late blight of potato, dutch elm, oak wilt, southern corn blight

Polyetic diseases/ multiyear disease: These are also polycyclic diseases but they complete their disease cycle in more than one year over years e.g. Cedar apple rust, Dutch elm disease and Chestnut blight.

According to major causal agents

Most useful base of classification as it indicate cause of the disease i.e. fungus or virus etc

Possible disease development and host pathogen interaction , Management practices to be applied.

Infectious/ parasitic (Biotic): Fungi, bacteria, virus, viroids, phytoplasma, RLBs, nematodes, higher parasitic plants etc.

Noninfectious or nonparasitic or physiological or abiotic diseases: nutritional deficiencies e.g. khaira disease of rice due to Zn deficiency, unfavourable environment e.g. frost injury, physiological wilt etc

Plant disorders (abiotic diseases) are:

Nutrient deficiency	**Disorder/Disease**
Boron	Browning or hollow stem of cauliflower
	Top sickness of tobacco
	Fruit cracking of apple
	Hard fruit of citrus
	Hen and chicken disorder of grape
	Heart rot of sugar beet
	Water core in turnip
Calcium	Blossom end rot of tomato/melon
	Bitter pit of apple
Copper	Die back of citrus
	Exanthema in fruit trees
	Reclamation of cereals and legumes
Iron	Green netting of citrus
	Chlorosis in sugarcane
Magnesium	Sand drown of tobacco
Manganese	Pahala blight of sugarcane
	Marsh spot of peas
	Grey speck of oat
	Crinkle leaf disease of citrus
	Speckled yellow of sugar beet
Molybdenum	Whip tail of cauliflower
Nitrogen	Buttoning of cauliflower
	Red leaf of cotton
Phosphorous	Purplish discoloration of alfa-alfa/corn
Potassium	Cotton rust
	Marginal necrosis of corn
Sulphur	Black tip of mango (CO, B & brick-kiln)
	Pan-sukh/Tip brun/Chatra/Ukra/Kadmara/Dakhnina of rice
	Yellowing of tea leaves

Zinc	Little leaf of citrus/mango
	Khaira disease of rice
	White tip of maize
	Mottle leaf of citrus
High temperature	Sunscald on fleshy fruits & vegetables (apples, peppers, tomatoes, onion & potato)
	Heat canker of linseed (>40°C)

On the basis of symptoms

Symptom: Symptom is the phenotypic and or physiological manifestation of a successful invasion of a host by a pathogen. A visible or otherwise detectable abnormality arising from a disease or a disorder is called symptom. Symptoms are not always true diagnostic for study diseases. Eg. Leaf spot, blight, wilt, rot, witches broom, yellowing, blossom end rot, black tip

The totality of symptoms is collectively called as ***syndrome***

Sign: Sign is a morphological or physiological structure of causal organism present in the disease specimen. Examination of these signs help in identifying the pathogen and diagnosing the disease. Eg. Spores, sclerotia, apothecia, hyphae, fruiting body etc.

Symptoms are divided into three general categories:

(A)Necrotic symptoms: those symptoms that result from cessation of function leading to death.

(B) Hyperplasia /hypertrophy symptoms:

Hyperplasia (Gr. Hyper= over + plasis= Molding, formation), Enlargement of tissue an increase in the number of the cells by cell division is known as hyperplasia. This is excessive growth of some plant or even entire plant. Eg. Scab

Hypertrophy (Gr. hyper =over + trophe = Food), enlargement of tissue an increase in the size of cells due to enlargement of the individual cell is known as hypertrophy. It is abnormal increase in the size of cell. Eg. Galls, Cankers, witche`s broom etc.

(C) Hypoplastic – under development or retardation o f function.

(A)**Necrotic symptoms**

1. Blight: Rapid killing of foliage, blossoms and twigs.

2. Blotch: Large irregular lesion on leaves, shoots and stems.

3. Canker: Necrotic, often sunken lesions in the cortical tissues of stems and roots.

4. Decay: disintegration of dead tissue

5. Dieback: progressive death of twigs and branches from their tips towards the trunk

6. Hydrosis: A water soaked, translucent condition of the tissue due to cell sap passing into intercellular spacing

7. Scald: blanching of epidermis and adjacent tissues.

8. Scorch: Browning of leaf margins resulting from the death of tissues.

9. Shot hole: circular hole, in leaves resulting from the dropping out of the central necrotic area of spots.

10. Spot: lesion, usually defined, circular or oval in shape, with a central necrotic area surrounded by variously coloured zones.

11. Wilt: leaves or shoot loose their turgidity and droop.

12. Yellowing: Leaves turn yellow due to disintegration of chlorophyll

(B) Hyperplastic /hyperplasia symptoms

1. Anthocyanescence: purplish or reddish coloration of leaves or other organs due to over development of anthocyanin pigment.

2. Callus: over growth of tissue at the margins of wounds or diseased tissues.

3. Curl: rolling or folding of leaves due to localized overgrowing tissues.

4. Fasciation: Flattened condition of plant part that is normally round.

5. Fasciculation or witch broom: broom like growth of densely clustered branches.

6. Sarcody: Abnormal swelling of tissues above girdled branches or stems.

7. Scab: Roughened, crust like lesions.

8 Tumefaction: Tumor like or gall like or knot like over growth of tissue**.**

9. Virescence: Development of chlorophyll in tissue where it is normally absent

C) Hypoplastic symptoms

1. Chlorosis: Failure of chlorophyll development in normally green tissue
2. Dwarfing: Sub normal Size of an entire plant or some of its parts.
3. Etiolation: Yellowing due to lack of light
4. Rusetting: Crowded condition of foliage due to lack of internodes elongation.
5. Suppression: prevention of the development of certain organs

III Signs Signs are divided into three general categories

- Vegetative structure
- Reproductive structure
- Disease product

A. Vegetative structure: Haustorium, Mycelium, Pathogen cells, rhizomorph, sclerotia,etc. are structure generally observed.

B. Reproductive structure: Acervuli, Apothecia, Asci, Basidium, Cleistothecia, Conidiophores, Conk, mildews, mold, Mushroom, Perithecia, pycnia, sorous, Sporangium, spores, sporodochium, stroma etc. are the structure commonly observed. Some major symptoms based on presence of reproductive structure are:

1. Bunt: a disease caused by fungi (belonging to tilletiaceae) in which grain content are replaced by odorous smut spores.

2. Downy Mildew :a plant disease in which sporangiophores and spores of the fungus appear as downy growth on the lower surface of leaves etc., caused by the fungi in the family peranosporaceae.

3. Powdery mildew: appearance on plant surface as white to dirty white powdery mass due to conidiophores, conidia and mycelium of the fungus.

4. Rust: A disease giving a rusty appearance to a plant and caused by one of the uredinales

5. Smut: a disease caused by smut fungi (Ustilaginales)it is characterized by masses of dark, powdery and some time odorous spores.

6. Sooty mold: a sooty coating on foliage and fruit formed by the dark hyphae of fungi that live on honey dew secreted by insects.

C) Disease products: in several bacterial disease, Such as bacterial blight of paddy, masses of bacteria ooze out to the surface of the affected organs where they may be seen as drops of various sizes or as thin smear over the surface. In some cases somewhat raised, black coated fungus bodies appearing as a flattened out drop of tar on leaves appear.

Alternate host: Plants not related to the main host of parasitic fungus, where it produces its different stages to complete one cycle (heteroecious).

Antagonism: The counteraction between organisms or groups of organisms.

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

Biotype: The smallest morphological unit within a species, the members of which are usually genetically identical.

Collateral host: The wild host of same families of a pathogen is called as collateral host.

Colonization: The growth of a pathogen, particularly a fungus, in the host after infection is called colonization.

Cop Damage: It is defined as any reduction in the quality or quantity of yield or loss of revenue resulting from crop injury.

Deficiency: Abnormality or disease caused by the lack or subnormal level of availability of one or more essential nutrient elements.

Disease cycle: The chain of events involved in disease development.

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

Adventious septa: Septa formed independently of nuclear division, especially associated with changes in the concentration of protoplasm in parts of a hypha.

Alternate host (as applied to rust): One of the two kinds of plants on which a parasite must develop for completion of its life cycle. Usually the term is applied to such host (other than primary host) on

which the rust fungus generally produces stage 0 & I (host bearing sexual stage). Example In black stem rust of wheat caused by *Puccinia graminis tritici,* Barberry is the alternate host.

Anamorph- mitotic **a**sexual form or conidial or imperfect state

Apothecium: which is a cup or saucer shaped fruit body bearing an exposed hymenium (open Ascocarp). E.g. *Discomycetes* (*Peziza, Geoglossum, Morchella, Sclerotinia, Helvella*).

Ascocarp: The fruiting body (sexual spore fruit) of Ascomycotina which contains sexual spores namely ascospores.

Ascospore: A spore produced in an ascus by free cell formation or the spore produced as a result of meiosis and enclosed within a specialized cover the ascus, are called ascospore.

Ascostroma* (*Ascostromata*)*: is a fruting body in which bituniciate asci develop in cavities-locules within the stroma. E.g. *Loculoascomycetes* (*Pleospora, Mycosphaerella, Venturia).*

Autoecious fungus/ rust: A parasitic fungus/ rust fungus than can complete its entire life cycle on the same host. Example Linseed rust (*Melampsora lini*).

Autoecism: It is a phenomenon where a pathogen is capable of completing its life cycle on a single host.

Axenic culture: Axenic culture is defined as the growth of organism of a single species in the absence of living organism or living cells of any other species.

Bacteria: They are prokaryotic single celled mostly achlorophyllous organisms whose body is surrounded by cell wall and nuclear material is not surrounded by membrane, lack membrane bound organelles such as mitochondria or plastids and also a visible endoplasmic reticulum.

Basidiocarps (fungus flower): Most Basidiomycotina produce their basidia in fruiting bodies of various types called basidiocarp. Such fruiting bodies are **not** formed in rusts and smuts. They may be microscopic in size to several feet in diameter. They could be gelatinous, fleshy, spongy, corky, woody, or indeed of almost any texture. Some examples include **bracket fungi, puff balls, mushrooms** etc.

Basidiocarps may be open exposing their basidia or they may be closed where basidiospores are liberated after basidiocarps disintegration. Basidia are produced in hymenium. Along with basidia, are interpressed sterile hyphal structure called

Basidiospores: Basidiospores usually are unicellular, haploid, globose or oval or elongated. They may be colorless or pigmented. Basidiospores usually receive a single nucleus from the basidium (however in some species two nuclei may move in basidiospore. It may also become binucleate due to mitotic division of its nucleus). Basidiospores which germinate directly, produce primary mycelia and in indirect germination secondary spores or buds are formed.

Besipetal: Produced successively with youngest at the base.

Biotype: Biotype is a population of individuals which are genetically identical (literally any species subdivision which is based on criteria other than morphological).

Brachy type: In a life cycle pattern of a rust in which aecial stage is omitted & remaining stages 0, II, III are produced is called as brachy type. Example *Puccinia suaveolens* (rust of Canada thistle (*Cirsium arvense*).

I. ***Cleistothecium:*** Which is usually globular and completely closed without any opening (ostiole) for liberation of ascospores. **Chasmothecium** (Braun et al 2002) is the new name given to fruiting body of powdery mildews. It is a unique spherical ascoma, with no natural opening and releasing asci and ascospores by developing a crack on it.

Disease cycle: A series of events involved in disease development, including the stages of development of the pathogen and the effect of the disease on the host, is called disease cycle.

Disease development: It refers to a series of events which occur between the time of infection and complete development of the disease.

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

Epidemiology: Epidemiology of disease is a study of the factors affecting the outbreak of an infectious disease. Vander Plank (1963) defined epidemiology as the science of disease in a population.

Four main type of Ascocarp/ ascoma (pl. ascomata)

Hemibiotroph (Facultative Saprophyte): The parasites which attack living tissues in the same way as biotrophs but will continue to grow and reproduce after the tissue is dead called as ***facultative saprophytes***.

Heteroecious: A parasitic fungus/ particularly rust fungus which require two different kinds of host to complete its life cycle is called as heteroecious fungus/ rust (heteroecious rusts therefore produce stages 0 & I on one host species and stage II & III on another). Example Black stem rust of wheat, *Coelomomyces psorophorae* (Blastocladiales)

Heteroecism: It is a phenomenon where a pathogen is capable of completing its life cycle on more than one host, usually two (on two different unrelated plants).

Host: An organism that harbours or support the activities of a parasite is known as the host.

However, a group of pathologist recognize economically most important host plant/ crops as primary host. Example Black stem rust of wheat, wheat is the primary host for *Puccinia graminis tritici*.

Hypersensitivity: The term hypersensitivity was first used by Stakeman (1915). Increased sensitivity by the host at the site of infection and shown by rapid cell death which prevents further growth by the pathogen and spread of infection is known as hypersensitivity.

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

Infection: It implies the establishment of the pathogen inside the host following penetration in which a parasitic relationship between the two organisms is established.

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

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

Invasion: The penetration and spread of a pathogen in the host.

It is the ability of a parasite fungus to complete its entire life cycle on a single host species (used particularly for certain rusts).

Multiple cycle disease (Polycyclic): Some pathogens specially a fungus, can complete a number of life cycles within one crop season of the host plant and the disease caused by such pathogens is called multiple cycle disease e.g. wheat rust, rice blast, late blight of potato etc.

Mutation: An abrupt appearance of a new characteristic in an individual as a result of an accidental change in genes present in chromosomes.

Mutualism: Symbiosis of two organisms that are mutually helpful or that mutually support one another.

Necrotroph: A pathogenic fungus that kills the host and survives on the dying and dead cells.

Paraphyses: Paraphyses are sterile, upward growing, basally attached hyphal elements and lie among the asci in hymenium. Paraphyses are supposed to assist in the dissemination of ascospores.

Parasite: An organism living upon or in another living organism (the host) and obtaining the food from the invading host. Not all parasites are pathogen. In some cases organisms are parasitic without becoming causal factors in the disease. Eg. The mycorrhizal fungus is certainly parasitic on the root of trees but it is not pathogenic. The root nodule bacteria (*Rhizobium* spp.) are another example.

Pathodeme: Pathodeme is that population of a host in which all individuals have a particular character of resistance in common (Robinson, 1969).

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

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

Pathogenicity is the ability of the pathogen to cause disease

Pathotype: This is a subdivision of a species distinguished by the common characters of pathogenicity, particularly in relation to the range of hosts.

Penetration: This is the first step in the contact of the inoculum with the host. Penetration refers to the initial invasion of the host by an organism. Penetration may or may not cause infection.

Perithecium*:* which is a flask-shaped fruit body opening by a pore or ostiole. E.g. *Pyrenomycetes* (*Neurospora, Claviceps, Nectria*).

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

Physiologic race: One or a group of microorganisms similar in morphology but dissimilar in certain cultural, physiological or pathological characters.

Physiotype: It is a population of pathogens in which all individuals have a particular character of physiology (but not pathogenicity) in common (Robinson, 1969).

Polymorphism: It is a phenomenon where a pathogen is capable of producing different types of spores during its life cycle (is called as polymorphism and such a rust is called as polymorphic).

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

Primary host (as applied in relation to rust): Conventionally in mycology literature, the host on which **stage III (telial stage)** is produced is recognized as primary host. Process of karyogamy and meiosis take place in teliospore therefore, teliospores is considered to be perfect stage of rusts.

Primary infection: The first infection of a plant by the over wintering or over summering of the pathogen.

Primary septa: (in relation to Basidiomycotina): The septa which are formed in association with nuclear division and are laid down between daughter nuclei.

Serotype: A serotype is a population of a pathogen (usually a bacterium or virus) in which all individuals possess a given character of serology in common (Robinson, 1969).

Symbiosis: A mutually beneficial association of two or more different kinds of organisms.

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

Syndrome: Diseased plants show several valuable symptoms by which a disease is recognized. These symptoms are collectively known as a syndrome.

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

Teleomorph- meiotic sexual form or perfect state or ascigerous (Hennebert and Weresub, 1977)

Fungus: The term fungus (plural fungi) is a **Latin** word, meaning mushroom. Gaspard Bauhin (1560-1624) used fungus term as a group name. Some authors use term "fungi" in a very general sense and "Fungi" (capital F) specifically for True fungi (Bruns *et al*, 1991). The ancient philosophers and naturalists first recognized fungi as mushrooms. The first monograph which included many larger fungi '*Fungorium in Pannoniis Observatoeum Brevis Historia*' writin by Clusius (1526-1606).The fungi are achlorophyllous and heterotrophic thallophytes. The study of fungi is known as **mycology** (Gr. *Mykes* = mushroom + *logos* = discourse) or **mycetology** and the scientist who is concerned with fungi is called as **mycologist**. Alexopoulos and Mims (1979) defined fungi as eukaryotic, spore-producing, acholorophyllous organisms with absorptive nutrition that generally reproduce both sexually and asexually and whose usually filamentous, branched somatic structures, known as hyphae, typically are surrounded by cell walls containing chitin or cellulose, or both of these substances together with many other complex organic molecules. Aneja and Mehrotra (2015) defined true fungi as "eukaryotic organisms lacking plastids, with absorptive nutrition, reproducing both sexually and asexually by spores and hyphae surrounded by cell walls containing chitin and β-glucans, and mitochondria with flattened cristae and peroxisomes". Dube H C (2013) defined "Fungi are eukaryotic, heterotrophic, absorptive organisms that develop a rather diffuse, branched, tubular body (or are more rarely single-celled) and reproduce by means of spores.

Virulence: The degree of infectivity of a given pathogen.

Viruse: are sub-microscopic, intracellular, infectious entities and are composed of nucleic acid and proteins.

Lecture 2. DISEASES OF MANGO

Mango is considered to be the king of fruit. India is the largest producer and exporter of mango in the world. Mango possess unique nutritional and medicinal qualities apart from being a rich source of vitamins A & C, besides its attractive form and appearance, delicious taste and appetizing flavor, the ripe mango fruit according to nutritional experts is also highly invigorating, fattening, laxative and diuretic. Every part of mango from root to tip is used in a variety of ways. This crop is affected by many fungal, bacterial and other non parasitic diseases.

S.No.	Major Disease		Pathogen
1	Malformation of mango	:	*Fusarium moniliformae* var. *subglutinans*
2	Powdery mildew of mango	:	*Oidium mangiferae*
3	Anthracnose of mango	:	*Colletotrichum gloeosporioides*
4	Die-back of mango	:	*Botryodiplodia theobromae*
5	Sooty mould of mango	:	*Capnodium ramosum*
6	Grey blight of mango	:	*Pestalotiopsis mangiferae*
7	Stem-end rot of mango	:	*Diplodia natalensis*
8	Red rust of mango	:	*Cephaleuros virescens*
9	Bacterial canker of mango	:	*Xanthomonas campestris* pv. *mangiferae indica*
10	Giant mistletoe of mango	:	*Dendrophthoe spp.*
	Minor Disease		
11	Black banded disease of mango	:	*Rhinocladium corticolum*
12	Pink disease of mango	:	*Pellicularia salmonicolor*
13	Blight of mango	:	*Macrophoma mangiferae*
14	Scab of mango	:	*Elsinoe mangiferae* and *Sphaceloma mangiferae*
15	Phoma blight of mango	:	*Phoma glomerata*
16	Black-mould rot of mango	:	*Aspergillus niger*
17	Alternaria rot of mango	:	*Alternaria tenuissima*
18	Bacterial leaf spot of mango	:	*Pseudomonas mangiferae-indicae*
19	Dodder of mango	:	*Cuscuta* spp

1. Mango Malformation Disease (MMD)

- This is one of the severe diseases of mango and is important in North India. It appears in and around Hyderabed & Medak Districts.
- In A.P. this was first noticed in Aragonda village in 1971.
- In India it is known to occur in U.P., Maharashtra, Haryana, Bihar, Punjab and A.P. particularly severe in U.P. causing much damage
- Coastal areas are free from the disease.
- Mango Malformation Disease is a fungal disease of mango caused by several species of *Fusarium*, some yet to be described.
- Mango is the only known host of the disease.
- The disease spreads on a tree very slowly, but if left unchecked, can severely reduce yields.
- The main method of spreading MMD to new areas is through infected vegetative planting material.
- There is no evidence that the disease can spread on fruit or the seeds, or that it affects human health.
- It usually associated with the bud mite, *Aceria mangiferae* but the mites have been shown to spread the disease within a tree and not between the trees.
- Mango malformation, also known as bunchy top, is a very serious threat to the mango industry, particularly in northern India.
- The etiology of the disease still remains obscure and diverse claims have been made about its causes, e.g**., physiological, viral, fungal, acarological and nutritional.**

Symptomatology:

Three distinct types of symptoms are produced.

1. Bunchy top of seedlings (BT)
2. Vegetative malformation (MV)
3. Floral malformation (MF) (fig-1)

Bunchy top of seedlings (BT):

- Bunchy top phase (BT) appears on young plants in the nursery beds when they are 4-5 months old.
- Formation of a bunch of thickened small shootlets bearing small rudimentary leaves or occasionally several bunches arising from a leaf axil at the top or lower down the main shoot.
- These shoot lets are much thicker than main axis from which they arise. The shoot remains short and stunted.
- The growth of the plant is stopped and it gives an appearance of bunchy top.

Vegetative malformation:

- Induces short internodes forming bunches of various sizes. They are found at the top of the seedling and give a bunchy top appearance.

Floral malformation (MF):

- Variation in the panicle formation, the malformed heads dry up in black masses and persist on the tree for a long time.
- And the secondary branches are transformed into vegetative buds and large number of small leaves and stems, which are characterized by appreciably reduced internodes and are compacted together giving a witches 'broom appearance.
- In other cases, the flower buds seldom open and remain dull green.

Fig. 1. Floral malformation

Etiology:

- *Fusarium moniliformae* var. *subglutinans*. Wollenw. &Reink. Micro conidia are one or two-celled, oval to fusiform and produced from polyphialides.
- Macro conidia are rarely produced and are 2-3 celled and falcate.
- Asexual fruiting body of the fungus is sporodochium.
- Chlamydospores are not produced.

Mode of spread and survival:

- Diseased propagated materials help in the spread of the disease.

Epidemiology:

- The disease is serious before flowering in the northwest region where the temperature is between 10-15°C during December-January.
- The disease is mild in the areas where temperature is between 15-20°C, sporadic between 20-25° C and nil beyond 25° C. the occurrence of malformation differed according to the age of the plants. 4-8 years old trees are highly susceptible.

Management:

- Spraying with NAA at 100-200 ppm during October reduces the disease incidence.
- Eradication of malformed shoots and panicles after spring and autumn flushes (April and October),
- spraying with acaracide (phosphamidon 0.05%) immediately after 3 flushing (February, May and October),
- Spraying with chelated copper (40 ppm) (mangiferin chelate or amino acid based chelate or copper fungicide) twice (August-September and December –January) before advent of the peak period of the fungal population,
- Spraying with chelated Zn++ twice (40 ppm) (December and February) to replenish the deficiency in the plants suffering long from the disease.
- In in vitro test mangiferin Cu++ chelate killed the conidia and mycelia,
- *Aspergillus niger* parasitized the Fusarium
- While carbendazim arrested germ tube growth and reduced conidia production thus affected infection rate (r) of *F. moniliforme* var. *subglutinans*.
- Followed by spraying of Carbendazim 0.1% or captafol 0.2% effectively controlled the disease.

2. Powdery mildew

The disease is worldwide in distribution. Reported from India, Pakistan, Ceylon and South Africa. In India the disease is particularly destructive in U.P. Maharashtra and Karnataka severe particularly during the months of December-March, i.e. cooler months.

Powdery mildew is one of the devastating foliar diseases of mango affecting almost all the cultivars. In India, the disease is wide spread including in the hill valleys and plains of U.P. and it is a serious threat to mango production. Its severity mainly depends on climatic conditions. The losses have been estimated upto 20% in Maharastra and 30-90% in Lucknow and U.P.

Symptoms:

- The disease is easily recognized by whitish or grayish powdery growth on the inflorescence and tender leaves
- Generally the infection starts from the inflorescence and spreads downwards covering the floral axis, tender leaves and stem. Infected leaves become twisted, curled and fall
- Infected floral parts are severely damaged and drop off. If the fruits are set, they do not grow in size and may drop before attaining pea size. Fruits are sometimes malformed, discolored due to severe mildew attack
- Because of poor fruits set and heavy flower and fruits drop, the loss due to the disease may be as high as 70-80%

Fig: 2. Powdery mildew on leaves and flowers

Etiology:

- *Oidium mangiferae*, Berthet. It produces septate mycelium and is hyaline, branched and superficial. Haustoria are sub epidermal.
- Conidia are hyaline, unicellular, elliptical and are borne singly or rarely in chains.

Mode of spread and survival:

- During off-season, the pathogen survived in intact green malformed panicles mostly hidden under dense foliage and its sexual forms has not been recorded.
- During flowering period, the conducive environmental condition activates the dormant mycelium in necrotic leaves.
- Abundant conidia are produces and blown over to the flushes through the wind on young panicles which provides spore load for initiating the disease.
- Fresh infection on young leaves happens during first week of the December.

Epidemiology:

- It usually occurs during Dec-Mar. The disease is particularly destructive in the coastal areas of Maharastra during cold and wet seasons.
- Rains or heavy mist in the morning accompanied by cool nights during the flowering period favors the disease.
- Predominance of susceptible variety, high wind velocity for 3-4days with maximum temperature above 300c, minimum temperature around 150c and maximum relative humidity of 73.3-83.9% and minimum of 23.4-25.5% are found conducive for quick spread.

Management:

The disease can be managed by pruning of diseased leaves and malformed panicles and three sprays of fungicides at different stages starting with Wettable Sulphur (0.2%) at the panicle size of 7.50 - 10.00 cm followed by Dinocap (0.1%) after 15-20 days of first spray and Tridemorph (0.1%) after15-20days of second spray. Wettable Sulphur (0.2%) can be used in all the three sprays and number of sprays may be reduced as per appearance time of disease.

Resistant varieties: Neelum, Zardalu, Banglora, Torapari-khurd and Janardhan pasand

3.Mango anthracnose:

Anthracnose is also known as blossom blight, leaf spot, fruit rot and twig blight. This disease is severe both in field and storage. The disease is present all mango area of India The verities neelam and bangalora are highly susceptible to this disease. Reported from several districts of Punjab in 1939. Now prevalent in all mango – growing tracts of the country. The disease is a problem both in the field and storage. **Symptoms:**

Leaf spot:

- The fungus attacks tender shoots and foliage. Brown or dark circular or irregular spots are formed on the leaves and such leaves are crinkled.
- The affected portion dry up and fall off and leaf ragged margins. Often these leaves are shed leaving the twigs bare.

Die back:

- The infection spreads to the green twigs and forms dark brown lesions on them. Young branches dieback.
- On the lesions and dead portions, minute, pink, cushion-shaped fructifications of the pathogen are seen during moist weather.

Blossom blight:

- Small dark spots are formed on the main stalk and lateral branches of the panicle. Individual flower stalks are also infected.
- The flowers wither and shed. When severely infected. All the flowers destroyed and no fruits are formed.

Fruit rot:

- The tender fruits turn black and fall off. Often dark lesions develop on the fruits and cause partial of complete shriveling, blackening and shedding.
- Matured fruits are also infected. Black, round or irregular, sunken spots are formed on the skin. as the fruit ripens the spots extend over the whole surface accompanied by the softening and rotting of the fruits.
- This type of injury is observed while the fruits are on the trees. it also occurs during transit and in storage. Spoilage of ripen fruits is common.
- Fructification of the pathogen is formed on the spots.

Etiology: *Colletotrichum gloeosporioides*. Penz, Spauld&Schrenk.

Colletotrichum gloeosporioides Penz. Anamorph of the Ascomycetes fungus *Glomerella cingulata* (Ston.) Spould and Shrenk, is widely distributed fungus causing leaf spot and anthracnose.

- The mycelium of *C. gloeosporioides* consists of rather narrow, sparsely septate hyphae which are at first hyaline but late take on slightly dark colour. Acervuli are abundantly formed on the affected host surface. These develop at first as tangled subepidermal masses of hyphae. These structures are elongated or irregular in shape and upto 500µm in diameter. From the tangled mass of hyphae numerous closely packed conidiophores arise and partially raised epidermis.
- The conodiophore are hyaline and unbranched. One or more conidia formed from the apex each conidiophore. Setae in acervuli is common on twig but not on the fruit. The conidia are sub hyaline but look pinkish in mass. They are broadly oval to oblong with rounded ends, aseptate some time with 1-2 globules.
- The perithecial stage (Glomeralla cingulata) develops on the stromatoid cushions. The perithecia are immersed in the host tissue. They are more or less compounded, subspheriacal, and with prominent ostiolar hair. Asci are sub-clavate, often slightly pedicellate and measure 55-70 µm in length. The ascospores are allantoids, hyaline, aseptate, 3.5-5 µ wide and 12-22 µm long.

Mode of spread and survival:

- Inoculum remains on dried leaves, defoliated branches, mummified flowers and flower brackets and they serve as primary inoculum.
- Secondary spread is through air born conidia. The fungus can enter the pores of green fruits.
- The latent infection of mature fruits may takes place through lenticels. The fungus apparently infects the fruit while it is green and develops in flesh during ripening.
- The latent infection is carried from the field to storage. Healthy fruits develop infection after in coming in contact with disease ones.
- The latent infection does not begin to spread until it reaches eating maturity.

Epidemiology:

- The acervuli are abundant on the dead twigs and 80% of the spores on them are viable. Fresh acervuli continued to appear on dead twigs and persist on the tree.
- The optimum temperature for infection was found to be 25oc and relative humidity 95-97%. The perithecial stage of the fungus is not very common.

- There is no evidence to show that fungus perpetuates through ascospores.

Management:

- Diseased twigs, leaves and fruits, which fall on the ground in the orchard, should be collected and all infected twigs should be pruned and burnt.
- Spraying of Bordeaux mixture 0.6% in the young plants during Feb, April and sept controls the disease. Spraying carbendazim 0.1% or thiophanate-methyl0.1% or chlorothalonil 0.2% for 15days interval until harvest effectively controls anthracnose.
- Before storage, fruits should be treated with hot water at 50-550 c for 15min. or thiabendazone 1000ppm for 5min. Spraying of coc +zineb after completion of heavy showers followed by wettable sulphur 0.2% before flowering and carbendazin 0.1% at 15days interval from fruits formation proved effective.

4. Dieback

This disease is prevalent in all mango-growing states in India. In U.P.30-40% of road this disease affects side and other plantation.

Symptoms

- The disease is characterized by dieing back of twigs from tip downwards particularly in older leaves.
- It is giving an appearance of scorching by fire followed by complete defoliation. Barks are discolored and darkened at certain distances from tip.
- Such dark patches are generally seen on young green twigs. When the dark lesion increase in size, dying of young twigs begin at the base affecting leaf mid ribs extending along the veins.
- The upper leaves use their healthy green color and gradually turn brown accompanied by upward rolling of leaf margin. In, advanced stage, such leaves shriveled, fall off in a month are more, leaving the shriveled twigs.
- Internal browning in the wood tissue is observed on the slitting along the long axis. Cracks appear on branches, which exude gum. In fruits, the pericarp darkens near base of the pedicel.
- The affected area enlarges to form a circular, black patch, which under humid atmosphere extends rapidly and turns the whole fruit completely black within 2/3days. The pulp becomes brown and softer.

Etiology: *Botryodiploidia theobromae* Pat.

- It is a Pycnidial fungi. Pycnidiospores are hyaline and thin walled, becoming thick walled, and dark brown and one septate.
- They have longitudinal striation and measures 20-30* 10-15micrometer with paraphyses upto50micrometer long.

Mode of spread and survival:

- The fungus is a wound parasite. Dead twigs and bark of the trees harbor the fungus. The spores are spread through rain splashes.

Epidemiology:

- High temperature during summer predisposes the trees to the disease.
- Relative humidity of about 80%, max. &min. temperature of 31.5° C and 25.9° C respectively and rains favour the disease development.
- It causes great damage and when mango grafts are kept in humid propagation shed.

Management:

- Fruits should be harvested on clear dry days.
- Injuries should be avoided on fruits at all stages of handling.
- Care should be taken to prevent snapping off of the pedicel.
- Dipping of mangoes in 6% solution of borax at 43° C for 3min. gives effective control. Carbendazim 0.1% or Thiophanate-methyl 0.1% or chlorothalonil 0.2% spraying in the field before harvesting gives effective control.

5. Sooty mould:

The disease is of common occurrence and affects many kinds of fruits and plantation crops.

Symptoms:

- The fungi produce mycelia, which is usually superficial and dark. They grow on the flowers, both tender and old leaves, stems and fruits.

- They grow and thrive on the sugary secretions of the plant hoppers and other insects.
- Black encrustations are formed on the surfaces of different parts of the plant. The photosynthetic ability of the plant is highly reduced because of sooty mould covering the photosynthetic area.
- During flowering time, its attack results in reduced fruit set and cause fruit fall. Black coating is also found on the fruits.
- Appearance of the affected fruits is lost and the price for such ugly fruits is usually low.

Mode of spread and survival: affected leaves and other crop debris serve as primary source of inoculum

Etiology: *Melioa mangiferae* Earle. *Capnodium ramosum* Cke. *C. mangiferae* Cke. & Brown and *Trichospermum acerinum* (Syd). Speg.

Epidemiology:

- High infestation with plant hoppers and the sugary substances (including excreta) secreted by them and other insects favour development of sooty mould. This is not a parasite or pathogen and do not draw any nutrient from the plants.
- Disease is severing in old and dense orchards where light intensity is low. Trees exposed to eastern side have fewer incidences while the trees in center of the orchard have more incidences.
- Continuous and heavy rainfall washes down these substances but high humidity proved congenial for growth of the fungus.

Management:

- Both the insects and sooty moulds are to be simultaneously controlled in the eradication process. The insects are to be controlled by spraying with carbaryl or phosphamidon 0.03%.
- It is followed by spraying with a dilute solution of starch or maida 1%. On drying, the starch comes off in flakes and the process removes the black mouldy growth fungi from different plant parts.
- Spraying insecticide followed by spraying with fungicide viz., Bordeaux mixture 1% is also recommended.
- Spraying of wettable sulpher, methyl parathion+gum acacia (0.2+0.1+3%) at 15days interval reduces the sooty mould incidence.

6. Grey Blight/ *Pestalotiopsis* Leaf Spot:

In India, this disease has been reported from many states.

Symptoms:

- Brown spots develop at the margins and tip of the leaf lamina and distributed irregularly on entire leaf.
- Initially the spots are brown and minute and they gradually increase in size and become dark brown. Black dots appear at the center of the spots represent the acervuli.
- On mature green fruits, small brown spots appear with grayish white center which later turns to bigger lesions with large number of acervuli seen as black dots.

Etiology: *Pestalotiopsis mangliferae* (P.Henn.) Stey.

- The fungus produces septate mycelia and acervulus as an asexual fruiting body.
- Conidia are5-celled, oblong to clavate or clavate to fusiform, colored cells are 15-16 micro meter long, upper two of them slightly darker than the lowest olivaceaus colored cells, septa and walls sometimes black and will have long pedicel; setulae 3, coarse, widely divergent and 19-26 micron long.

Mode of spread and survival:

- The fungus present in stem is multiplies under favorable conditions. It spread through wind- born conidia.

Epidemiology:

- The fungus is capable of growing at temperature between 20-250 c. mycelia growth sporulation takes place at pH 5.5-6.0. Wounding leads to more disease incidence.

Management:

- Carbendazim 0.1% after heavy rains followed by wettable sulphur 0.2% before flowering controls the disease. Bordeaux mixture 1.0% can also used for the control.

7. Stem-End Rot

It is a destructive disease of mange and it is known to occur in India and other mango growing countries. In India it was first described during 1945. Since then it has been observed in Delhi, Rajasthan, U.P` and other states.

Symptoms:

- The onset of die back becomes evident by discoloration and darkening of the bark some distance from the tip.
- The dark area advances and young, green twigs start withering first at the base and then extending outwards along the vines of the leaf edges.
- The affected leaf turn brown and its margin roll upward. At this stage, the twig or branches dies, shrivels and falls.
- This may be accompanied by exudation of the gum. Infected twig show external discoloration.
- Brown streaking of vascular tissues is seen on splitting the twigs lengthwise.
- The fungus also infects the fruits.
- Infected fruit pericarp darkens near the pedicel base. More portions of fruit turn black to soften.

Etiology: *Diploidia natalensis* (Pole Evans.)

The fungus produces brown to black, globouse to sub globose, pyriform, erumpent pycnidia that are ostiolate. Two types of conidia are produced within a pycnidium. Hyline and olive-brown. The former are thin walled and unicellular, while the later are thick walled and bicelled with 4-6 longitudinal striations.

Mode of spread and survival: the fungus persists in infected plant parts, which serve as source of inoculum.

Epidemiology:

- Relative humidity above 80%, max. &min. temperature of 31.50 C &25.90 C respectively.
- Rains favor the disease development.
- Nutritionally deficient plants are heavily affected.

Management:

- Plants with balanced fertilization resist the disease.
- The coating of stem with fungicidal paints immediately after harvest or packing of fruits directly in the cellophane bags the infections completely.
- Removal of infected pedicel during fruit ripening also helps in keeping the disease under control.

8.Red Rust

The algal disease of mango has been observed in India and elsewhere. Its major distribution in India has been in Bihar, Karnataka, and U.P. the disease appeared in an epidemic form in the state orchards in Tarai in 1956. Reduction in photosynthetic activity and defoliation as a result of algal attack lower vitality of the host plant.

Symptoms:

- The disease is characterized by initial green coloured patches, as and when disease advances the organism turns red rusty spots on the leaves and young twig.
- The spots are initially circular, slightly elevated and later coanesce to form irregular spots.
- The upper surfaces of the spot consist of numerous, unbranched filaments, which project through cuticle.
- Some of the filaments represent sterile hairs while others the fertile ones.
- Spores mature, fall off and leave cream to white velvet texture on the surface of leaf.

Etiology: *Cephaleuros virescens* (Kunze).

- The algae after a period of vegetative growth develop its reproductive structure.
- Certain cells become sporangia. They are of 2 types.
- Those formed directly on the thallus are sessile and thick walled, 40-50micrometer in diameter with orange pigments.
- They are formed singly on the vegetative filaments. Some are produced above the surface on special sporangiophores consisting of thick, rigid, septate hairs with a length of 50micrometer, swollen into a vesicle at the tip. Each vesicle carries 3-6 sporangia on curved pedicels.
- When the sporangia are riped, the contents are converted in to zoospores and liberated through an opening in the wall.

- The zoospores are orange in color, ovoid and swim actively by means of cilia.

Survival and spread

- **Primary**: **Algal filaments and sporangia** in infected leaves
- **Secondary**: Rain splashed **sporangia** and **zoospores**

Epidemiology:

- The disease is more common on close plantation.
- The zoospores cause initial infection.
- High moist condition favours development of fruiting bodies of the algae.

Management:

- Avoid close plantations
- Prune unproductive branches to improve air circulation within the canopy of a tree
- It is controlled by spraying with Bordeaux mixture 1.2% or COC 0.1% or limesulphur.

9. Bacterial Canker

In India it was first reported from Pune. It occurs in Bihar, Karnataka, maharastra, tamilnadu, U.P.

Symptoms:

- The disease attacks the leaves, leaf stalks, stem and fruits.
- On the leaves disease first manifests itself as minute, water soaked irregular lesions, black and is surrounded by chloratic haloes.
- Due to vein limitations the spots become angular and result in cankerous patches, which sometime dry up.
- Sever infection results in defoliation. The bacteria also infects the fruits first showing water soaked lesions, which later become dark brown to black and causes sever cracking of fruits, accompanied by heavy bacterial exudation.
- There may be only a few lesions on each fruit but more lesions on tender fruits may lead to sever fruit drop.
- On branches on twigs the lesions become raised with longitudinal fissures, and are accompanied by the bacterial gummy ooze.

Etiology: *Xanthomonas campestris* pv.*mangiferae-indicae* (Patel et al.) Robbs et al. it is a gram negative rod, motile by monotrichous flagella

Phylum: Proteobacteria Class: GammaProteobacteria Order: Xanthomonadales Family: Xanthomonadaceae

Genus: *Xanthomonas* sp: *campestris* pv. *mangiferae-indicae*

Mode of spread and survival:

- Infected nursery trees have been a major source of BBS in new orchards
- Bacterium enters the leaf through stomata and lenticels in fruit and through lenticels in twigs. The bacterium survives in infected parts on the tree.
- The pathogen survives up to 8months in the leaves. Bacteria from cankers on the twigs are the cause for primary infection on the fruits.
- Disease spread is rapid during rainy days. Disease spread to the new area through infected planting material.
- When fruits are found in bunches disease spreads when they contact each other.

Management:

- Use of clean planting and grafting material and Use of certified seedlings
- Two sprays of streptocycline200-300ppm at 20days interval reduce fruit infection. Dipping the fruits in 200ppm solution of agrimycin-100 is effective.
- Mango verities like Bombay green, fazali, Jehangir and suvarnarekha are resistant.

10 Giant mistletoe: *Dendrophthoe* spp.

Loranthus is a **partial stem parasite**. Loranthus seeds are disseminated by birds on to the stems of the host.

Sytmptoms:

- Loranthus seeds do not require a host germination stimulus and will readily germinate
- The seedling radicle is negatively phototrophic and thus grows towards a dark surface (often the host branch)

- The first attachment structure formed is called a **holdfast**. The haustorium from the holdfast eventually connects to the host xylem and removes water and mineral nutrients from the host
- When in **contact with the host cambium**, the **loranthus haustorium induces formation of additional wood** that enlarges into **fluted columns**
- Loranthus produces **long attractive tubular flowers** which **attract birds** that **disperse seeds**

Phanerogamic Parsites: *Dendrophthoe* (=Loranthus) ampullaceus D. calcycalatus, D. involucratus, D. longiflorus, D. parasiticus and D. philippensis, D. scurrula are partial stem parasites.

Mode of spread and survival:

- The flowering parasite survives in the host plant.
- The parasites flowers profusely in the host plant and produces fruits.
- Birds eat the fruits and excrete seeds on branches of other trees.
- Seeds of the parasites germinate during wet condition and establish on the new host.

Epidemiology: trees in poorly maintained or neglected plantations are highly susceptible.

Management:

- The parasite is cut before berry formation.
- The branches or twigs showing the parasites should be cut about 2.5cm below the point of attachment.
- The cut ends should be protected with Bordeaux paste.

Minor Diseases

1.Black banded / black stem:

Rhinocladium corticolumn Massee – [Syn. *Pexiotruchum corticolum* (Massee) Subram.]. The occurrence of disease in mango was recorded at Pune. Now it occurs in A.P., Goa, Gujrat, Karnataka, maharastra, T.N, and W.B.

Black, velvety or felt-like growth is seen on the midribs and bark of twigs and branches of mango. The disease is very low on main branches. The fungus develops on the colonies of scale insects and therefore it is not responsible for the death of branches but the scale insects are the primary causes for the damage of twigs. It presence a characteristic and conspicuous black banded appearance. The mycelia growth and clusters of conidiophores present a velvety appearance during rainy seasons which drop off in summer months leaving light black bands on the affected portions. Badly infected twigs and branches are to be cut and destroy. The surface of twigs or branches may be scraped off and brushed with a solution of COC with insecticide to get rid of attack of both.

2.Pink Disease

Pellicularia salmonicolor (Berk. &Br.) Dater (Syn. *Corticium salmonisolor*) Berk. &Br. Pinkish powdery coating on twigs and branches due to profused conidial production are the symptoms. Cutting infected branches and protecting the cut wounds with Bordeaux paste controls the pink disease.

3. Blight:

Macrophoma mangiferae Hingoraniand Sharma. Leaf tips dry. Infection spreads towards leaf petiole and causes blighting. Removal and destruction of infected plant parts and spraying with Bordeaux mixture 1.5% at weekly intervals controls the disease.

SCAB:

Elsinoe mangiferae and *Sphaceloma mangiferae* (Patel et al.) Dye. Round or irregular pale brown to grey lesions are formed on leaves with intensification of infection. The leaves become crinkled, deformed and defoliation occurs. Grey or brownish spots develop on young fruits. They enlarge; become corky leading to spoilage of fruits and

reduction of the market value. Repeated spraying with Bordeaux mixture 1% controls the disease.

4. Phoma blight:

Phoma glomerate (Corded) Woolly and Hochapf. The symptoms appear on old leaves only. Initially the lesions are minute, irregular, and yellow to light brown and scattered over the leaf surface. As the lesions enlarge their colour changes from brown to cinnamon. Fully developed spots are characterized by dark margins and dull grey necrotic centers. In severe cases withering and defoliation of infected twigs occur. Spraying with benomyl 0.2 % followed by COC 0.3 %was found effective.

5. Black- Mould Rot

Aspergillus niger v. Tieghem. The affected fruits show yellowing of base and development of irregular, hazy, grayish which coalesce into dark brown or black lesions. The mesocarp of the rotted area becomes depressed and soft. The stalk and infection results in premature fruit drop. A fruit dip treatment with benomyl 155ppm can control the rot.

6. Alternaria rot:

Alternaria tenuissima (Kuntze: Pers) Wiltshire. The disease appears in the small, circular and brownish spots, which enlarge and become irregular to form big water-soaked patches. Reddish patches develop on the flesh below the spotted area of fruit.

7.Bacterial leaf spot:

Pseudomonas mangiferae-indicae. The disease manifests by forming minute water soaked spots towards the leaf tip. These spots form in groups and become black as the disease advances, which are usually haloes. In severe cases these spots form in groups and become necrotic. The leaf dries up in patches. The fruits may drop off.

DODDER: *Cuscuta chinensis*

Mango trees are attacked by the total stem parasite, *Cuscuta* spp. The first appearance of the parasite, dodder in the field is noticed as small masses of branched, thread like, leafless stems which are devoid of the green pigment and which twine around the stem are leaves of the host. The common colour is creamy yellow or orange. The leaves are represented by minute functionless scales. When the stem comes in contact in host, minute root like organs penetrate the host cortex reaching into the fibro vascular bundles. The tiny, white, pink or yellowish flower occurs in clusters. A single plant may be produces many as 3000 seeds. It perpetuates through seeds, which fall on the ground and remain dormant until a favorable seasons returns. Clover, be seem, flax and many oil seed crops are commonly attacked. The crop seed should be properly cleaned and should be free from dodder seeds. Grazing animals should not be allowed to move through dodder-infested area. Badly infested crop should be burnt and destroy before the parasite produces flowers and seeds. Field should be left fallow after selected eradication measures have been completed. Higher crop rotation beginning with non-host crop should be followed to reduce its infestation.

LECTURE 3: DISEASES OF CITRUS

S.No	**Major disease**	
1	Gummosis	*Phytophthora nicotianae* var. *parasitica, P. palmivora, P. citrophthora*
2	Powdery mildew	*Oidium tingitaninum*
3	Diplodia gummosis	*Diplodia natalensis* (Perfect stage: *Physalospora rhodina*)
4	Dry root rot	*Fusarium solani*
5	Scab/Verucosis	*Elsinoe fawcettii* and *Sphaceloma fawcettii*
6	Citrus Sooty Mould	*Capnodium citris*
7	Citrus Anthracnose	*Colletotrichum gloeosporioides*
8	Citrus canker	*Xanthomonas axonopodis* pv. *citri*
9	Tristeza or quick decline	Citrus Tristeza Virus (CTV)
10	Greening or Huanglongbin (HLB)	*Candidatus Liberobacter asiaticus* (Fastidious Phloem limited Bacterium)
11	.Felt disease	*Septobasidium pseudopedicellatum*

1) Gummosis: *Phytophthora nicotianae* var. *parasitica, P. palmivora, P. citrophthora*

Etiology: Aseptate mycelia, zoospore are asexual spores produced in the sporangium, oospore are sexual spores or resting/dormant spores borne in oogonium

PSI: Dormant mycelia and oospore present in effected debris and infested soil.

SSI: Zoospore spread through soil, irrigation water.

Economic importance: Gummosis is widespread in Punjab and Assam. Lemons are more susceptible than grapefruit and rough lemons. In South India, it is common in sweet orange.

Symptoms

- Disease starts as **water soaked patches on basal portions of the stem** near ground level
- Patches turn dark staining of bark brown
- Infection progresses into the wood
- Infected **bark dries, shrinks and cracks and shreds lengthwise** in to vertical strips
- **Reddish brown gum exudes from the bark** of infected trunk. Gum exudation is considerable in sweet oranges, but relatively little in grapefruit
- Infection extends to crown roots
- **Affected collar region is girdled** and finally the infected tree dies
- Prior to death, the tree usually blossoms heavily and dies before the fruits mature



Life Cycle: There are 3 stages:

1) ASEXUAL STAGE: Zoospores borne in sporangium
2) SEXUAL STAGE: Oospores borne in Oogonium
3) VEGETATIVE STAGE: Mycelia with haustoria

- Oospores are sexual spores and also resting spores, present on affected debris for a longer time (6-8 months). When the conditions are favourable, these oospores germinate by producing germ tube, the tip of the germ tube swells to form sporangium.

- Initially sporangium is multinucleated structure, then each nuclei starts formation of zoospore wall. Once these zoospores matures, they start moving randomly and burst open the sporangium wall and become air borne.
- Air borne zoospores move certain distance, then they loose their flagellum and forms circular which is the encystment of sporongia.
- Haustoria is intercellular, Mycelia is intracellular. Once the conditions are adverse temperature increases, dried humidity, due to this fungi switch on to the sexual reproduction, here male reproductive organ is Antheridium and female reproduction oogonium between 2 gametangial processes.
- Oogonium is circular in nature, eunucleated, sometimes 1 cell or 4 cells are there. Antheredium tubular in nature and multinucleated, Gametangial contact.
- Once union of oogonium and gametangial takesplace Plasmogamy takesplace. After Antheridium lesicata takes place karyogamy.

Epidemiology:

- Cool weather, temperature 18-22^{0}C: 90-95% RH, High soil moisture, PH 6-7.
- **Prolonged direct contact of trunk with water**, as in flood irrigation and water logging predisposes trees to disease
- Incidence is more in black soils than in light soils
- **High water table** leads to high incidence
- The disease is severe in high rainfall areas
- **Low budded grafts** are mostly affected

Management

1. Preventive measures

- Selection of proper site with adequate drainage
- Selection **high budded** grafts (30 to 45 cm or above)
- Following **Double ring method of irrigation** by providing an **inner ring** about 45 cm around the tree trunk to prevent direct moistening of trunk
- Avoid injuries to crown roots or base of stem during cultural operations
- Use resistant **sour orange or trifoliate orange rootstocks** for propagating popular/commercial varieties
- Painting Bordeaux paste or with ZnSO4, CuSO4, lime (5:1:4) to a height of about 60 cm above the ground level at least once a year.

2. Curative measures

- Scrape/chisel out the diseased portion
- Protect the cut surface with **Bordeaux paste** followed by spraying with **Fosetyl-Al 0.2%**
- Soil drenching with **0.2% Metalaxyl** (Metalaxyl+Mancozeb = Ridomil MZ 72)
- Apply ***Trichoderma viride*** multiplied on **neem cake**

2. POWDERY MILDEW*: Oidium tingitaninum*

Symptoms:

- Whitish powdery growth on young leaves & twigs.
- The affected leaves get distorted and in severe condition drop down.
- Infected twigs exhibit characteristic die back symptom.
- Young fruits are also covered by whitish powdery mass of the fungus and drop off prematurely, resulting in poor yield.

Etiology and Spread:

- Comparatively cool and moist regions are prone to disease development.
- Damp mornings with are few hours of sunshine favour onset of the disease.
- The fungus is an ectoparasite and absorbs food materials from the epidermal cells of leaf through houstoria.
- It is a wind- borne disease. Septate mycelia, barrel shaped conidia born in chains, ectophytiic, sub epiderml haustoria, external mycelia.
- PSI: Dormant mycelia.
- SSI: Air borne barrel shaped conidia.

Life cycle:

- Dormant mycelia present in the affected parts. During congenial conditions germinates and produce oidea.
- After maturity barrel shaped conidia releases, flight and land on host.
- Infection takes place by producing sub epidermal haustoria & plant start producing powdery growth comprising of oidea.
- Oidea is an asexual fruiting body of the powdery mildew, barrel shaped conidia borne in chains on oidiophore.
- Then they release, flight & landing on their respective host.
- Infection process continues asexually:

Management:

- Prophylactic measures: cloudy warm weather, spray Wettable sulphur 3gm/ lt
- Aerial spray: Bavistin 1.25gm/lt,calixin 1ml/lt
- Wider spacing
- Avoid high density planting
- Avoid excess N application
- Provide recommended K application

3. Diplodia gummosis: *Diplodia natalensis* (Perfect stage: *Physalospora rhodina*)

Economic Importance: Occurs commonly in Andhra Pradesh, Tamil Nadu and Uttar Pradesh. It is common on **Sathgudi** and **Batavian** oranges, **mandarins** and **lemons** in A.P. and Tamil Nadu.

Symptoms

- **Upper portions of the trunk, branches and twigs** are usually attacked
- Infection starts on growth cracks or ridges at **crotches**
- **Black gum oozes** out from the cracks developed on the diseased portion
- Infection spreads from bark to wood which dries and becomes discoloured
- Sometimes branches break at the infected portion
- **Dieback of tender twigs** and also profusely bearing branches occurs
- Large limbs are killed and if left unchecked the whole tree may be killed

Survival and spread

Primary: Black **pycnidial** bodies on the diseased bark

Secondary: **Pycnidiospores** or **conidia** by air, rain and insects

Favourable conditions

- Reduced tree vigour
- Insect damage
- Malnutrition
- Old age

Management

- Good orchard management to **maintain vigour of tress**
- Wound in the bark and gummed portions especially on limbs and forks should be scraped and protected with **Bordeaux paste**
- Spraying **Carbendazim 0.1%** on limbs and forks of affected and also on healthy trees

4. Dry root rot: *Fusarium solani*

Economic Importance: Dry root rot is a major problem in all citrus growing areas of Andhra Pradesh in both **sweet orange** and **acid lime**. It is also common in North Arcot district in Tamil Nadu and in Mandarins in Wynad

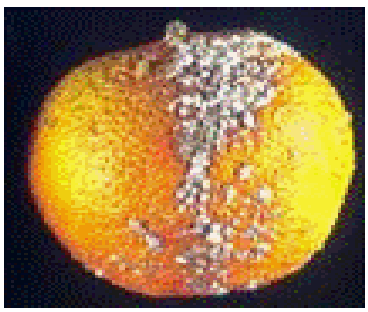
Symptoms

- Affected trees blossom profusely bear a heavy crop of small sized fruits
- Disease is characterized by **sudden loss of turgidity yellowing and withering of leaves**
- Infected plants do not recover even when watered
- Moist decay of root bark in the early stages which later becomes dry and shredded with hard dead wood underneath
- **Peeling of bark** of the **affected roots** and formation of black sclerotia if *M. phaseolina is involved*, on the root surface is also common

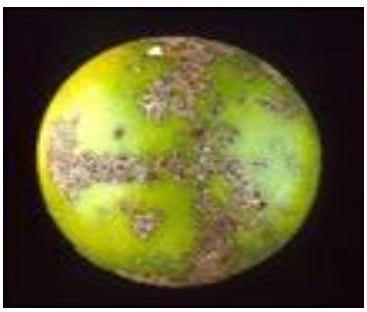
Survival and spread
Primary: **Chlamydospres** in soil
Secondary: **Macro and micro conidia** through irrigation water and implements
Favourable conditions
- Lack of sufficient **soil moisture**
- **Poor aeration** in defective soils with hard pan below leading to unfavourable soil-airmoisture relationship in the subsoil
- Nitrogen and other **nutrient deficiency**

Management
- Select soils of **sufficient depth** and **without hard pan** below
- Select **healthy grafts and seedlings** for raising new orchards
- Avoid **deep ploughing or digging** which are likely to injure roots
- Maintain **vigour of plants** correct nutrient and moisture deficiencies
- **Leaf mulch** in the tree basins during the dry season helps in **conserving soil moisture** and thereby reducing disease incidence
- Drench the soil with **Carbendazim 0.25%** or **Bordeaux mixture 1%** at the rate of 1 litre per m2 of the tree basin in early stage of infection
- Apply ***Trichoderma viride*** multiplied in 10 kg of **neem cake** per tree annually

5. Scab/Verucosis : *Elsinoe fawcettii* and *Sphaceloma fawcettii*
Commons scab or sour orange scab - *Elsinoe fawcettii*
Sweet orange scab – *E. australis*
Anamorph – *Sphaceloma fawcettii* var. *scabiosa*
Symptoms
- Attacks leaves, twigs and fruits of mandarin.
- Sour orange, lemon, mandarin, tangelos extremely susceptible Grapefruit, sweet oranges and acid lime highly resistant. Severe in rainy seasons.
- On the leaves the disease starts as small pale orange coloured spots.
- The leaf tissue is distorted to firm hollow conical growths with the lesion at the apex.
- The crest of these growths becomes covered with scabby corky tissue colour at first but later becomes dark olive with age.
- Lesions most common on undersurface of leaf. They penetrate leaf and are later visible on both sides.
- Infected areas run together and cover large area. Leaves wrinkled, distorted and stunted.
- On twigs similar lesions are produced.
- They form corky outgrowths.On fruits irregular scably spots or caked masses produced.
- Cream colour in young fruits; dark olive grey in old fruits.
- Fruits attacked when young become misshapen with prominent warty projections. They drop prematurely



Lime fruit



Sweet orange

Etiology and spread:
1. It is believed that the pathogen perpetuates and survives in off season as perithicium.
2. Secondary spread may be through the conidial stage, which is mostly produced on the host.
3. Conidia are produced between 7 degree & 33 degree celcius at 66-100% RH on young lesions.
4. Conidia from old lesions are dispersed during rains, but only to short distance.

Management

- Collect the infected leaves and burn it.
- The disease can be controlled by spraying with 1% Bordeaux mixture, difolatan and benomyl.
- Chemical:Carbendazin-1.25gm/lit
- Avoid excess N application
- Provide recommended K application.

6. CITRUS SOOTY MOULD: *Capnodium citris*

It is not actually a disease of plants. The fungi purely grows on the surface by utilizing the inset excreta or honey secretions by insects and plant. By growing such blacky mold on the surface, abstructing the sunlight to reach the photosynthetic area (green chlorophyll) of the plant and thus interfering in photosynthesis.

Symptoms:

1. Black colored sooty mass covering the leaf surface, sometimes on young stem, fruit surfaces.
2. Black sooty mass comprising of conidia and mycelia.
3. Affects normal photosynthesis, thereby plant growth decreases.
4. This is purely ectophytic and not plant parasitic fungi. By utilizing leaf exudates and honey like substances secreted by insects and also insect excreta, this fungi grows on the surface.

Etiology and Spread

Management:

1. 1% Starch sprays, after it forms flakes on the sooty mass, along with flakes sooty mass fall off from the leaves after drying.
2. Spraying systemic insecticides to manage the insects population could help in avoiding or reducing the sooty mold.

1. **CITRUS ANTHRACNOSE: *Colletotrichum gloeosporioides***

Symptoms:

1. The disease leads to defoliation and tip drying of twigs, it is called whither tip.
2. Shedding of leaves and dieback of twigs.
3. On the dead twigs acervuli appear as black dots.Light green spots appear which later turns brown.
4. The pathogen also infects the stem-end of immature fruits causing fruit drop.
5. In severe cases branches die back.

Etiology

Septate mycelia, asexual fruiting body-acervulus setae are present
Primary source of inoculum: Dormant mycelia
Secondary source of inoculum: Conidia produce by Acervulus

Epidemiology:

Warm weather, temperature 30-32oC, RH 80-85%, Cloudy weather susceptible to host.

Management

1. Collect the affected leaves and burn it.
2. Avoid excess N application.
3. Summer irrigation is best.
4. Chemicals: Carbendazim-1.5gm/lt
5. Benomyl-1gm/lt

2. Citrus canker: *Xanthomonas axonopodis* pv. *citri*

Economic Importance: In India, citrus canker is endemic and occurs in all the citrus growing areas. It is reported from Punjab, Tamil Nadu, Andhra Pradesh, Karnataka, Rajasthan, Madhya Pradesh, Assam, and Uttar Pradesh. **Acid lime** is highly susceptible than other citrus fruits. Total destruction of citrus orchards was done for eradication of canker in Florida State of USA

Symptoms

- Canker appears on leaves, petioles, twigs, branches, fruit stalks, fruits and thorns. When it is severe, trunk and roots are also affected
- But the symptoms are most conspicuous on leaves, twigs and fruits

- On leaves minute water soaked round spots develop which enlarge slightly and turn **brown, eruptive and corky**
- On acid lime and sweet orange **leaves** spot measure about 2 to 3 mm in diameter and are surrounded by a characteristic **yellow halo**
- Due to severe infections of the leaves there may be defoliation, and severe infections of the twig and stem may cause die-back symptoms. The plants also remain stunted and fruit yields are reduced considerably
- Canker lesions **on the fruit are not surrounded by yellow halo**. Several lesions on fruit coalesce to form a patch. The crater-like appearance is marked on fruits than on leaves
- The market value of the fruits is considerably reduced by the canker spots, though such infections are mostly confined to the fruit skin

Survival and spread

Primary

Bacterial cells survive in **leaves** for 6 months on infected trees

Autonomous dispersal through **infected seedlings**

Secondary

- **Bacterial cells** spread by **rain splashes**
- Citrus leaf miner (Phyllocnistis citrella) helps in the dissemination of the bacterium

Favourable conditions

- **Free moisture** for 20 minutes at 20-30°C and **high relative humidity (>85%)** favour initiation of disease
- Infestation by citrus leaf miners (***Phyllocnistis citrella*)**

Management

- Select **healthy seedlings and grafts** for planting in new areas
- **Prune out and burn** all canker infected twigs before monsoon
- Periodical spraying of **Streptocycline (1 g) + Copper oxychloride (30 g) in 10 litres of water** at fortnightly interval in nurseries and at fortnightly interval in orchards during rainy season
- Use canker tolerant varieties like "**Tenali selection**" and "**Balaj**i"
- **Control leaf miner** when young flush is produced

3. **Tristeza or quick decline:** Citrus Tristeza Virus (CTV)

Flexuous filamentous virion belonging to Closterovirus group with +ve ssRNA

Economic Importance: This disease was first reported in *Citrus aurantifolia* and *C. sinensis* from Italy and Florida in the U.S.A. In India, tristeza is prevalent in Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Bihar, West Bengal and Sikkim.

It affects all citrus types but sweet orange, grapefruit and lime are more attacked. Tristeza symptoms consisting of a quick or chronic tree decline are particularly common and severe on trees propagated on sour orange root stocks. The name "Tristeza" was suggested to describe the **sad appearance** of the diseased citrus trees. **Kaghzi lime** and **Nasnaran** are **indicator** plants for CTV detection.

Symptoms

- Tristeza affected trees look **chlorotic and sickly** in the early stages. Gradually the leaves drop and the defoliated twigs show die-back. The declining trees die gradually but sometimes apparently healthy trees die suddenly
- **Vein clearing or vein flecking** (elongated translucent area) in young leaves of acid lime is visible when viewed against light (characteristic symptom)
- Characteristic **stem pittings** are formed on infected trees
- In sweet orange, the specific symptom of tristeza is **honeycombing**, a fine pitting of inner face of bark in the portion of trunk below the bud union. In acid lime vermiform or linear pits appear in the woody cylinder
- Tristeza infected citrus trees on sour orange rootstocks cause **phloem necrosis** at the graft union

- Diseased trees usually **blossom heavily**. Trees with stem pitting are stunted and set less fruits. The fruits are of smaller size and of poor quality (insipid fruits). As the fruits develop, the tree wilts partly or completely.
- Grapefruit and acid lime are susceptible irrespective of root stock

Survival and spread

Primary

The virus particles spread through budwoods and grafts

Secondary

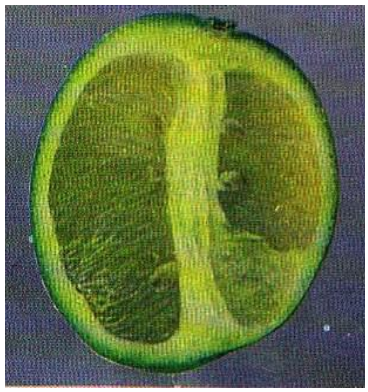
Virus particles transmitted by aphid vector, ***Toxoptera citricida***

Management

- **Strict quarantine** measures to be enforced. Use **certified budwood** free of CTV to prevent primary (vertical) spread of disease
- **Remove all diseased trees** as and when the disease is noticed. Fresh plantings to be taken with virus free materials on tolerant rootstocks. For sweet orange and mandarin avoid susceptible root stocks
- For Andhra Pradesh, Maharashtra and Karnataka, **Rangapur lime** is recommended as a root stock resistant to Tristeza. For the Punjab region, Jattikhatti, Cleopatra mandarin and sweet orange are recommended as resistant root stocks
- For acid lime, use seedling preimmunised with mild strain of tristeza virus (**Crossprotection**)
- Periodic sprays of insecticides like **dimethoate or methyl S demeton** at 2 ml/l to reduce the secondary (horizontal) spread of the disease in the orchard

10. Greening or Huanglongbin (HLB): *Candidatus Liberobacter asiaticus* (Fastidious Phloem limited Bacterium), Obligate gram negative bacterium

Economic importance: Greening disease is known to occur in Andhra Pradesh, Karnataka,
Punjab, Uttar Pradesh, Himachal Pradesh, Rajasthan, Maharashtra, Jammu, Bihar, Bengal and Sikkim. This disease affects almost all citrus varieties irrespective of root stock but more **severe on sweet orange** than on acid lime, mandarin and grapefruit. In India **Mosambi sweet orange** and **Darjeeling orange** (*Citrus reticulata*) are good **indicator plants** for greening.



Symptoms

- Affected trees are stunted with pronounced leaf and fruit drop. Varied chlorotic patterns on leaves are noticed which are persistent and cannot be corrected by mineral nutrient sprays
- Reduction in leaf size is common. Many affected leaves show small **circular green islands** within the chlorotic areas. Heavy leaf fall occurs with the onset of summer. Often new flush may come out with leaves that are short, upright and chlorotic having green veins or with green blotches on the leaves
- Twig die-back occurs. Some branches in a tree exhibit severe symptoms whereas others in the same tree are apparently normal
- **Fruits** show reduction in size, **lopsided** in growth and **oblique (curved) columella**
- The rind surface exposed to sun appears yellow whereas the remaining portion remains dull green. Diseased fruits are valueless owing to small size, distortion, low in juice and soluble solids, high in acid and insipid taste
- Seeds are poorly developed, dark coloured and aborted

Survival and spread

***Primary*:** The **bacterial cells** spread through **budwoods and grafts**

Secondary*:** The **bacterial cells** transmitted through citrus **psylla, *Diaphorina citri. The bacterium is also transmitted from citrus to Periwinkle (*Catharanthus roseus*) through dodder

Management

- Select **certified disease-free seedlings**. Use pathogen free bud wood for propagation
- Raise virus free plants through shoot tip grafting
- Remove and destroy infected trees
- Control psyllids with insecticides like **dimethoate, or methyl s demeton**
- Tetracycline (500 ppm) spray though effective, requires fortnightly application and is also not advocated for human health reasons

11. Felt disease: ***Septobasidium pseudopedicellatum***

Symptoms

- The disease starts with onset of monsoon in case of acid lime
- A soft felt like fungal growth encircles the twigs and branches
- The fungus grows over the bark and does not penetrate the surface. The growth is light brown to grey in colour and colonies of **scale insects** can be seen underneath it
- This results in drying of twigs and branches terminal to the point of infection

Management

- Prune the infected branches at least 2" below point of infection and destroy by burning
- Spray twice with Monochrotophos 0.05% and Zineb 0.25% with the onset of monsoon at monthly interval to prevent scale infestation and fungal infection

LECTURE 4: DISEASES OF GRAPE

S.No.	**Major disease**		
1	Powdery mildew		*Uncinula necator (I.S: Oidium tuckeri)*
2	Downy mildew		*Plasmopara viticola*
3	Anthracnose / Birds eye disease		*Elsinoe ampelina* (I.S: *Gloeosporium ampelophagum* or *Sphaceloma ampelina*)
4	Alternaria leaf spot		*Alternaria vitis*
5	Rust		*Phakopsora euvitis*

1) Powdery mildew: *Uncinula necator (I.S: Oidium tuckeri)*

Losses in yield of fruits may be upto 40-60%. In addition to loss of yield, infected berries tend to have higher acid content than healthy fruits and are unsuitable for wine making.

Symptoms

- The disease attacks vines at any stage of growth. All the aerial parts of the plant are attacked. Cluster and berry infections usually appear first
- Floral infection results in shedding of flowers and poor fruit set
- Early berry infection results in shedding of affected berries
- Powdery growth is visible on older berries and the infection results in the **cracking of skin of the berries**. Often infected berries develop a net-like pattern of scar tissues
- Powdery growth mostly on the upper surface of the leaves
- Malformation and discolouration of affected leaves. Leaf lesions appear late and cause lesser damage than cluster or berry infection
- Infection of stem leads to dark brown discolouration

Survival and spread

Primary: Through **dormant mycelium** and **conidia** present in the infected shoots and buds

Secondary: Through air-borne **conidia**

Favourable conditions

- Cool dry weather
- Maximum temperature in the range of 27-31ºC with R.H. up to 91% favour disease incidence (November and December).

Management

- Clean cultivation of vines or removal and destruction of all diseased parts
- Dustings of vines with 300 mesh Sulphur (1st when new shoots are 2 weeks old, 2nd prior to blossoming, 3rd when the fruits are half ripe)
- Prophylactic spray with B.M. 1% or Lime sulphur at dormant stage delays development of disease by decreasing initial inoculum
- Spray wettable sulphur @0.3% or Dinocap or Tridemorph @0.1%
- Oxythioquinox (Morestan) @0.03% sprayed at 4 days interval starting from last week of December to 1st week of March
- Grow resistant varieties like Chholth Red, Chholth white, Skibba Red, Skibba White

2) Downy mildew: *Plasmopara viticola*

Economic importance

- Since 1875, this disease caused heavy losses to vine industry in France
- It led to discovery of Bordeaux Mixture by Prof. Millardet in 1885

Symptoms

- Symptoms appear on all aerial and tender parts of the vine. Symptoms are more pronounced on leaves, young shoots and immature berries
- Irregular, yellowish, translucent spots limited by veins appear on upper surface of leaves
- Correspondingly on the lower surface dirty white, downy growth of fungus appears
- Affected leaves become yellow and brown and dried due to necrosis
- Premature defoliation
- Dwarfing of tender shoots

- Infected leaves, shoots and tendrils are covered by whitish growth of the fungus
- White growth of fungus on berries which subsequently becomes leathery and shrivels
- Infected berries turn hard, bluish green and then brown
- Later infection of berries results in soft rot symptoms. Normally, the fully grown or maturing berries do not contact fresh infection as stomata turn non-functional
- No cracking of the skin of the berries



Survival and spread

- ***Primary***: Oospores present in the infected leaves, shoots and berries. Also as dormant mycelium in infected twigs
- ***Secondary***: Sporangia or zoospores by wind, rain and insects

Favourable conditions

- Optimum temperature : 20-22°C
- Relative humidity : 80-100 per cent
- High soil moisture

Management

- Field sanitation by collection and burning of fallen leaves and twigs
- Vine should be kept high above ground to allow circulation of air by proper spacing
- Pruning (April - May & September - October) and burning of infected twigs
- Grow resistant varieties like Amber Queen, Cardinal, Champa, Champion, Dogridge and **Red Sultana**
- The disease can be effectively managed by giving 3-5 prophylactic sprays with Bordeaux mixture 1% or **Fosetyl -Al (Aliette)** 0.2% or curative spray with **Metalaxyl + Mancozeb (Ridomil MZ 72)** 0.2% or Azoxystrobin 0.1%
- Spray schedule with Bordeaux mixture1% and other chemicals
  1 – Immediately after pruning of vines
  2 - When new flush is formed (3-4 weeks after pruning)
  3 – Before buds open
  4 - When bunches or berries are formed
  5 – During shoot growth

3) Anthracnose / Birds eye disease: *Elsinoe ampelina* (I.S: *Gloeosporium ampelophagum* or *Sphaceloma ampelina*)

- It is especially serious on new sprouts during rainy season. Among various foliar diseases of grapevine in India, anthracnose has longest spell spread over from June to October
- **Symptoms**
- Visible on leaves, stem, tendrils and berries
- Young shoots and fruits are more susceptible than leaves
- Circular, greyish black spots or red spots with yellow halo appear on young leaves
- Later the centre of the spot becomes grey, sunken and fall off resulting in a symptom called ‘shot hole’
- Black, sunken lesions appear on young shoots
- Cankerous lesions on older shoots. Girdling and death of shoots may occur
- Infection on the stalk of bunches and berries result in the shedding of bunches and berries

- **Sunken spots with ashy grey centre and dark margin** appear on fruits (**bird's eye** symptom). In warm and wet weather, pinkish spore mass develops in the centre of spots
- **Mummification** and shedding of **berries**


Survival and spread

Primary: Survives as dormant mycelium in the infected stem-cankers

Secondary: Wind borne and rain splashed conidia

Favourable conditions

- Warm wet weather with continuous drizzle of rain and windy weather for 2-3 days
- Low lying and ill drained soils
- Anab-e-Shahi variety is susceptible.

Management

- Removal of infected twigs
- Selection of cuttings from disease free areas and dipping them in 3% FeSO4 solution for 30 minutes before planting.
- Spraying Bordeaux mixture 1% or COC @ 0.25% or **carbendazim** @ 0.1%.
- Varieties like Banglore blue, **Golden Muscat**, Golden queen and Isabella are resistant

4) Alternaria leaf spot: *Alternaria vitis*

Symptoms

- In the initial stage, minute, yellow spots appear on the upper surface of leaves
- Later, spots enlarge and form brownish spots with concentric rings in them
- Individual spots appear rarely in the middle of the leaves
- Appearance of patches of spots mostly along the margin of leaves
- In severe cases of attack, leaves dry completely and defoliation occurs

Survival and spread

Primary: Survives as mycelium or conidia in infected plant debris

Secondary: Wind borne conidia

Favourable conditions

- High humidity
- High rainfall and dew
- Heavy dose of nitrogenous fertilizers

Management

- Sanitation of the orchard
- Selection of disease free planting material
- Foliar spray of mancozeb@0.25%

5) Rust: *Phakopsora euvitis*

Common throughout South-East Asia and other parts of the world. Cultivar **Black prince** is highly susceptible

Symptoms

- Minute yellow coloured pustules are formed initially on lower surface and later on upper surface
- These pustules turn in to orange powdery spores on the underside of mature grapevine leaves
- Under severe infection, the entire leaf surface is covered by sori leading to premature defoliation
- The disease eventually weakens the vine due to poor shoot growth
- Reduction in quantity and quality of fruit

Survival and spread

- ***Primary***: Teliospores in infected plant debris. *Meliosma myriantha* is the alternate host on which pycnia and aeciospores are produced
- ***Secondary***: Wind borne uredospores
- The pathogen also infects *Ampelocissus* spp in Australia

Management

- Field sanitation
- Destruction of alternate host
- Spray zineb@0.2% or dust sulphur@25Kg/ha or Oxycarboxin 0.2% or Triadimefon 0.1%
- Breeding resistant varieties

LECTURE 5: DISEASSES OF BANANA

S.No.	**Major diseases**		
1a	Yellow Sigatoka		*Mycosphaerella musicola* (I.S: *Pseudocercospora musae*)
1b	Black sigatoka		*Mycosphaerella fijiensis* (I.S: *Paracercospora fijiensis*)
2	Panama wilt		*Fusarium oxysporum* f.sp. *cubense*
3	Moko disease / Bacterial wilt		*Ralstonia solanacearum* (race 2)
4	Anthracnose		*Colletotrichum musae*
5	Freckle or Black Spot		*Phyllostictina musarum*
6	Erwinia rhizome rot		*Erwinia caratovora* sub.sp. *caratovora* and *Erwinia chrysanthemii*
7	Bunchy top / Curly top / cabbage top /strangles disease		Virus
8	Banana Mosaic / Infectious chlorosis / Heart rot)		Cucumber Mosaic Virus (CMV)
9	Banana bract mosaic		*Banana bract mosaic virus* (BBrMV)
	Post Harvest Disease		
10	Anthracnose		*Colletotrichum musae*
11	Fluffy white rot		*Fusarium moniliforme*
12	Crown rot		*Botryodiplodia theobromae*
13	Cigar-end rot		*Verticillium theobroma*

1) Yellow Sigatoka – *Mycosphaerella musicola* (I.S: *Pseudocercospora musae*)
Black sigatoka – *Mycosphaerella fijiensis* (I.S: *Paracercospora fijiensis*)

- First observed in Java in 1902
- Epidemic in 1913 in *Sigatoka* valley in Fiji
- Wide spread in nature and occurs is many countries except in Egypt and Israel
- In India a serious threat in states of Assam, Tamil Nadu, Karnataka & A.P
- The most important commercial cultivars belonging to Cavendish group are highly susceptible
- Black Sigatoka is not prevalent in India

Symptoms

- Early symptoms appear on the lower leaves
- Initially small reddish brown specks develop on leaves near the tip or margin of lamina
- Specks may also be produced near the midrib
- Specks increase in size and turn in to **spindle shaped spots** with reddish brown margin and gray centre surrounded by a yellow halo
- Spots formed near the midrib enlarge and extend towards the margin of lamina
- Spots coalesce and the entire spotted area appears dried
- Disease gradually progresses on to upper leaves
- Infection becomes severe after bunch emergence with the entire foliage infected under favourable conditions
- Fruits in bunches of infected plants are under developed and may ripen prematurely

Survival and spread

Primary: Pathogen survives on dry infected leaves on the field soil and primary infection takes place through **ascospores** produced in the infected plant debris

Secondary: **Conidia** by wind and rain splash

Favourable conditions

- High humidity, heavy dew and rainy weather with temp above 21o C
- Prolonged leaf wetness periods
- Poor drainage and low soil fertility particularly of potassium
- Closer planting
- Susceptible cultivars like Grand Naine, Dwarf Cavendish and Giant Cavendish
- More suckers in a mat because of non removal

Management

- Planting banana in well drained soils
- Growing moderately resistant cultivars like Karpura Chakkerakeli
- Planting at recommended density (1000 plants/acre)
- Prunning suckers periodically to avoid overcrowding in the field
- Removal and destruction of affected leaves followed by spraying with BM 1% + linseed oil 2%
- Applying recommended dose of potassium fertilizer
- Spraying mancozeb or cholorothalonil 0.2% suspended in mineral (paraffin) oil
- Spraying chlorothalonil 0.2% with non ionic adhesive in pre-monsoon period and propiconazole 0.1% interspersed with tridemorph 0.1% at 20 days interval in rainy period

2) Panama wilt- *Fusarium oxysporum* f.sp. *cubense*

- First reported from Australia in 1876
- The popular variety Gros Michel, mostly grown for export quality fruits, was most susceptible and had to be replaced with Cavendish bananas which were resistant in the Latin American countries
- Cultivars **Rasthali (Amrutapani), Gros Michel, Karpooravalli** cultivars are susceptible
- Four races of the pathogen are known to exist but race 1 is mostly prevalent in India attacking Silk group of cultivars (Rasthali or Amritapani)

Symptoms

- Fungus attacks roots and finds its way in to the pseudostem
- Conspicuous symptoms usually appear on 3 to 5 months old plants, although 2-3 months old plants are also killed under highly favourable conditions
- Symptoms initially seen in **older plants** in a mat
- The earliest symptoms are faint yellow streaks on the petiole of oldest, lower most leaves
- Affected leaves show progressive yellowing, break at the petiole and hang down along the pseudostem
- **Longitudinal splitting** of pseudostem is very common
- Light yellow to dark brown discolouration of vascular strands in pseudostem. Usually the **discolouration appears first in the outer or oldest leaf sheath and extends in to the inner sheaths**
- The fungus grows and blocks the vascular system resulting in wilting of the plant
- Vascular discolouration in cross sections of rhizome appears reddish brown towards periphery progressing in to centre of rhizome
- Rhizomes of affected plants give characteristic odour of rotten fish if infection is due to odoratum isolate of the pathogen
- Young suckers also develop the disease but rarely develop external symptoms
- Affected plants do not produce bunches. Even if produced, **fruits are malformed and ripen prematurely or irregularly.** However the pathogen does not infect the fruits



Survival and spread

Primary: **Chlamydospores** in soil and propagules in infected suckers used for planting

Secondary: **Micro and macro conidia** through irrigation water

Favourable conditions

- Saturated poorly drained heavy soils
- Cultivation of susceptible cultivars like Amritapani
- Infection by burrowing nematode, *Radopholus similis*, predisposes the plants to disease

Management

- Use of disease free suckers for planting
- Avoid ill drained soils
- Flood fallowing for 6 to 24 months or crop rotation with puddle rice
- Application of lime (1-2 kg/pit) to the infected pits after chopping of the plants parts
- Dipping of suckers in carbendazim (0.1%) solution before planting
- Neem cake + *Trichoderma viride* should be applied in planting pits
- Soil drench with 0.2% carbendazim or rhizome injection with 0.2% carbendazim
- Growing resistant Cavendish varieties, *viz*., **Basrai** (Vamanakeli or Dwarf cavendish), **Poovan** (Karpura chakkarakeli) etc.

3) Moko disease / Bacterial wilt: *Ralstonia solanacearum* (race 2)
(*Pseudomonas* or *Burkholderia*)

- Gram negative bacterium with rod shaped cells that are motile by 1-4 flagella
- Also infects collateral hosts like *Heliconia*
- First recorded in Guyana in 1840 in *Moko* plantain
- Not reported from India

Symptoms

- Symptoms start on rapidly growing **young plants**
- The youngest three to four leaves turn pale green or yellow and collapse near the junction of lamina and petiole
- Characteristic discoloration of vascular strands, wilting and blackening of suckers
- Vascular discolouration (pale yellow to dark brown or bluish black) is concentrated near the **centre** of the pseudostem, becoming less apparent on the periphery
- Greyish brown bacterial ooze is seen when the pseudostem of affected plant is cut transversely
- A firm **brown dry rot** is found within fruits of infected plants (characteristic symptom)
- Death of whole plant occurs under severe infection.

Survival and spread

Primary: Bacterial cells in soil and through diseased plant suckers used for planting

Secondary: Bacterial cells through irrigation water

Life Cycle:

• The bacteria survive through infected rhizomes and also in soil for 6 months to 2 year.

- The spread is through use of infected rhizome, cutting machetes at the time of planting, and through insects which carry the bacteria from oozing suckers and male flowers to bracts to healthy inflorescence and other parts of the plant.
- Entry into the host is mainly through wounds such as those caused during various cultural operations and during attack of insects and nematodes.
- The bacteria multiply rapidly in the xylem.
- Auxin balance of the plant is disturbed.
- IAA is synthesized by the bacterium and by the host and accumulates due to inhibition of the auxin degrading system.
- Loss of virulence in the bacterium is generally accompanied

Management

- Grow relatively resistant varieties like **poovan** and monthan
- Adopt strict plant quarantine and phytosanitary measures and plant healthy suckers
- Exposure of soil to sunlight during dry hot weather
- Eradicate infected plants and suckers by rouging or killing *in situ* by application of herbicides
- Disinfestation of tools with formaldehyde diluted with water in 1:3 ratio
- Crop rotation (3 years rotation with sugarcane or rice) & providing good drainage
- Allow fallow period or flooding during off-season
- Fumigation of infected site with Methyl Bromide or chloropicrin
- Drenching soil in infected pockets with bleaching powder solution (1.5%) and Bordeaux mixture 1% + streptocycline (0.02%)
- Biocontrol with *Pseudomonas fluorescens*

4. Anthracnose*: Colletotrichum musae*

Symptoms:

- It can be seen in the distal end of banana. The skin turns black. Shrivels and covered with characteristic pink colored asexual fruiting body acervulus.
- As the disease advances, it spreads to entire finger, entire bunch and resulting in premature fruit ripening.
- The shrivelled fruits covered with pink spore masses, which finally rot. Ripe fruits are more susceptible than unripe fruits
- Latent Infection: usually originated in the field on uninjured fruits. When fruits approaches maturity, the fungus resumes activity and cause typical lesions on ripe fruits.
- Non-latent Infection: usually begins during or after harvest as small peel wounds and continue to develop without dormancy.

Etiology:

- Asexual fruiting body is Acervulus. Conidiophores are cylindrical, septate, branched and sub hyaline towards the base.
- Conidia are hyaline, aseptate, oval to elliptical, flattened at the base.

Mode of spread and survival:

- Primary source of inoculum: Dormant mycelia for long time in the fallen leaves.
- Secondary source of inoculum: Air and splash borne conidia produced from the acervuli.

Epidemiology:

- The disease is favored by high temp and humidity. 30 -35 ^{o}C temp and 85 -100% relative humidity and also by fruit damage.
- Black end is the name given to the decaying of stem end on single fingers whereas, Finger stalk rot are also known as Santa Marta stem end rot or Neck rot and is common in complete bunches.
- Disease is more abundant during rainy season. Ripe fruits in storage are more susceptible than the unripe fruits in the fields. Cavendish is more susceptible variety.

Management:

- In the field, distal bud should be removed when all the hands have opened to prevent infection.
- Infected materials must be burnt.
- Fruit should be free from infection and as sound as possible before it is transported, stored and ripened.
- Banana bunches should harvested at correct stage of maturity.

- After harvested of the bunches, they should be transported to the storehouse without causing any bruises to them. The transported bunches should be carefully and cooling should be done.
- Fruit stored at 7-10^{o}C.
- Pre harvest spray with Carbendazim@ 0.1% four times at fortnightly interval is highly effective.

5. Freckle or Black Spot: *Phyllostictina musarum*

Symptoms

- Minute raised dark brown spots appear with black dots in the centre on leaves and fruits
- On the fruits the pathogen is confined to the skin.
- The fungus produces pycnidium which are dark. Cconidiophores simple, short, elongate.
- Conidia are byline, single celled ovoid.
- Fungus survives in infected plant debris. Conidia spread by rain water and wind.

Management

- Spray Copper oxychloride 0.25%. Add wetting agent such as teepol or sandovit added at the rate of 1ml/lit of water.

6) *Erwinia* rhizome rot: *Erwinia caratovora* sub.sp. *caratovora* and *Erwinia chrysanthemii*

Symptoms

- Usually young plants are attacked. Under favourable conditions even mature plants are infected
- In newly planted young sprouting sucker the rhizome is infected and infection progresses in to pseudostem leading to toppling or tipover of the germinating sucker
- In established plants water soaked spots develop on outer leaf sheaths on base of pseudostem near the soil line
- The spots turn brown and soft rotting of pseudostem tissue and rhizomes takes place
- Infected plants have scanty roots with dark brown lesions and necrotic tip
- Infection spreads to upper part of pseudostem and to rhizomes
- In many cases, the pseudostem tips over because of breaking caused by rotting at the ground level

- Mature plants are slow to exhibit symptoms and may produce small sized bunches which may fail to emerge from the shoot tip
- In infected rhizomes, pockets of dark water soaked areas develop. Infection may result in the production of cavities which resemble root borer tunnels

Survival and spread

Primary: Bacterial cells in soil and through diseased plant suckers used for planting

Secondary: Bacterial cells through irrigation water

Favourable conditions

- Juvenile stage of the crop is highly susceptible
- Prevalence of high temperature (37o C) in early stages of crop
- Water logging and high temperatures favour infection by *E. chrysanthemii*
- Growing susceptible cultivars the Cavendish and Tella chekkarakeli

Management

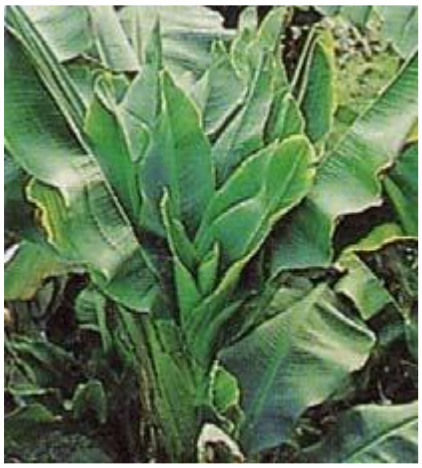
- Avoid planting susceptible varieties during periods of high rainfall or in water logged soils in problematic areas
- Crop rotation with rice or sugarcane for three to four years
- Ensure that only healthy suckers are planted. Dip the suckers in copper oxychloride (5g/lt) + monochrotophos (2.5ml/l) solution
- Maintain proper soil aeration by intercultivation
- Maintain optimum soil moisture by light and frequent irrigation
- Grow cowpea in interspaces to reduce soil temperature
- Remove and destroy infected plants along with roots
- Drench the infected suckers with bleaching powder (1.5%) solution
- Restrict to one or two ratoons based on disease incidence

7) Bunchy top / Curly top / cabbage top /strangles disease

- Banana bunchy top virus (BBTV)
- First reported from Fiji in 1889 in Cavendish varieties
- Around 1940, introduced into **India from Srilanka** through cyclone
- The virus is a domestic quarantine pest in India. Hence movement of planting suckers from North East, Tamil Nadu, Karnataka and Kerala to other parts of the country is banned
- The virus is a **ssDNA** virus with isometric particles belonging to Babu virus group

Symptoms

- Infection may start at any stage of crop growth
- Paling of lamina with interveinal chlorosis that is evident against light
- Prominent dark green streaks on the petioles and along midrib and leaf veins that range from a series of dark green dots to a continuous dark green line (**Morse code**)
- Infected plants show marked stunting
- Leaves are reduced in size with narrowed lamina and shortened petiole, produced at shortened internodal length, become erect and brittle and crowded at the top (bunchy top)
- Leaf margins also show chlorosis and slight curling and necrosis
- Infection of young plants leads to failure of bunch emergence
- Tips of inflorescence bracts of infected plants remain green and do not turn to normal pink or purple

Survival and spread

Primary: Virus particles through diseased suckers used for planting

Secondary: Virus particles transmitted by banana black aphid, *Pentalonia nigronervosa*

Colocasia esculenta serves as a latent reservoir host

Favourable conditions

- Progressively increasing temperature from February onwards favours virus spread and symptom expression
- Prevalence of infected reservoir host
- Prevalence of vector

Management

- Adoption of strict quarantine measures
- Use of only certified banana suckers or tissue culture plants for planting
- Periodical monitoring and rouging of infected plants with all suckers in the mat by rouging or killing by injecting herbicide, 2, 4-D
- Raising barrier crops like sunhemp in three to four rows on the field boundaries to check aphids from entering the fields from neighbouring infected fields
- Vector control with systemic insecticides, *viz*., Phosphomidon @ 1ml/l or Methyl demeton or Dimethoate @ 2 ml/l
- Discouraging intercropping with *Colocasiai* in disease endemic areas

8) Banana Mosaic / Infectious chlorosis / Heart rot: Cucumber Mosaic Virus (CMV)

The virus is a domestic quarantine pest in India. Hence movement of planting suckers from Gujarat and Maharashtra to other parts of the country is banned

Cucumber mosaic virus (CMV) is a Cucumovirus with spherical particles having ssRNA

Symptoms

- Typical mosaic-like or discontinuous linear streaking in bands extending from margin to midrib running parallel to veins (**Mosaic**)
- Leaf size is reduced and leaves show thickened veins
- Chlorosis of newly emerged leaves (**Infectious chlorosis**)
- Occasionally rotting of central youngest leaf and leaf sheaths in severe cases (**Heart rot**) which progress into the pseudostem leading to death of plants
- Diseased plants do not reach maturity and may fail to produce bunch



Survival and spread

Primary: Virus particles through diseased suckers used for planting

Secondary: Virus particles transmitted by banana black aphids, *Aphis gossypii, A. maydis*

Cucumis sativus serves as a latent reservoir host

Favourable conditions

- Late and post monsoon period favours virus spread and symptom expression
- Prevalence of infected reservoir host
- Prevalence of vector

Management

- Adoption of strict quarantine measures
- Use of disease free suckers for planting
- Dry heat treatment of suckers at 400 C for 1 day
- Avoid growing cucurbits as intercrop
- Raising barrier crops like sunhemp in three to four rows on the field boundaries to check aphids from entering the fields from neighbouring infected fields
- Vector control with Methyl demeton or dimethoate or Dimethoate @ 2 ml/l at 3 – 4 weeks interval

9) Banana bract mosaic: *Banana bract mosaic virus* (BBrMV)

- The virus disease was first reported in Kerala as *Kokkan* disease
- Very rapidly spreading in all the banana growing states in the absence any regulation on movement of suckers
- BBrMV is a potyvirus with long flexuous rod particles having ssRNA

Symptoms

- Symptom expression is clearly seen in Monthan (cooking banana) and Karpura
- Chakkerakeli cultivars
- In cooking bananas water soaked chlorotic streaks initially develop on sheaths and petioles of leaves at the top. The streaks later turn pinkish
- In Karpura Chakkerakeli and other commercial cultivars like the Cavendish the disease is
- characterised by continuous or discontinuous pinkish streaks along the pseudostem
- The most characteristic and confirmatory symptom is development of pinkish to purplish streaks that are either continuous or discontinuous on bracts of inflorescence
- In severe cases, pink streaks continue on the lower surface along the length of midrib
- Flattening at the top of the plants (crown) with leaves arranged as in travelers palm is common in cooking banana cultivars
- Unclasping of leaf sheaths from the pseudostem is a feature of the disease

- Pseudostems of infected plants bow or curve at an angle rendering them prone to break even at moderate wind speeds
- Infected plants generally do not flower or flower very late and produce a small bunch with
- elongated and brittle peduncle

On Male Bud of Red Banana

Survival and spread

Primary: Virus particles vertically spread through diseased suckers used for planting

Secondary: Virus particles are horizontally transmitted by banana black aphids, *Aphis gossypii, A. maydis* and *Rhopalosiphum maidis*

Favourable conditions

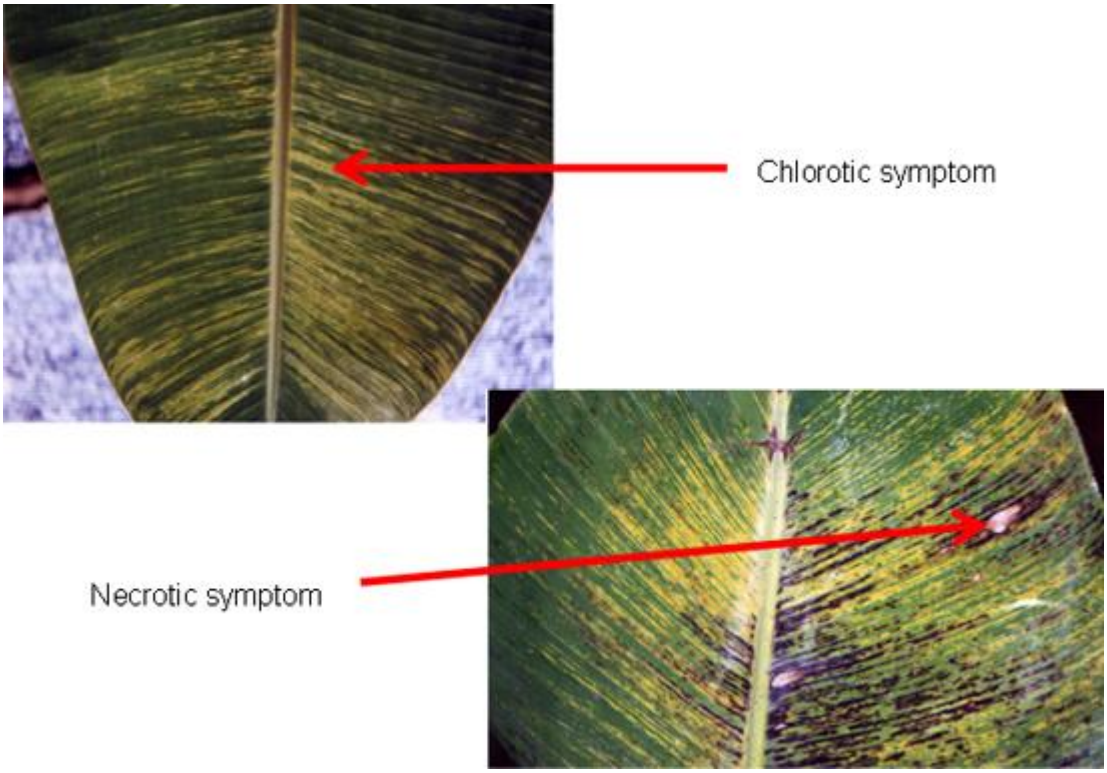
- Disease spread and symptom expression is severe in winter months (low temperature)
- Prevalence of vector

Management

- Use of disease free suckers for planting
- Dry heat treatment of suckers at 400 C for 1 day
- Raising barrier crops like sunhemp in three to four rows on the field boundaries to check aphids from entering the fields from neighbouring infected fields
- Vector control with Methyl demeton or dimethoate@ 0.2% at 3 – 4 weeks interval

9. Banana streak virus

- Disease severity is very variable, and probably depends on environmental conditions, as well as on host and virus genotypes.
- The most characteristic foliar symptoms of infection are chlorotic streaks, which become necrotic with time. The leaf lamina may also be narrower, thicker and become torn.
- Stunting of the plant, constriction of the bunch on emergence (choking), altered phyllotaxis (leaves arranged in a single vertical plane instead of the normal spiral pattern), and detachment and splitting of the outer leaf sheaths of the pseudostem.



Control measures

- The eradication of infected plants,
- The use of BSV-free planting materials.
- BSV can be carried in vitro plantlets, as it is not eliminated by shoot-tip culture.
- Virus particles can only be detected in areas of leaf tissue with symptoms.
- Parts of leaves with pronounced symptoms should be used for serological indexing.

POST HARVEST OF BANANA

1. **Anthracnose- *Colletotrichum musae***
2. **Fluffy white rot – *Fusarium moniliforme***
3. **Crown rot – *Botryodiplodia theobromae***
4. **Cigar-end rot – *Verticillium theobroma***

1. Anthracnose - *Colletotrichum musae*

Symptoms

- Small, black, circular specks on the skin- sunken & coalesce to form large spots.
- Bright salmon-coloured conidial mass appears on the spots.
- Severely infected fruits become dark due to blemishes.
- Acervuli also develop on the skin and the pulp becomes partially soft.
- Non-latent infection usually starts during or after the harvest of bunches in small peel wounds and it continues to develop without a dormant period.
- Many latent infections at the time of harvest show large number of appressoria on the surface of the peel.
- The spread of the disease is by air-borne conidia and numerous insects which frequently visit banana flowers also spread the disease.
- Temp.30 to 35°C and RH- 85.7 -100 %

Management

- Post harvest dipping of fruits in Carbendazim 400 ppm, or Benomyl 1000 ppm, or Aureofunginsol 100 ppm.

2. Fluffy white rot: *Fusarium moniliforme*

Symptoms

- Small, olive brown spots appear on the tip –fruit.

- Large clove brown to mummy brown patches.
- Infection becomes deep – seated – pulp – leaking of juice of foul odour and a fungal growth.
- Spread through diseased propagation materials
- Temp. 25-35 oC and more than 50% RH favourable for the development of disease

Management

- Post harvest dipping of fruits in Carbendazim 400 ppm, or Benomyl 1000 ppm, or Aureofunginsol 100 ppm.

3. Crown rot: *Fusarium roseum, Lasidiplodia theobromae, Deightonialla torulosa*

Symptoms

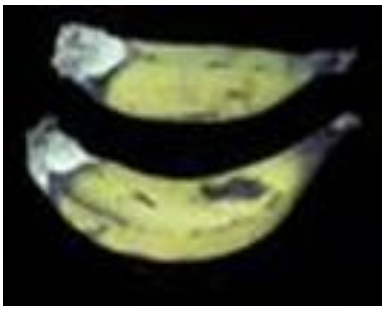
- Darkening of the hand and the adjacent peduncle. The discoloured area covers almost one fourth of the fruit if the conditions are favourable. Loss of ability of hand to support fruit.
- The conidia are usually 3 to 5 septate. The conidia are spread by air.
- Occurrence of black tip – fruit piercing moth. Infection – direct penetration – fungus.Temp.23.90 oC
- Wind blown bunches – develop severe spotting on the fingers- rainy weather.

Management

- Control of crown rot starts in the field with the regular removal of leaf trash.
- Proper field sanitation can greatly reduce the number of crown rot fungi spores present.
- Do not keep rotting fruits or plant waste materials near the packing station.
- Maintain clean washing water in the delatexing baths and change the water frequently to stop it becoming heavily contaminated with spores.
- Dehanding should be done carefully with a sharp knife so as to avoid leaving a ragged cut. Finally, post-harvest treatment of fruits with an effective fungicide is essential.

4. Cigar-end rot: *Verticillium theobromae*

Symptoms



- Tip of immature fruit and spreads upward.
- Ashy conidia and conidiophores cover the rotted portion.
- Imparting burnt ashy cigar-end appearance with a dark border.
- Decay may extend up to one-third of the fruit but internal tissues develop a dry rot.
- Conidia are hyaline, oblong to cylindrical, borne at the ends of tapering phialides, aggregated into rounded, mucilaginous transluscent heads.
- The fungus – plant debris – microsclerotia.
- Infected plant parts – irrigation water – implements.

Management

- The principal method of control is frequent manual removal and burning of dead flower parts and infected fruits.
- Use of fungicide to control the disease is also recommended.
- In the packhouse, care should be taken to cull infected fruits to avoid contaminating the washing water with spores.
- Cigar-end rot is effectively controlled by covering the flower (immediately after emergence) with a polyethylene bag before the hands emerge.

LECTURE 6: DISEASES OF GUAVA (*Psidium guajava* L.)

Guava it is hardy, aggressive, and a perennial that has only recently become a cultivated crop. The guava (*Psidium guajava* L., Myrtaceae), is one of 150 species of Psidium most of which are fruit bearing trees native to tropical and subtropical America. Guavas are plants in the myrtle family (Myrtaceae) genus *Psidium*. This crop is incited by different diseases.

S.No.	Major Diseases	
1	Wilt	*Fusarium oxysporum* f. sp. *psidii*
2	Fruit canker	*Pestalotiopsis psidii*
3	Stem canker	*Physalospora psidii*
4	Anthracnose	*Gloeosporium psidii* (=*Collectotrichum psidii*)
5	Red rust	*Cephaleuros virescens*
	Minor diseases	
6	Leaf spot	*Cercospora psidii*
7	Phomopsis fruit rot	*Phomopsis psidii*

1. Fusarium wilt : *Fusarium oxysporum* f.sp. *psidii*

Occurrence of serious wilt was reported from Haryana, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

Symptoms:

The disease is characterised by yellowing and browning of leaves, discolouration of the stem and death of the branches along one side. Sometimes the infection girdles the stem and the whole plant may wilt. Leaves die and the twig barks split.

Pathogen: *Fusarium oxysporum* f.sp. *psidii* Prasad, Mehta and Lall. *F.solani* (Mart.) Sacc., Mycelium is white or pink with a purple tinge. Microconidia are borne on simple phialides arising laterally on the hyphae. Microconidia are oval to ellipsoid, cylindrical, straight to curved and 7 to 10 x 2 to 3 pm. Macroconidia are 3 to 4 septate and 32 to 50 x 3 to 7 um in size. They are fusoid to subulate and pointed at both ends. Sporodochia and spinanodes are present. Chlamydospores may be intercalary or terminal.

Asexual spores : Micro & macro conidia

Vegetative spores : Chlamydospores (Resting spores)

Sexual spores : Ascospores borne in ascus

Primary source of inoculum: Soil borne inoculum in the form of chlamydospores and infected plant parts.

Secondary source of inoculum: inoculums produced on the infected host

Mode of spread and survival: The fungus first colonizes on the surface of the roots and enters the stem tissues at the basal portions near the ground level. It multiplies in vascular region and affects the cortical cells.

Epidemiology: Higher disease incidence is noticed during the monsoon period. The disease appears in August and increases sharply during September - October. It is severe in alkaline soils.

Management:

- Dry branches should be cut off and wilted plants uprooted.
- Soil should be treated with lime or gypsum to make the soil pH 6.0 to 6.5 balanced nutrition of host reduces seventy of the disease when organic nitrogen is supplied.
- The soil of the pits should be treated with 37 to 40 per cent formaldehyde (45ml of formaldehyde plus 270 ml of water plus 35kg of soil).
- This treatment has to be covered with a polythene sheet for at least 15 to 20 days. When the traces of formalin disappears, the pits are filled with this soil after planting the tree
- Soil drenching of Carbendazim 1.5g/lit considerably reduces the disease

2. Fruit canker/Scab/Grey blight: ***Pestalotiopsis psidii***

Symptoms:

- Infection generally occurs on green fruits.
- Minute, brown or rust- coloured, unbroken, circular, scabby lesions of 2 to 4 mm dia appear on the fruit which later tear the epidermis open in a circinate manner.
- The margin of the affected area becomes raised.
- The scab disfigures the fruits and their market value is highly reduced.

- Primary source of inoculum: Dormant mycelia. *Helopeltis antonii*, a kajji bug which punctures the young fruit sucking juice and that damage exposes the fruit to infection by the pathogen.
- Secondary source of inoculum: Air borne conidia
- Mode of spread: spread is through the wind-borne conidia.

Epidemiology:

- The fungus is capable of growing at temperature between 20 and 25°C.
- Mycelial growth with intensive sporulation takes place at 5.5°C.
- Wounding results in quick attack by the fungus.

Management:

- Since the wound by insect predisposes the fruit to infection, spray the young fruits after pollination with a suitable systemic insecticide (Dimethoate – 2ml/l) will take care of the infection.
- Spread of the disease can be checked by three or four spraying with Bordeaux mixture1.0 percent or copper oxy chloride 0.2 per center.
- Summer irrigation +Nutritional management reduces the disease

3. Stem canker: *Physalospora psidii*

Symptoms:

- Affected twigs show wilting and death.
- Cracks and lesions are formed along the stem, ar- resting translocation of nutrients.
- Infected fruits turn dark brown to black and dries up resulting in die-back symptoms.
- Fruit rotting takes place, blighting of leaves to enlargement
- Fungus: *Physalospora psidii* Stev. & Pier. Perithecia is glabrous with a fleshy wall. Ascospores are hyaline, narrow, ellipsoid and one celled.
- Conidia are single celled, ovoid with a rough wall and measure 20 to 26 x 9 to 12 jam. On the stems and fruits pycnidia are formed in stroma.

Mode of spread and survival: The pathogen remains in the infected tissues beneath the bark and become active under favorable conditions.

Management:

- In severe infection, the disease can be prevented by the removal and destruction of the infected stem.
- In mild infection, pruning of infected stem and branches is done and the cut-ends are painted with Bordeaux paste (1 part copper sulphate and 2 parts each of lime and linseed oil) or Chaubatia paste (copper carbonate - 800 g, red lead - 800 g and linseed oil - 1 litre).
- Spraying the trees with copper oxychloride 0.2 per cent after pruning reduces canker incidence.

4. Anthracnose/Die-back/Fruit spot/Twig blight: *Glomerella psidii (= Colletotrichum psidii*)

The disease is a serious problem in Karnataka, Punjab and Uttar Pradesh.

Symptoms:

- The disease attacks all plant parts except roots.
- Severity of the disease may show die-back of main branches resulting in death of plants.
- The most characteristic symptoms appear during the rainy season as small pin-head sized spots on the unripe fruits.
- They gradually enlarge to form sunken and circular, dark brown to black spots.
- The infected area of the unripe fruits become harder and corky.
- Acervuli are formed on fruit stalks.

Pathogen: *Gloeosporium psidii* Delacr. (Perfect stage: *Glomerella psidii* (Del.) Sheld.) Conidia are hyaline, aseptate, oval to elliptical or straight, cylindrical, obtuse apices or flattened at base. Conidiophore is cylindrical and tapers towards apex.

It is hyaline and septate with single terminal phialide. Acervuli are dark brown to black.

Mode of spread and survival:

- The pathogen remains dormant for about three months in the young infected fruits.
- It becomes active and incites rot when the fruit begins to ripe. In moist weather, acervuli appear as black dots scattered throughout the dead parts of the twigs.
- From the twigs, the fungus penetrates the petioles and attacks the young leaves, which become distorted with dead areas at margins or tips. The conidia are spread by wind or rain.

Epidemiology:

- The cool season (Jan - Mar) and the hot, dry weather (Apr-Jun) prevent the spread of infection.
- In moist weather, acervuli are produced in abundance on dead twigs and pinkish spore masses are seen. Conidia initiate fresh infection.
- The temperature for disease development on fruits ranges from 30 to35°C.

Management:

- Spraying the trees with Bordeaux mixture 1.0 per cent or copper oxychloride 0.2 per cent or Carbendazim 0.1% before the onset of monsoon reduces the disease incidence.
- Apple Guava (light red fleshed) is moderately resistant to anthracnose.

5. Red rust: *Cephaleuros virescens*

This disease is exceptionally severe in guava.

Symptoms:

- The alga produces specks to big patches on the leaves. They may be crowded or scattered.
- The pathogen extends between cuticle and epidermis and penetrates the epidermal cells.
- Fruit infection by alga is not common on fruits. Fruit lesions are usually smaller than leaf spots.
- They are dark green to brown or black in colour.
- Primary source of inoculum: Dormant mycelia
- Secondary source of inocu,um: Zoospores

Alga: *Cephaleuros virescens* Kunze

Mode of spread and survival:

- The disease is more common on closely planted mother plants. The zoospores cause the initial infection.
- High moist condition favours the development of fruiting bodies of the alga.

Management: This algal disease is controlled by spraying with Bordeaux mixture 1.0 per cent or copper oxychloride 0.3 per cent.

Minor diseases

1. Leaf spots: ***Cercospora psidii***

- The disease appears as water-soaked, irregular patches which look brown on the lower surface of the leaves.
- Old leaves are mostly affected and the severely affected ones curl and subsequently drop off.
- Affected leaves show round or lightly irregular spots, brownish-red in colour.
- The central portion of the spot turns white. These spots coalesce to form large irregular, white patches surrounded by a brownish margin.
- These leaf spot diseases are checked by spraying with copper oxychloride 0.3 per cent.

2. Phomopsis fruit rot: ***Phomopsis psidii*** **Camara.**

- The symptoms appear on unripe fruits at the blossom-end.
- Infected fruits show small, conspicuous, white or light brown and circular spots. Some of the infected fruits are shed prematurely.
- As the fruits ripen, the spots extend and cover the fruit surface. The infected tissues become softer and emit an undesirable odour.
- Weekly sprays with Bordeaux mixture 1.0 per cent or copper oxychloride 0.3 per cent are required for the control of fruit rot.
- Six monthly sprays with Mancozeb 0.2 per cent during fruiting stage are helpful in controlling fruit rot.

3. Sooty mould: ***capnodium psidii***

Symtoms:

- It is ectophytic fungus and not a parasite. Black superficial growth on entire surface of leaves and twigs. Under dry spell such affected leaves curl & shrivel.
- During flowering time the appearance of the disease results in reduced fruit set and fruit fall. Blackish powder like fungal conidial structures covered on the leaf surface.
- The fungus grows on the excreta and honey secretions of insects as black sooty mass of spores and will not invade plant tissue.

- Disease severity increases in increased population of leaf hoppers, aphids and other insects. Impact of this disease on host is photosynthesis activity and yield decreases.
- Primary source of inoculum: Dormant mycelia :
- Secondary source of inoculum: Air borne conidia: Spread : Insects, Aphids, wind
- Epidemiology: 28 -32°C Temperature 85-90% RH, Warm Weather and susceptible host

Management

- Sprays of wettable sulphur 0.2% along with insecticide Dimethoate 1.5ml/lit
- Spray of 1% starch solution makes flakes of the fungus and due to small wind falls of from the plant.

LECTURE 7: DISEASES OF SAPOTA

S.No.	Major Diseases	
1	Leaf spot	*Phaeopleospora indica, Pestalotiopsis versicolor*
2	Flat limb	*Botyodiploidia theobromae*
3	Sooty	*Capnodium versicolor*
4	Red rust	*Cephaleuros versicolor*
	Post Harvest Diseases	
5	Soft rot	*Pestalotiopsis mangiferae*
6	Fruit rots	*P. palmivora, Petalotiopsis versicolor, P. sapotae*

1. Leaf spot: *Phaeopleospora indica , Pestalotiopsis versicolor*

- *Phaeopleospora indica*: Earlier circular spots which pinkish then gradually to brownish in colour and the centre of the spot sometimes whitish grey colour. And numbers of spots are more on leaves.
- *Pestalotiopsis versicolor*: spots are circular and brownish and bigger. Later stages can see the black dots on centre of the spot. These black dots are the asexual fruiting body of the fungus (Acervulus).
- In advanced stages leads to defoliation.

Management: Carbendazim 0.1% and Companion (Combi product) includes carbendazim and mancozeb 12% and 72% to avoid resistant development in pathogen,

2. Flat limb: ***Botyodiploidia theobromae***

- In young stems instead of normal growth flattening takes place. On this flatted stem can see the small sized leaves with small petioles.
- This is a sporadic disease in plant 1 or 2 branch in whole plantation 1 or 2 plants are affected.

Management

- Cut the affected stems and burn and cut portion paste with COC 0.3% to avoid dieback

3. Sooty mould: ***Capnodium versicolor***

Symptoms:

- Disease severity increases in increased population of leaf hoppers, aphids and other insects. Black superficial growth on entire surface of leaves, fruits and twigs. Fungus is not a parasite. It grows on the excreta and honey secretions of insects.
- Under dry spell such affected leaves curl & shrivel. During flowering time the appearance of the disease results in reduced fruit set.
- Sooty mass is a superficial growth of the fungus and it multiplies on insect secretions. Impact of this disease on host is photosynthesis activity and yield decreases.
- Primary source of inoculum: Dormant mycelia
- Secondary source of inoculum: Air borne conidia: Spread: Insects, Aphids, wind
- Epidemiology: Temperature 28 -32° C, 85-90% RH, Warm Weather and susceptible host

Management

- Sprays of wettable sulphur 0.2% along with insecticide Dimethoate 1.5g/lit
- Spray of 1% starch solution makes flakes of the fungus and due to small wind falls of from the plant.

4. Red rust: ***Cephaleuros versicolor***

- The algal disease and it has been observed in India and else where. It is one of the minor disease of importance. Reduction in photosynthetic activity and defoliation as a result of algal attack lower vitality of the host plant.

Symptoms:

- The disease is characterized by initial green coloured, circular patches with marginal serrations.

- The upper surfaces of the spot consist of numerous, unbranched filaments, which project through cuticle.
- As and when disease advances the organism turns red rusty spots on the leaves and young twig.
- Spores mature, fall off and leave cream to white velvet texture on the surface of leaf.

Etiology: *Cephaleuros virescens* (Kunze).

- The algae after a period of vegetative growth develop its reproductive structure.
- Certain cells become sporangia. They are of 2 types.
- Those formed directly on the thallus are sessile and thick walled, 40-50micrometer in diameter with orange pigments.
- They are formed singly on the vegetative filaments. Some are produced above the surface on special sporangiophores consisting of thick, rigid, septate hairs with a length of 50micrometer, swollen into a vesicle at the tip. Each vesicle carries 3-6 sporangia on curved pedicels.
- When the sporangia are riped, the contents are converted in to zoospores and liberated through an opening in the wall.
- The zoospores are orange in color, ovoid and swim actively by means of cilia.

Epidemiology:

- The disease is more common on close plantation.
- The zoospores cause initial infection.
- High moist condition favours development of fruiting bodies of the algae.

Management: it is controlled by spraying with Bordeaux mixture 1% or Copper Oxychloride 0.3% or lime sulphur0.2%.

Post Harvest Diseases: Sapota

1. **Soft Rot: *Pestalotiopsis mangiferae***

Symptoms:

- The disease appears as water-soaked spots covering the entire fruit within 3 to 4 days.
- Rotted fruits become soft and dark brown and later numerous acervuli are seen in rotted zones.
- The fungal colonies are yellowish white.
- Mycelium is branched & septate.
- Acervuli are black, globose to sub-globose
- Conidiophores are short and simple
- Conidia are fusiform, 4-septata.
- Middle three cells are dark brown.
- End cells are hyaline and pointed.
- Apical cell is with 1 to 3 hyaline setulae.

2. **Fruit Rots**

Phytophthora palmivora, Pestalotiopsis versicolor, P. glandicola, P. sapotae and *Botrydiplodia theobromae* are the causal agents of fruit rots in sapota.

- Diseased fruits exhibited water-soaked lesions which become brown within 2 to 3 days.
- Subsequently the whole fruit is covered with tufts of mycelium.

Management

Spray Mancozeb 0.25%.

Lecture - 8 PAPAYA: (*Carica papaya*) Family: Caricaceae

INTRODUCTION:

Papaya is an ideal fruit for growing in kitchen gardens, backyards as well as in orchards. Papaya is a quick growing tree, bearing at age of about 8-10 months of transplanting. Papaya is indeed, very remunerative if done on modern methods. Papaya is a tropical fruit crop that is normally consumed fresh and is valued as a health food because it's rich in vitamins C and A. Papaya is a whole some, refreshing and delicious fruit. It is a rich source of vitamins. It is rich in Calcium and other minerals. Unripe fruits are also used as vegetable. Papaya is used in pickles and preserves of various kinds. The fruits are beneficial in curing of piles, dyspepsia of liver spleen and digestive disorders. Ripe fruits are used in the preparation of jam, jelly, nectar, soft drinks, ice cream, flavoring crystallized fruits and are canned as syrup.

It is now being grown under 39,000 ha with production of 9.05 lakh ha. Its productivity is highest among all fruit crops. However, papaya is severely damaged when infected by fungal and viral diseases.

Diseases of papaya:

S.No.	**Major diseases**		
	(A) Fungal Diseases		
1	Powdery Mildew		*Odium indicum* Kamat, *Odium caricae* Noack, *Leveillula taurica* (Lev.) Arnauld
2	Leaf- Blight		*Corynespora cassiicola* (Burk and Curt).
3	Damping-Off		*Pythium aphanidermatum* Nirvan; *Rhizoctonia solani* Subramaniam.
4	Foot Rot		*Pythium aphanidermatum* Nirvan.
5	Anthracnose		*Colletotrichum gloeosporioides* Penz.
	(B) **Viral Diseases of papaya**		
6	Papaya Mosaic,		*Papaya Mosaic Virus*
7	Leaf Curl of Papaya		*Leaf Curl of Papaya Virus*
8	Papaya Ring Spot Virus (PRSV)		*Papaya Ring Spot Virus (PRSV)*
	(C) **Post Harvest Diseases of Papaya**		
1	Macrophomina fruit Rot		*Macrophomina phaseoli* (Maubl).
2	Rhizophus fruit Rot or Soft Rot		*Rhizophus stolonifer* (Ehr.)
3	Phomopsis fruit Rot		*Phomopsis caricae* (Pterrak and Cif)
4	Anthracnose of fruit		*Colletotrichum gloeosporioides*

1.) Powdery Mildew (*Odium indicum*, Odium caricae, *Leveillula taurica*):

Symptoms

- The disease appears as on the foliage and pods. Infection is first apparent on the leaves as small slightly darkened areas, which later become white powdery spots.
- These spots enlarge and cover the entire leaf area. Severely infected leaves may become chloratic and distorted before falling. Affected fruits are small in size and malformed.
- In more severe cases dieback symptoms develop.

Etiology :

- *Odium indicum* belongs to the Phylum: Ascomycota, and Order: Erisiphales.
- The pathogen is an obligate parasite. The mycelium is septate, hyaline.
- Odium caricae is in conidial form. Mycelium is hyaline, ectophytic; creeping.
- Conidia are formed in chains of 2-4, hyaline and elliptical.
- The asexual spore is conidia; are borne on long chains and are barrel shaped.
- The sexual spores are the ascospores, globose, and are gregarious. Each ascocarp contains one ascus.

Epidemiology:

- The development of powdery mildew in papaya is promoted by high humidity (80-85%) and a temperature range of 24-26°C; sunshine duration for 9.1 hours.
- Susceptible varieties are more prunes to infection.
- **Mode of survival :** Primary source of inoculum Dormant mycelia
- Secondary source of inoculum: Air borne conidia.
- Spread: Air borne.

Disease cycle:

- Ascospores produced in the cleistothecium are the resting spores present in the debris.
- The primary infection may be initiated either from ascospores released from cleistothecia or conidia carried by wind from collateral hosts to papaya.
- The spores after falling on healthy leaves germinate, produce germ tubes and produce haustoria's inside the leaf tissues, develop a fungal vegetative body and produce conidia. The conidia are blown away by wind and cause secondary infections. The fungus is strictly an obligate parasite.

Management:

- The important criterion in reducing infection is the clean cultivation.
- Maintain sanitation in the field. Follow scientific method of cultivation practices.
- Increase the application of potassium and inversely reduce application of nitrogen in order to improve resistance in plants.
- As soon as the disease symptoms are observed, dusting Sulphur (30 g/10 liters of water) is found effective.
- The first spray of Triademefon (0.1%) during September and repeated at 15 days interval.
- Spraying Calixin 75 EC (5 ml/10 liters of water) at 15 days interval helps to control the disease.

Leaf- Blight (*Corynespora cassiicola*):

Symptoms:

- The disease causes severe damage to leaves.
- The disease first appears as small, discoloured lesions, which are irregularly scattered on the leaves. These spots become irregular in shape, then increase in size, and appear brown to grey in colour. A light yellow zone surrounds the spots.
- Several lesions coalesce to cover large areas of the leaf and in severe infections the whole leaf dies.
- A considerable reduction in the yield is observed.

Management:

- Disease can be controlled by spraying of Dithane M-45 (0.2%) starting form the appearance of the disease symptoms.

Damping-Off (*Rhizoctonia solani;* *Pythium aphanidermatum* Nirvan):

It also one of the serious disease caused by the fungi.

Symptoms

- This is a disease of young seedlings. On collar region discoloration takes place initially.
- Lesions are seen on the stem at or just above soil level.
- The stem becomes watery and shrinks, followed by death of the plant.

➢ Primary source of inoculum : Dormant mycelia as the mode of survival of the organism
➢ Secondary source of inoculum: Sclerotial bodies.
➢ Spread: The disease spread by way of cultural operations in the soil, irrigation water and wind blooms.

Epidemiology:

- The young seedlings are more susceptible to the disease than elder ones.
- The disease is more severe in warm wet weather and becomes worst when seedlings are crowded.

Management:

- Well-drained soil should be used for planting and the crop should not be excessively irrigated.
- Before sowing the seeds should be treated with fungal culture of *Trichoderma viride* (5 g/kg of seed) or Captan (3 g/kg of seed) to protect the newly emerging seedlings.

Damping off; Foot Rot (*Pythium aphanidermatum*):

Foot rot is also known as collars rot or stem rot or root rot and damping off ; is the most serious disease of papaya. In India, the disease appears during the rainy season and is prevalent throughout the country. It is more common in trees of age 2-3 years.

Symptoms

- In case of nursery plants damping off symptoms are produced whereas in adult plants foot rot, collar rot symptoms are produced.
- Foot rot is characterized by the appearance of water-soaked patches on the stem near the ground level.
- These patches enlarge rapidly and girdle the stem, causing rotting of the tissues, which then turn dark brown or black. The affected internal tissues give a honey comb like appearance.
- Simultaneously, the terminal leaves of infected plants turn yellow, start drooping and fall off.
- Such affected plants withstand strong wind and topple over and die.
- If the disease attack is mild, only one side of the stem rots and the plants remain stunted.
- Fruit if formed are shriveled and malformed. Gradually the plant dies.

Causal organism: *Pythium aphanidermatum*

Kingdom--------Chromista
Phylum---------Oomycota
Class----------Oomycetes
Order----------Peronosporales
Family----------Pythiaceae

- Mycelium is well developed, wooly and coenocytic, hyphae 2.8-7.5 micron in diameter.
- Sporangia loculate, toruloid, and vesicle formed at the time of germination, zoospores 30-40 in number present within the vesicle and are born on spherical oogonia.
- They germinate by producing a germ tube.
- The sexual spores are the oospores, born singly and moderately thick walled.

Epidemiology:

- A number of factors like inoculums density, soil moisture, temperature, pH, light intensity have influence on pathogen development.
- One week old seedlings are more susceptible than one year old trees.
- But stem rot caused by *Pythium aphanidermatum* is common in plants of age 2-3 years. The disease usually appears during rainy season and severity increases with the intensity of rainfall.
- Optimum temperature of 36 360 c excessive moisture level, uncontrolled irrigation, heavy rainfall, and water logged condition are favorable for disease development. Abundance of moisture around the base is conducive for disease development and its spread.

Disease cycle:

The pathogen is soil inhabitant and is capable of growing and surviving on the residue left in the soil where it produces abundant oospores in the decaying organic matter.

Management:

- Application of *Trichoderma viride* (15 g/plant) mixed in well-decomposed FYM should be applied around the root zone of the plants at the time of planting.
- The crop should be irrigated by adopting the ring method of irrigation so that the water does not come in direct contact with the stem.
- In the case of new plantings, preventing water logging of the soil may control the disease.
- The soil should be drenched with 2-3 litres of Copper oxy chloride (0.3%)/
- The application should be carried out regularly at 15 days interval from the time of planting.
- During fruit formation, the plant should be sprayed with the same solution at the same time interval. Alternately, Mancozeb (0.25%) may also be applied.
- In the case of disease attack in existing crops, the rotted portion of the plant should be scraped
- The base of the plant should be drenched with three litres of Copper oxychloride (0.3%).
- The plant should be drenched during fruit formation with Copper oxychloride or Mancozeb at the earlier mentioned concentrations twice at 15 days interval.

Anthracnose (*Colletotrichum gloeosporioides*):

Anthracnose causes considerable losses and is very common in all the papaya growing areas.

Symptoms:

- The disease prominently appears on green leaves and also on green immature fruits.
- The disease symptoms are in the form of brown to black depressed spots on the fruits.
- The initial symptoms are water-soaked, sunken spots on the fruit.
- The centers of these spots later turn black and then pink when the fungus produces spores.
- The flesh beneath the spots becomes soft and watery, which spreads to the entire fruit.
- Small, irregular-shaped water-soaked spots on leaves may also be seen. These. Spots eventually turn brown.
- On the fruits, the symptoms appear only upon ripening and may not be apparent at the time of harvest.
- Brown sunken spots develop on the fruit surface, which later on enlarge to form water soaked lesions.
- The flesh beneath the affected portion becomes soft and begins to rot.

Causal organism:

- *Colletotrichum gloeosporoides* is mainly responsible for anthracnose in papaya.
- It belong to the Kingdom-Fungi, Class-Filamentous, Ascomycetes; Order-Phyllachorales.
- The mycelium is branched, sparsely septate, hyaline hyphae. Setae are 1-4 septate and swollen at the base.
- Conidiophores are hyaline and unbranched. The conidia are sub hyaline and variable in shape.
- The sexual spores are the ascospores, born on perithecia.
- The perithecial stage develops on stromatoid cushions in which the perithecia are immersed.

Epidemiology:

- The pathogen is more severe at 25-30 o c and at relative humidity of 85-90%.
- The conidia of pathogen are disseminated by raindrops splashes and insects. The susceptible varieties are prune to infection.

Disease cycle:

- The pathogen is able to survive saprophytically for a long duration on fallen leaves, petioles, and fruits.
- Infection on fruits can take place right from blossoming onwards till their maturity.
- The fungus enters through pores of fruits where it is still green and develops further in the flesh during ripening period.
- The pathogen produces ascospores in the senescing petioles which becomes airborne, lodge on fruit surface, germinate and produce appressoria.
- The pathogen can cause latent infection in mature fruits though lenticels.
- The fungus grows in fruits flesh hydrolyzing sucrose during the course of infection.

Mode of spread and survival:

- Primary source of inoculum: The fungus survives as dormant mycelia for long time in the fallen leaves.
- Secondary source of inoculum: Air and splash borne conidia produced from the acervuli.
- Management:
- The affected fruits should be removed and destroyed.
- The fruits should be harvested as soon as they mature.
- Spaying with Copper Oxychloride (0.3%) or Carbendazim (0.1%) or Thiophanate Methyl (0.1%) at 15 days interval effectively controls the disease.
- Fruits for exports should be subjected to hot water treatment or a fungicidal wax treatment.

Papaya Mosaic:

Symptoms

- The disease attacks the papaya plants of all age groups, but is most serious on young plants. The aphid species are responsible for transmitting the disease.
- The disease symptoms appear on the top young leaves of the plants.
- The leaves are reduced in size and show blister like patches of dark-green tissue, alternating with yellowish-green lamina.
- The leaf petiole is reduced in length and the top leaves assume an upright position.

- The infected plants show a marked reduction in growth.
- The fruits borne on disease plants develop water soaked lesions with a central solid spot. Such fruits are elongated and reduced in size.
- It is a viral disease, transmitted by aphid; they are *Aphis gossypii, A.malvae*.

Management:

- Good field sanitation such as removal and destruction of affected plant reduce the spread of the disease.
- Also, losses can be minimized controlling the population of aphid.
- Application of Carbofuran (1 kg a.i. /ha) at the time of sowing seeds followed by 2-3 foliar sprays of Phosphamidon (0.05%) at an interval of 10 days starting from 15-20 days after sowing effectively checks the population of aphids.

Leaf Curl of Papaya: The disease effects yield and quality of fruits and serious losses are caused in terms of production and productivity.

Symptoms

- The disease is transmitted by the vector white fly (*Bemisia tabaci).*
- Severe curling, crinkling and deformation of the leaves characterize the disease. Mostly the young leaves are affected.
- Apart from curling the leaves also exhibit vein clearing and thickening of the veins.
- Sometimes the petioles are twisted. In severe cases complete defoliation of the affected plant is observed.
- The affected plants show a stunted growth with reduce fruit yield.

Causal virus:

- The disease is caused by Tobacco leaf curl virus, belonging to Gemini virus group.
- It is neither seed nor soil borne nor sap transmissible but is transmitted by grafting and white flies.
- The germinate particle contain ssDNA.

Epidemiology:

The virus causing leaf curl disease of papaya has wide host range like Zinnia elegance, tomato, tobacco, and datura. White fly is the major vector transmitting the disease.

Management:

- Removal and destruction of the affected plants is the only control measure to reduce the spread of the disease.
- Checking the population of white flies also can reduce the infection severity.
- Soil application of Carbofuran (1 kg a.i./ha) at the time of sowing and 4-5 foliar sprays of Dimethoate (0.05%) or Metasystox (0.02%) or Nuvacron (0.05%) at an interval of 10 days effectively controls the whitefly population.

Papaya Ring spot Virus

Symptoms:

- The earliest symptoms on papaya are a yellowing and vein-clearing of the young leaves.
- This is followed by a very conspicuous yellow mottling of the leaves and sometimes severe blistering and leaf distortion. Dark-green streaks and rings also appear in the leafstalks and stems.
- The disease derives its name from the striking symptoms that develop on fruit. These consist of concentric rings and spots or C-shaped markings, a darker green than the background-green fruit colour.
- Symptoms persist on the ripe fruit as darker orange-brown rings.
- Vigor of trees and fruit set is usually reduced depending on the age of the plant when infected. Fruit quality, particularly flavour is also adversely affected.
- Other key symptoms are intense yellow mosaic on leaf lamina and numerous "oily" streaks on petioles.
- The leaf canopy becomes smaller as the disease progresses due to the development of smaller leaves and stunting of the plant.
- Fruit yield and brix levels are markedly lower than fruit from healthy plants. Leaf and fruit symptoms are most intense during the cool season.

- Leaves often develop a shoe-string appearance caused by the extreme reduction of leaf lamina similar to that caused by broad mites.
- Papaya trees of all ages are susceptible and generally will show symptoms two to three weeks after inoculation.
- Trees infected at a very young stage never produce fruit but rarely die because of the disease.
- There are, however, some severe strains, which cause wilting and sometimes death of young trees.

Biology: These viruses typically have long flexuous rod-shaped particles about 800-900 nm long and are transmitted by numerous species of aphids in a non persistent manner. Papaya ring spot virus is grouped into two types, PRV-p and PRV-w. The former type infects both papaya and cucurbits while the latter type infects cucurbits but not papaya. In fact, PRV-w causes major damage to cucurbits and was previously referred to as watermelon mosaic virus I. Both types cause local lesions on *Chenopodium quinoa* and *C. amaranticolor*.

Papaya ring spot virus

Spread

- The virus is spread from plant to plant by any species of aphids, in non-persistant manner.
- Many species of aphids are capable of transmitting the virus and it takes only a few seconds of feeding time for an aphid to acquire the virus onto its mouthparts.
- It is then able to spread the virus to other plants during brief feeding probes.
- Papaya ring spot virus is not spread by other insects and it does not survive in soil or dead plant material.
- The virus can also be spread by the movement of infected papaya plants and cucurbit seedlings. Once infected, plants cannot be cured by spraying with pesticides or removing plant parts showing symptoms.

Epidemiology

- Papaya ring spot virus can be rapidly spread by several aphid species in a non persistent manner.
- Though many cucurbits are susceptible to PRV-p, they do not serve as an important alternate host. Instead, the dominant strain in cucurbits is PRV-w.
- Therefore, the spread of the virus (PRV-p) into and within an orchard is primarily from papaya to papaya.
- There is no evidence that PRV can be transmitted through seeds from infected papaya or cucurbits.
- The development of the disease in an orchard follows the general pattern of viruses that are spread by aphids in a non persistent manner.
- The amount of primary infection increases as the distance from infected papaya trees decrease.
- Secondary infection spreads rapidly and an orchard can become totally infected in three to four months.
- This situation occurs in young orchards located close to infected plants and during periods when populations of winged aphid flights are high.

Management

Non-Chemical Control

Efforts to control papaya ring spot in papaya have included roguing, breeding for tolerance to PRV-p, cultural practices, and cross protection. None of these methods, individually, provide ideal control of the disease. In most cases, the best control is achieved by using a combination of these approaches.

- Quarantine measures: The most effective control is to prevent the introduction of PRSV-P into the major growing areas of papaya.
- Roguing infected plants. Our experience is that early detection of infected plants and prompt removal can contain an outbreak. However, rouging is unlikely to be effective once the disease becomes established in a plantation. .
- The most important is to establish orchards with seedlings that are not infected with PRV-p. Secondly, new orchards should be situated as far as feasible from infected orchards.
- Orchards should not be established by inter-planting seedlings among trees that are infected with PRV-p. Additionally, disease incidence can be reduced byplanting a non-host crop, such as corn, around the orchard and even between rows.
- The rationales for this is that aphids flying into the papaya orchard would first land and feed on the

alternate crop and lose their ability to transmit the virus to papaya due to the non persistent mode of transmission Aphids can be controlled by application of Carbofuran (1 kg a.i./ha) in the nursery bed at the time of sowing seeds followed by 2-3 foliar sprays of Phosphamidon (0.05%) at an interval of10 days starting from 15-20 days after sowing.

POST HARVEST DISEASES OF PAPAYA:

Fruit Rot of Papaya:

(1). Macrophomina rot: Caused by *Macrophomina phaseoli*

SYMPTOMS: *Macrophomina* rot appears as small water soaked spots on fruit surface. Gradually, such spots become deeper and sunken causing rotting of inner tissues. Subsequently, small sclerotia develop on these spots. The inner tissues of such fruits develop brownish black color having dark mycelial growth.

Causal Organism: Caused by *Macrophomina phaseoli* .The conidiomata is pycnidial, pycnia is brown colored and thick walled. Conidia are septate. Sclerotia are black colored and hard.

Epidimiology: It prefers warm weather and usually invades immature unthrifty damaged or senescent tissues. Maximum decay occurs at 300 c and 100% RH.

(2)Rhizophus rot or soft rot: Caused by *Rhizophus stolonifer*

Symptoms: Rhizophus fruit rot or watery fruit rot develops on injured fruits, which develops irregular water soaked lesions. These lesions are in due course, covered with whitish fungal growth which later on turns dark brown. The fruit becomes watery and emit foul smell. Infection spread quickly to the adjoining fruits.

Causal Organism: Caused by *Rhizophus stolonifer* .The sporangiophores are produced on arching stolons, usually born opposite tuft of rhizoids and and typically unbranched sporangiophores not in umbels

Epidimiology: Factors such as nature and type of wounds, rainfall, pre and post harvest treatments and shipment conditions influence the development of rot.

(3)**Phomopsis rot**: Caused by *Phomopsis caricae*

Symptoms: In this, initially water soaked spots appear which will become sunken and dark brown to black in advance stages. Sometimes such spots are surrounded by white raised tissues on the side. The whole area becomes soft and pulpy giving the typical appearance of soft rot.

Causal Organism: It is caused by *Phomopsis caricae*. The hyphae are hyaline initially which turn to sub hyaline later. The conidiophores are rod shaped tapering towards the apex. Conidia are mostly rod shaped. Pycnidia are flask shaped.

(4). Phytophthora rot: *Pytophthora palmivora*

Symptoms: *Phytophthora* rot appears as small water soaked lesions on fruit surface. Gradually, such lesions become deeper and sunken causing rotting of inner tissues. Subsequently, it produces white coating and covers all external surface of the ripened fruits. Whitish coat comprising of sprangio phore and sporangia.

Causal organism: *Pytophthora palmivora*. Mycelium is aseptate, asexual spores are zoospores borne in sporangia.

Epidemiology: It prefers cool weather and usually invades mature, damaged or senescent tissues. Maximum decay occurs at 180 c and relative humidity of 100%.

Management of post harvest diseases:

- Harvesting at proper maturity and cool hours is necessary to avoid post harvest disease
- Post harvest dipping of fruits for 5 min in TBZ (1000) ppm or benomyl (20) has been observed to reduce storage decay
- Dusting of fruits with benzoic acid (0.1%) coated in koaline also reduces the rotting.
- The disease free plantations should be selected for raising new plantations.
- The harvested fruits should be dried in sun for 2 hrs and the packing boxes should be sprayed with 3 % formaline.

Lecture 9: DISEASES OF JACK FRUIT:

Diseases of importance include

S.No.	Major diseases		Pathogen
1	Die back		*Botryodiplodia theobromae*
2	Phytophthora rot		*Phytopthora palmivora*
3	Stem rot, fruit rot and male inflorescence rot		*Rhizopus artocarpi*;
	Minor disease		
4	Leaf spot		*Phyllosticta artocarina*
5	Black rot		*Rosellinia arcuata*, and
6	Charcoal rot		*Ustilana zonata*,

Major Diseases

1. Die back (*Botryodiplodia theobromae*)

SYMPTOMS

- The most of they becomes evident by discoloration & darkening of the bark some distance from the tip.
- The dark area advances & young green twigs start withering first at the base & then extending out words along the veins of leaf edges.
- The affected leaves turn brown & their margins roll upwards at this stage.
- The twig or branches dies shrivels & falls there may be exudation of gum from affected branches such branches are often affected by shoot borers infected twigs show internal discoloration.
- At this stage, the twigs or branches die, shrivel and fall, and there may be an exudation of gum from affected branches. Such branches have also been found to be affected by shoot borers and shot hole borers. when split open.
- In early stages, epidermal and sub-epidermal cells of twigs are often slightly shrivelled on such twigs, erumpent aceruvuli of *Colletotrichum gloeosporioides* are also observed.

CAUSAL ORGANISM: *Botryodiplodia theobromae*

ETIOLOGY:

- Pycnidia are asexual fruiting body, up to 5mm in diameter. Conidia are asexual spores, thin walled at first and become thick walled, septate mycelia is present.
- Primary source of inoculum: Dormant mycelia
- Secondary source of inoculum: Soil and airborne conidia.

EPIDEMOLOGY

Temperature at 25^{O} -30^{O}C. low relative humidity (80- 85%), susceptible host.

Management:

- Pruning of infected twigs followed by spraying of carbendazim 0.1% or thiophonate methyl 0.2 % or chlorothaloni 0.2% is recommended.
- Controlling shoot borer, & shot hole borers by suitable insecticides is also important in reducing die back disease

2. *Phytophthora* rot: *Phytopthora palmivora*

Symptoms:

- Infection takes place through whole or wounded skin in rough skinned verities & through wounds in smooth skinned verities.
- Water socked lesions occur 48-78 hours after inoculation. They enlarge to form light brown spots with sporulating hyphae near the edge affected fruits develop soft rot.
- The damage caused to the bark of crown roots and or bark of the trunk is called Phytophthora gummosis collar rot or foot rot.

Causal Organism: *Phytopthora palmivora*

Epidemiology

- Sporangial production rain water was the best and P. *palmivora* thrives best at 25-28°C. A soil pH of 5.4-7.5 favours the disease

Management: Spraying with Benomyl 1g/lt completely control the rotting

3. Rhizopus Rot of Jackfruit

Symptoms

At first, soft, watery, brown spots develop on the flowers and fruit. Subsequently, a powdery, fuzzy-looking mass of black spores and white fungal mycelia covers the jackfruit surface. The pathogen engulfs the young fruit, resulting in the characteristic black, rotten, shrunken, and sometimes mummified fruit remains. Fruit symptoms can appear on the tree or can develop on fruit that are in storage or transit.

Cause

Three species of plant-pathogenic fungi of the genus *Rhizopus can cause this disease in the tropics: Rhizopus oryzae, Rhizopus artocarpi, and Rhizopus stolonifer.*



EPIDEMIOLOGY:

- Warm, humid, rainy conditions favor the development of rhizopus rot. Wind, rain, and insects dislodge and spread the tiny fungal spores.
- When deposited on moist fruit surfaces, the spores germinate and infective mycelia grow into the tissues.
- The infection produces a layer of black spores on the fruit surface to start secondary cycles of infection and disease. Although wounds can predispose the fruit to infection, unwounded flowers and young fruit are also susceptible.
- *Rhizopus* can survive on decaying plant litter or in the soil to initiate new infections.

Management

- Prune the tree to encourage good ventilation and to reduce relative humidity in the canopy.
- Remove and destroy diseased fruit from trees and the ground. Clean up decaying organic debris within and around the tree.
- Ensure that water does not pond around the tree's root zone. Control weeds around young trees.
- Intercrop jackfruit with trees that are not susceptible to infection by Rhizopus. Keep ripe fruit from contact with the soil or decayingorganic material.
- Avoid wounding the fruit. Wash fruit after harvest in clean water and dry thoroughly before packing or transporting.
- Do not pack fruit with symptoms, destroy them.
- Avoid storing fruit after harvest in hot, poorly ventilated containers.

Chemical Control:

- Spraying of the young fruits with capton 0.2% or Bordeaux mixture 1.0% or copper oxy chloride .025%.
- An interval of three weeks during the months of Jan – Feb & March is effective in controlling the disease.

MINOR DISEASE

A. Leaf spot- (*Phyllosticta artocarina*)

Symptoms: It produces white spots with broad dark margins on leaves. It can be controlled by spraying Bordeaux mixture 1.0%. *Pestalotiopsis clastica* also causes leaf spots *colletotrichom gloeosporioides*. It is characterized by dark brick red spots on both the leaf surfaces in mature spots the centres become grayish with erupted dark acervulus, The margins of the spots turn dark brown.

Management:

The disease is effectively controlled by spraying Carbendazim 0.1% or Thiophanate methyl 0.2% or Difolatan 0.2%.

Black Root Rot : :*Rosselinia spp.*

Symptoms :Affected roots are covered with a net work of black strands of wooly mycelium. White stars of mycelium occurs under the bark of the roots.

Control :apply 4.5 litre of perenox solution @5g per litre of water per hole before planting.

Collect and Burn all infected material

Charcoal rot : :*Ustulina zonata*

Symptoms :Bushes die or dry up suddenly with all their leaves attached. The diseases attack the roots of the plant through contact with the infected roots of nearly shade tree.

Control: cut down the tree and uproot the stump of shade tree.

Dig a trench around the over grow tree and cut all the side roots.

LECTURE 10: DISEASES OF PINE APPLE

S.No	**Major Diseases**		
1	Heart rot		*Phytopthora cinnamomi* and *Phytopthora parasitica*
2	Base rot		*Ceratocystis paradoxa*
3	Wilt		Pine apple wilt virus
4	Pink disease		*Pantoea citrea*
	Minor Diseases		
1	Fruit let core rot		*Penicillium spp*
2	Bacterial fruit rot		*Pantoea ananas* pv. *ananas.*
3	Fruit rot		*Curvularia eragrostidis*

1. Heart rot

Causal organism*: Phytopthora cinnamomi* and *Phytopthora parasitica.*

Symptoms

- In the field, heart rot of young plants is seen as a change in the colour of leaves from normal green to yellowish green and browning of leaf tips.
- The based of the leaves shown yellowish white rotten area bordered by a distinct and characteristic brown margin.
- The chlorophyll region commences.
- The affected area has a fetid odor due to secondary bacterial invasion.
- The rot extends into the stem of the plant producing a soft cheesed-like rotting condition.
- The roots of plants are largely destroyed with the result that the plants are stunted and fruit formation is delayed or dose not occurs at all.

Etiology:

- Aseptate mycelia, inter & intra cellular Haustoria.
- Sexual spores – Oospores (oogonium).
- asexual spores – Zoospores and sporangium

Primary source of inoculum – oospores & Chlamydospores present in debris. Secondary source of inoculum – air & splash borne zoospores

Mode of spread:

- The fungus inhabit sand survive in the soil in the form of oospores.
- The spores spread through runoff water, rain splash.

Epidemiology:

- Heart rot under warmer and somewhat drier conditions is frequently associated with alkaline soils and poor drainage.
- It is serious in cool, wet soil.
- Temperatute:250c, heavy rain soon after planting leads to heavy disease incidence.
- Plants of one or two year old age are more susceptible.

Management:

- Deep planting should be avoided.
- Soil should not be allowed to enter the hearts during planting.
- Diseased plants should be removed and burnt
- Bordeaux mixture(1%) spray reduces the disease
- **Affected plantations should be sprayed with Chlorthalonil 20g or Zineb 20g/10 litre of water.**
- Good soil drainage and use of healthy planting material at helps in minimising the spread of the disease.

2. Base rot

- Causal organism: *Ceratocystis paradoxa*

Symptoms:

- It is typically black rot of the butt of the plant.
- The softer tissues are destroyed and only stringy fibers remine decay of the butt is followed by wilting of the foliage and the diseased plant break off at low level
- The leaves show grey spots with dark margin the spots turn olive brown or white. With advance of the diseases tissues dry and leaves become destroyed.
- Finally skin flesh and core disintegrated.
- The fruit decay is accompanied by a sweetish odor, during such times the fungus is found on rotting tops and sucker left lying in heaps in damp sutiation.

Mode of spread:

- It a parasite.
- The fungus survives in the form of black spores in the soil.
- Infection takes place during picking and packing by spores distributed by wind or rain or affect parts.

Epidemiology:

- The disease is prevalent in warmer months following wet weather.
- The disease development is favored by warm weather.
- Wet soil or storage condition, serious losses occur when the suckers have been kept in a damp place or when the planting has been followed by prolonged wet weather.

Management:

- The planting material should be cured for at last two are three days in the sun before planting or packing for transport
- Dipping of the plant captofoln13.5kg/ha.
- Dipping of fruits after harvest for three minutes in benomyl 0.2% or thiabendazole 0.1%.

3. WILT

- Causal organism: pine apple wilt virus

Symptoms:

- Leaves develop characteristic bronzing starting from third or fourth whorl on words.
- The leaves show bright pink colour browning of the tips with downwards curling of the margin.
- The pink colour becomes more pronounced and leaves from the top dry downwards
- . Finally the tips dry up completely.
- The bright pink colour becomes dull and the root system collapses.

Mode of spread and survival:

- The disease is transmitted through mealybugs, Dysmicocus brevipes.

Management:

- Higher levels of nitrogen decreased the disease incidence.
- Wilt incidence has lesser in plots having a plant population.
- Diseased sucker can be recovered within 30-50 days by hot water or heat treatment at 50oc for 3 hours.

4. Pink Disease: - *Pantoea citrea*

History

- Pink disease was originally described in 1915 in Hawaii.
- The pathogen responsible for causing pink disease remained obscure and the nature of the pink color formation of the pineapple fruit tissue was not understood.
- A myriad of bacteria associated with the pineapple plant, many of which originated from the surrounding soil, made identifying the primary cause of the disease extremely difficult.
- The biochemical basis of the disease was thought to be complex and difficult to elucidate, and was therefore left uncharacterized.
- Attempts at identifying the pathogen led to implicating several distinct bacteria as the causal agents of pink disease. *Gluconobacter oxydans, Acetobacter aceti,* and *Erwinia herbicola* were the prominent suspected species.

SYMPTOMS

- Pink disease symptoms are difficult to observe in the field since outward symptoms are not apparent.
- Infections of the foliage are not usually found. Under severe invasion of the fruit by *P. citrea,* a translucent appearance of the sub-dermal fruit tissue occasionally can be observed.
- The most common appearance of symptoms occurs when infected fruit preparations are heated as a result of the canning process.
- Heating causes the formation of red to rusty brown coloration of the usually golden yellow tissue.

The Pathogen

- *Pantoea citrea* is a Gram-negative, facultative anaerobic, non-spore forming, bacilliform bacterium with physiological and biochemical as well as 16S rDNA features corresponding to those of the Enterobacteriaceae.
- On nutrient agar and trypticase soya agar, the colonies are entire, smooth, glistening, translucent, but not mucoid. The colonies become taupe in color. *Pantoea citrea* grows readily in pineapple juice as well as in fresh pineapple fruit tissue.
- Unlike other *Pantoea* species, *P. citrea* is unable to utilize citrate or tartrate. Besides the genetic makeup that causes the pink disease reaction in the pineapple fruit, the bacterium elicits the hypersensitive response in tobacco.
- Many strains harbor pUCD5000, a small plasmid containing genes that help promote the development of pink coloration.
- The pathogen is amenable to genetic manipulation and is compatible with many plasmid vectors used as molecular biological tools.
- The sequence of the entire genome is forthcoming and should shed a complete picture on the organization of operons and genes involved in causing the pink disease in pineapple.

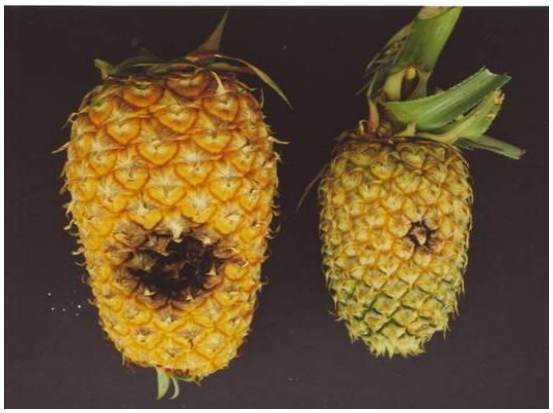
Management:

- Although there are no experimental evidence attributing insects directly with the transmission of *P. citrea* to the fruit, the high correlation of higher pink disease incidence with lowered application of insecticides tend to suggest that this assumption is correct.
- Plant breeding for resistance to pink disease has shown some promise.
- Crosses between the wild-type resistant varieties with the horticulturally acceptable varieties such as Smooth Cayenne cultivars are currently being screened to develop successful resistance.
- Plant genetic engineering strategies are also being considered.
- Genes used to lower the substrate that leads to 2,5-diketogluconate formation and genes used to inhibit the growth of *P. citrea* in fruit tissue are some examples that can be incorporated in the transgenic pineapple.
- Biological control methods also have been assessed. Several bacterial species that are antagonistic to *P. citrea* have been tested in the laboratory and in the field.
- The most promising biocontrol isolates, such as *Bacillus gordonae,* further reduced disease incidence in combination with insecticides.
- From a practical view point, the requirement of relatively large fermentation facilities to produce and process large quantities of bacteria is a key limiting factor.

- Production, supply, maintenance, and trained labor are needed to continually produce the biocontrol agent.
- This end of the biocontrol program is not cost effective when compared with insecticides. Outside suppliers of the biocontrol agent would help alleviate some of the production cost.
- However, for one pineapple producing company alone, more than 60 square miles (15,540 hectares) of pineapple are propagated year round. Hence, the application of a biocontrol agent (e.g., at the rate of 1 kg of biocontrol inoculum [wet packed weight] per hectare requires 50 liters of culture medium) to such a vast area is perceived as economically unfeasible.

Fruitlet core rot

- Fruitlet core rot (Figures 2 & 3) is usually caused by a combination of two fungi, *Penicillium and Fusarium spp.* The infected tissue turns light to dark brown, with water-soaked symptoms (Figure 3). Mites are thought to be associated with this disease, through causing injury to the fruitlets. The soil-borne fungi then enter through the wounds to infect the fruitlets.

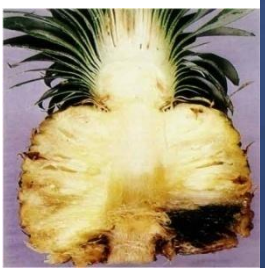


- Fruit with fruitlet core rot

Cross-section of fruit with fruitlet core rot

Curvularia fruit rot

The causal fungus of this disease *Curvularia eragrostidis,* was found to enter the fruit through cracks at the "eyes" of the pineapple fruit. The greyish fungus on the infected part of the fruit later turns dark to almost black, giving the disease



Fruit rot caused by *Curvularia eragrostidis*

- **Black-rot or Soft-rot**
- A delay of some days between harvest and utilization of the ripe fruits leads to the development of black-rot or soft-rot. The fungus makes its entry through wounds caused during picking and packing. Infestation starts at the stalk-end of the fruit, resulting in small,circular, water-soaked spots that are very soft. Gradually, fruit rots and emits foul smell.
- **Control: Dipping of fruits for 5 minutes in Thiabendazole (100 ppm) or Benomyl** 3000 ppm) minimise rotting. Avoiding injury to the fruit during harvest and transit prevents disease occurrence.

LECTURE 11: DISEASES OF POMEGRANATE

INTRODUCTION

Pomegranate (*Punica granatum*) is one of the favorite table fruits of tropical & sub tropical regions, a native of Iran and belonging to family punicaceae. Pomegranate is extensively cultivated in Mediterranean countries like Spain, Morocco, Egypt, Iran, Afghanistan & Baluchistan. Ripe pomegranate fruits are consumed fresh. Juice extracted from fruits makes an excellent drink. Apart from this, an attractive jelly anar-rub and syrup can also be manufactured from ripe fruits.
IMPORTANT DISEASES OF POMEGRANATE

S.No.	A) Major Diseases	
1	Cercospora leaf spot	*Cercospora punicae*
2	Bacterial blight	*Xanthomonas axonopodis pv. punicae*
3	Leaf spots	*Colletotrichum gloeosporioides*
4	Leaf spots	*Sphaceloma punicae*
5	Leaf spots	*Fusarium fusaroidies*
6	Leaf spots	*Phomopsis aucubicola*
7	Leaf spots	*Drechslera rostara*
8	Wilt	*Ceratocystis fimbrita*
	B) Minor Diseases	
1	Canker	*Ceuthospora phyllosticta*
2	Leaf and fruit spot	*Coelophoma empetri*
3	Flower and fruit spot	*Phytophthora nicotianae*
4	Fruit Spots	*Beltaraniella humicola*
5	Fruit Spots	*Pestalotiopsis vesicolor*
6	Cladosporium fruit rot	*Cladosporium oxysporum*
7	Aspergillus fruit rot	*Aspergillus spp.*
8	Mild soft fruit rot	*Penicillium chrysogenum*
9	Soft fruit rots	*Rhizopus arrhizus & R. stolonifier*
10	Dry fruit rot	*Syncephalastrum racemsum*
11	Fusarium fruit rot	*Fusarium equiseti*
12	Phomopsis fruit rot	*Phomopsis sp.*
13	Root knot nematode	*Meloidogyne incognata*

1. Cercospora leaf spot - *Cercospora punicae*

Causal organism: *Cercospora punicae* P.Henn.

Symptoms

- Light brown zonated spots appear on leaves and fruits.
- Black, elliptic spots appear on the twigs.
- The infected areas in the twigs become flattened and depressed with raised edges.
- Such infected twigs become dry and in severe cases the whole plant dies.

Etiology

- Conidiophores are olivaceous brown, short fasciculate, sparingly septate. Conidia are hyaline to pale olivaceous, cylindrical, sub fusoid to sub - clavate, septate.

Life cycle

Mode of survival and Spread

- The pathogen survives in infected plant parts as dormant mycelia and spreads through airborne conidia produced in acervullus.

Epidemiology

- The disease becomes severe during August to November, when there is high humidity and atmospheric temperature between 20 to 27°C

Management

- Cultural practice
- Clean cultivation, i.e. sanitation, including removal of weeds.
- Spray nitrogen solution or bleaching powder to enhance degradation of fallen leaves or infected plant parts.

- Cut all the affected branches and burn.
- pruned area should be smeared with Bordeaux paste or COC paste.
- Chemical
- Spray thiophanate methyl (0.1%) or mancozeb (0.2%) or cardendazim (0.1%) on the plants.

Bacterial blight

Causal organism: *Xanthomas axonopodis* pv. punicae

Symptoms

- Small, irregular, water soaked spots appear on the leaves.
- Spots vary from two to five mm in diameter with necrotic centre of pin-head size.
- Spots are translucent which turn light brown to dark brown after sometime and are surrounded by prominent water-soaked margins. Spots coalesce to form large patches.
- Severely infected leaves defoliated.
- The bacterium attacks stems, branches and fruits also.
- On stem, the disease starts as brown to black spots around the nodes .It further causes girdling and cracking of nodes. Finally the branches get broken.
- Brown to black spots formed on fruits which are raised and oily in appearance.

Etiology

- It is a Gram-negative rod, motile with single polar flagellum. It is non acid fast and aerobic.
- Mode of spread and survival
- The bacterium survives on the tree.
- The pathogen survives for 120 days on fallen leaves during the season.
- The primary infection occurs through infected cuttings.The disease spreads through wind and splashed rains.

Epidemiology

- High temperature and low humidity favour the disease. Temperature of 30 - 34° C and relative humidity (80 to 85%) is favourable for multiplication of the pathogen.

Management

- Clean cultivation and strict sanitation in the orchards help in reduction of disease incidence.
- Collect and burn the fallen leaves
- Spraying of 1 % urea solution on fallen leaves enhances their degradation process.
- Bleaching powder spray on the fallen leaves reduces the inoculum
- Spraying Bordeaux mixture (1.0%) controls the disease.
- Spray 0.05% streptocycline to control the disease
- Copper oxy chloride spray (0.3% concentration) can also be done.
- Pruning at correct stage would reduce the disease(Bahar pruning)
- Ganesh has been found to be a moderately resistant variety for bacterial blight disease

Leaf spot

Causal organism: *Colletotrichum gloeosporioides*

Symptoms

- The disease appears as small, regular to irregular, dull violet or black spots on the leaves.
- These spots are surrounded by yellow margins.
- The infected leaves turn yellow and defoliate.

Epidemiology

- The disease is in severe form during August to November months when there is high humidity and the temperature between 20 and 27°C
- Mode of survival and Spread
- The pathogen survives in infected plant parts as dormant mycelia

- It spreads through airborne conidia produced in acervullus.
- Mode of entry is through stomata

Management

- Clean cultivation.
- Spray nitrogen solution (urea %) or bleaching powder to enhance degradation of fallen leaves or infected plant parts.
- Prune and burn infected branches and pruned material. The pruned area should be smeared with Bordeaux paste or COC paste.
- Spray thiophanate methyl (0.1%) or mancozeb (0.25%) or carbendazim (0.1%) on the plants.

Leaf spot

Causal organism: *Sphaceloma punicae* (Bitancourt and Jenkins)

Symptom

- The disease attacks leaves, shoots, calyx and fruits. Rusty spots appear on leaves.
- Infected leaves turn yellow and die, Rusty colored pustules appear on fruits.
- Drizzling rains and abundant dew favour disease development and spread

Epidemiology

- The disease is severe during August to November months when there is high humidity and atmospheric temperature between 20 and 270 C.

Mode of survival and Spread

- The pathogen survives in infected plant parts and spreads through airborne conidia

Management

- Clean cultivation.
- Spray nitrogen solution (Urea %) or bleaching powder to enhance degradation of fallen leaves or infected plant parts
- Prune and burn affected branches and pruned material. The pruned area should be treated with Bordeaux paste or COC paste.
- Spray thiophenate methyl (0.1%) or mancozeb (0.2%) or carbendazim (0.1%) on plants as preventive sprays.

Fusarium wilt

Causal organism: *Fusarium fusarioides* (Farg & Cif)

Symptoms

- The disease appears as minute specks towards the leaf margin.
- The spots are brown, circular to irregular in shape which coalesce and form big dark brown necrotic blotch at a later stage.

Epidemiology

- The disease is severe during August to November with when there is high humidity and the temperature between 20 and 27°C.

Mode of survival and Spread

- The pathogen survives in infected plant parts and spreads through airborne conidia

Life cycle

Management

- Clean cultivation, i.e. sanitation, includes removal of weeds. On fallen leaves or infected plant parts, spray nitrogen solution (urea %) or bleaching powder to enhance these degradation process.
- Prune infected and burn infected branches and pruned materials. The pruned area should be treated with Bordeaux paste or COC paste.
- Spray thiophonate methyl (0.1%) or mancozeb(0.2%) or cardendazim(0.1%) on trees.

CANKER

Causal organism: *Ceuthospora phyllosticta*

Symptom

- Elliptic black spots are formed on twigs.
- Infected areas become flattened and depressed with raised edge.
- Later the bark becomes dry which cracks and the wood below show abnormal, dark brown to black discoloration.
- Twigs beyond the cankerous spots turn dry and in severe cases the infected trees become dead.

Mode of spread and survival

Pathogen can survive on the cankerous growth of leaves, stem or fruits. In the warm rainy season bacteria ooze out from cankers and spread through water splash and air. It enters the through stomata and wounds on the plants.

Life cycle

The bacterial spores present in the cankers ooze out when conditions are congenial for them and become water splash borne or air borne. When they come in contact with the host plant surface, they enter through stomata or injuries, multiply inside the plant, cause infection, and develop symptoms like cankerous growth on the surface and thus repeat the life cycle.

Leaf and fruit spot

Causal organism: *Coelophoma empetri* (Rostrup)

Symptom

- On leaves the spots appear as circular, reddish and brown to dark brown in colour.
- These spots coalesce to form bigger sized lesions which are necrotic and dark brown.
- The infected leaves turn pale yellow and drop at a later stage.
- Numerous minute, circular, tan brown spots appear on fruits which turn brown to black later.
- The spots coalesce to form irregular, depressed and hard necrotic lesions.
- Lesions are restricted to epidermis baring black, spherical pycnidia.

Flower and fruit spot

Causal organism: *Phytophthora nicotianae*

Symptoms

- Diseased spots on flower result in premature shedding.
- Lesions are also formed on fruits.
- Twigs in the trees are also infected.

Mode of survival and Spread

- Oospores are spherical, sporangia are broadly turbinate with spherical basal portions and apical part prolonged into a break or papillate

Life cycle

- Oospores are thick walled, sexual diploids spores present in the infected debris
- When conditions are congenial, the oospore germinates as a sporangium and releases zoospores
- After their release the zoospores encyst (Short period resting phase) and the zoospores looses their flagellum.
- Soon after landing on the host surface, encysted zoospore germinates to produce germ tube and enter inside the host through stomata.
- The mycelium multiplies by producing intracellular haustoria and absorbing nutrients which causes infection by producing sporangium and thus continues the life cycle.
- In adverse conditions, it undergoes sexual reproduction with gematangial contact type of reproduction between oogonium and antheridium followed by Plasmogamy, Karyogamy mitosis, meiosis and oospore formation.

Management

- Clean cultivation.
- Spray nitrogen solution (Urea) or bleaching powder to enhance degradation of fallen leaves or infected plant parts.
- Prune and burn infected branches and pruned material and the pruned branches should be treated with Bordeaux paste or COC paste.
- Spray thiophenate methyl (0.1%) or mancozeb (0.2%) or cardendazim (0.1%)

Fruit spot disease

Causal organism : *Beltaraniella humicola*

Symptoms

- Black, circular spots appear that gradually enlarge and coalesce to form big spots and cause necrosis.
- The margin of spots varies from reddish to brown in colour.
- Infection is restricted to rind of the fruit and undesirable of the pulp.

Mode of survival and Spread

- The pathogen survives in infected plant parts as dormant mycelia and spreads through airborne conidia

Epidemiology

- The disease is severe during August to November months. When there is high humidity and the temperature between 20 and 27°C.

Management

- Clean cultivation.
- Spray nitrogen solution(urea %) or bleaching powder to enhance degradation of fallen leaves or affected plant parts.
- Prune all the affected branches and burn them.
- The pruned area should be coated with Bordeaux paste or COC paste.
- Spray thiophanate methyl (0.1%) or mancozeb (0.25%) or carbendazim (0.1%).

Fruit spot

Causal organism: *Pestalotiopsis versicolor* (Speg.)

symptoms

- The disease manifests its symptoms as minute, brown to rust coloured spots on the fruits.
- The spots coalesce with the disease development and cause necrotic patches.
- The central portion of the lesion is depressed inwards with raised margin and in case of severe infection, tear open the rind.
- In several cases infection penetrates deep into the fruits and causes discoloration of seeds.

Cladosporium fruit rot disease

Causal organism: *Cladosporium oxysporum*

The diseased fruits develop orange-red to dull-brown circular spots which become olive-brown. In advanced stage of the disease, the entire fruit rots. Hyphae of the fungus are septate. Light olive-green, 2.5 - 30 µm in width; conidiophores are light brown and simple; conidia light brown to olive green, 1-celled, fusoid and 1 - 20 x 3.5 - 4.5 µm.

Aspergillus fruit rots

Causal organsim: *Aspergillus flavus* (Link)

It causes brown discoloration which gradually becomes blackish and slimy. Later, it gets slightly depressed and covered by green conidial heads of the fungus. The disease causes soft rot of fruits and emit fermented odour.

Mild soft rot

Causal organsim: *Penicillium chrysogenum* (Thom)

Soft, watery spots of two to four cm diameter appear on the fruits. They increase in size and coalesce together. The spots are found covered with white mycelia and bluish green spores.

Mode of survival and Spread

The pathogen survives in infected plant parts as dormant mycelia and spreads through airborne conidia

Epidemiology

The disease is severe during August to November months when there is high humidity and atmospheric temperature between 20 and 27°C

Management

- Clean cultivation.
- Spray nitrogen solution (urea %) or bleaching powder to enhance degradation of fallen leaves or affected plant parts.
- Prune all infected branches and burn them.
- The pruned area should be coated with Bordeaux paste or COC paste.
- Spray thiophanate methyl (0.1%) or mancozeb (0.25%) or carbendazim(0.1%) on the plant

Soft rots

Causal organism: *Rhizopus arrhizus* & *R. stolonifer* (Fisher)

Symptoms

- Small spots appear on fruits which increase in size and coalesce. Infection is restricted to rind, but the entire internal content decays into a pulpy mass. Under dry conditions, cracks originate from

the point of infection. Packing straw should be treated with sulphur dioxide. Treatment of fruits with linseed oil or mustard oil or castor oil protects them from rotting.

Dry rot

Causal organism: *Syncephalastrum racemosum* (Cohn)

Symptoms

- Small, isolated dark patches are formed on surface of the fruits which turn dry and covered with mycelium and spores of the fungus. Inner pulp rots.

Fusarium rot

Causal organism: Fusarium equisetti (Corda)

Symptoms

Circular and depressed lesions appear on the fruits. Lesions are surrounded by concentric wrinkle. These lesions increase in size and cover almost the entire fruit.

Phomopsis rot

Causal organism: *Phomopsis* sp.

Symptoms

- The disease starts from calyx end and gradually spreads over the entire fruit. Pycnidia appear on infected areas. One spray with copper oxychloride (%) checks the spread. Copper oxychloride (0.5%) spray, three times at ten days interval, controls the disease.

Management of fruit rots

- Harvest the produce during cool hours.
- During grading, wounded infected, irregular sized fruits should be discarded.
- Use aerated boxes and smooth bedding and filling material for packaging.
- Store the produce before transit in completely controlled atmospheric condition
- Remove all infected /dried part from the grading / packing areas.
- Sterilize/decontaminate the storage bins with 0.5% formaldehyde or 70% ethyl alcohol.
- Chemical treatment with Benomyl @ 1g/lit, by dipping the fruits in the solution.
- Dip the fruits in wax solution for coating or dip the fruits in neem or Castor oil or dip the fruits in *Trichoderma* solution

Root Knot Nematode

Causal organism: *Meloidogyne incognita*

Symptoms

Gradual yellowing of plant; stunting, root discoloration, formation of knots on the roots, root decay and finally plant collapse, are the major symptoms.

Mode of survival and spread

Survives in infected soil & plants and spread through irrigation water.

Epidemiology

Soil moisture, neutral pH, sandy loam soil, susceptible host are the parameters of congenial atmosphere.

Management

- Use healthy certified plants.
- Use disease free area for new plantations.
- Pull out the infected plants &burn.
- Avoid excess N application in the soil and increase K application which induces resistance in the plants.
- Apply Carbofuren @ 10-15g with 5-10 Kg of FYM around the root zone.
- Apply neem cake @ 5Kg/plant. Flooding of plot creates anaerobic condition.VAM can also be applied.

ORCHARD HEALTH MANAGEMENT PRACTICES

- The orchard health management practices include clean cultivation and orchard sanitation which are the primary requirement for developing a healthy orchard of any fruit crop.
- The twig and branches were pruned 2 inches below the canker and Bordeaux past was applied on the cut ends immediately after pruning , followed by recommended spray.
- The secateurs and other pruning tools were disinfected using sodium hypochloride (1%) after completing pruning of each tree.

- Infected plant parts (leaves, flowers, fruits & twigs) in orchards were collected from the orchard and burnt.
- The ground below canopy were drenched with bleaching powder @ 25 kg/ha/1000 litre water to reduce the bacterial inoculums on left-over plant debris in soil within the orchards.
- Farm yard manure (FYM), NPK and micronutrient containing fertilizers were applied as per recommendation based on soil test value and insecticides were used as per requirement to check insect infestation, as these may act as carrier of the pathogen.
- To regulate flowering, defoliation was done using curacuron, in the month of July/Aug.
- Irrigation was given through drip as per requirement during the whole season

SPRAY SCHEDULE

- First spray, of Bordeaux mixture (1%) was given immediately after pruning.
- Second spray was given at foliage initiation /emergence with streptocycline (500 ppm)+Copper oxychloride (0.25%). Non ionic sticker was used with fungicides (except with Bordeaux mixture)during the rainy season.
- Third and subsequent spray of Bordeaux mixture (0.5%) was given at 10-15 days interval depending upon rains.
- Fourth spray consisted of streptocycline (500 ppm)+ Carbendazim (0.10%).
- Second to fourth sprays were repeated at 7-15 days period depending on weather conditions.

The package for wilt management was finalized by the scientists by the scientist from NRC on Pomegranate, Solapur, MPKV Rahuri and MAU Parbhani, in the meeting held at NRCP, Solapur on July, 26, 2008

- Prefer site having light –medium soil for the orchard with proper drainage.
- Plant orchard with disease free planting material grown in disease free solarized soil.
- Make pits 1m X 1mX 1m, at a spacing of 4.5 m (row X row)X 3.0 m (plant Xplant). This will accommodate about 740 plants. Disease also spread through root to root contact hence narrower spacing will aggravate the wilt problem.
- Pit are dug about a month prior to planting and kept open for at least 1 month. So that it is disinfected by intense solar radiation during the day.
- Drench pit with 0.2 % Carbendazim in 5 L water per pit.
- Carbaryl dust and or chlorpyrifos 50 g per pit is dusted on the bottom and sides of the pits just before filling the pits.
- Pit are also treated with calcium hypochlorite @ 100 g per pit, before filling
- Pits also treated with calcium hypochlorite @100 g per pits before filling
- At pit filling if soil is heavy mix sand :soil in 1:1 ratio in each pit mix with top soil

FYM	20 kg
Vermicompost	2 kg
Neem cake	3 kg
Trichoderma formulation	25g
PSB	15 g per plant (10 kg per ha)
Azotobactor formulation	15 g per plant (10 kg per ha)

- Follow proper soil and water management
- On observing a wilted plant immediately drench soil with chloropyriphos (0.25%)+ carbendazim (0.2%) or propiconazole /Tilt(0.15%) or hexaconazole (0.15%) @ 5litre per tree. Drench atleast 2-3 plant on all four sides around the infected plant/s. chloropyriphos will take care of shot hole infestation if any.
- The pathogen propagules are also observed on arial parts. So spray entire orchard with 0.1% carbendazim.
- Uproot dead wilted dry plant and burn immediately. While removing the wilted plant from the orchards for burning, protect the root zone with cover, as the spores of the pathogen are present abundantly on the roots and may spread on the other plants.
- Avoid pruning in spring and early summer which also insect active period, because insect sap attracted to sap produced wounds and thus help in dissemination of pathogen propagules .
- Protect all pruning wounds, with Bordeaux paste.

- For controlling shot hole borer (Xyleborus spp) which is associated with wilt disease , 10 liters preparation containing Red soil (4kg)+chloropyriphos (20ml)+ copper oxychlorides (25g) can be applied on plant base from second year onwards. Red soil should be soaked in water overnight and chemicals mixed next day.
- For stem borer control, inject in the holes on the trunk Fenvalerate @ 5 ml/litre and lug the holes with mud.
- Where nematodes are a problem apply phorate @ 20kg/ha or Carbofuran @ 2kg a.i./ha in the plant basin, in a ring near root zone and cover it with soil.
- Plant *Targets erecta* (African marigold) between plant to plant space in a row, or in a ring, on he border of plant basin, these help in reducing nematode population. For effective results these should be grown for more than 4-5 month.
- Follow clean cultivation and orchard sanitation measures strictly

Lecture 12: DISEASES OF BER

S.No.	Major Disease		Pathogen
1	Powdery mildew		*Oidium erysiphoides f.sp. zizyphi*
2	*Alternaria* leaf spot		*Alternaria chartarum*
3	Rust		*Phakopsora zizyphi-vulgaris*
4	Soft rot		*Phomopsis natsume*

1. Powdery mildew – *Oidium erysiphoides* f.sp. *zizyphi*

The disease is noticed generally at the end of October and prevails from **November to April**

Symptoms

- White to greyish powdery mass appears on young leaves and fruits
- Severely affected leaves shrink and defoliate
- White powdery growth appears on young fruits which later becomes profuse and finally turns brown to dark brown in colour
- Infected fruits become corky, crack, misshapen, underdeveloped and finally drop prematurely

Survival and spread

Primary: **Dormant mycelium and conidia** on infected plants

Secondary: Wind borne **conidia**

Favourable conditions

- Cool and dry conditions with morning R.H more than 90%

Management

- Spray Dinocap 0.1% or Wettable sulphur 0.2% during first and third weeks of November
- Two sprays of Carbendazim 0.1% at 15 days interval, starting from the time when the fruits are of pea size followed by Dinocap 0.1% spray at 10-15 days interval

2. **Alternaria leaf spot:** *Alternaria chartarum*

Symptoms:

The disease is characterised by the formation of small irregular' brown spot on the upper surface of the leaves.

- On the lower surface dark brown to black spots are formed.
- The spots coalesce to form big patches. The diseased leaves later drop.

Plant debris serve as potential source of primary infection.

Management: The disease can be controlled effectively by spraying Mancozeb 0.25 per cent

3. **Rust:** *Phakopsora zizyphi-vulgaris*

Symptom

- On the lower surface of the leaves small, irregular, reddish brown uredopustules appear. Later they cover the whole area of the leaves.
- The infected leaves dry and defoliate. It is an autoecious rust.

Management

- Spraying with Mancozeb 0.2 per cent or Zineb 0.2 per cent or Wettable sulphur 0.2 per cent controls the disease.

4. **Soft rot:** *Phomopsis natsume*

Symptom

- The disease appears as a light russet vinaceous coloured, irregular spot on the fruits.
- It increases in size and make the whole fruit into pulpy, brown to black in colour with soft and loose outer skin.

Management: The disease can be-controlled by spraying with Carbendazim 0.05 per cent.

LECTURE 13 DISEASE OF APPLE (*Malus domestica*)

Family: Rosaceae

Origin: Caucsus mountains of south west Asia

Introduction

Apples are most delicious fruit for its crispness long storage life, Apple is the king of temperate zone, they are good for human health. Apples are high in vit. c fiber low in calories, pectin .They are rich source of mineral nutrients. They contains rich amount of iron &acts as a blood purifier. An apple acts as natural tooth brushers. Himachal Pradesh is consider as the apple bowl of India

Diseases of Apple

S.No.	Major disease		**Pathogen**
1	Apple scab		*Venturia inaequalis*
2	Powdery mildew		*Podosphaera leuchotricha*
3	Cedar apple rust		*Gymnosporangium juniperi virginianae*
4	Fire blight		*Erwinia amylovora*
5	Black Rot		*Botryosphaeria obtuse*
6	Sooty blotch		*Leptodontium elatius*
7	Flyspeck		*Zygophiala jamaicensis*
8	Phytopthora Crown Rot, Collar Rot, and Root		*Phytopthora spp.*
9	Crown gall		*Agrobacterium tumefaciens*

Apple Scab

In India this disease was first reported in the Kashmir valley and in Lahore in 1935. 1973 first epidemic of apple scab in Himachal Pradesh and Kashmir. 1978-1983 the cab affected area in Himachal Pradesh reach from 150 ha to 40000 ha. 1985 In Kashmir 60 % apple orchard was infected with apple scab.

Symptoms: the First appear on the under surface of **sepals or young leaves** of the **flower bud** as light, somewhat olive colored, irregular spots. Soon after the spots or lesions become olive green with a velvety grayish- dark surface. Finally the lesions obtained a metallic black colour and may be slightly raised. The mature lesions almost cover the upper surface of the leaf. After severe early leaf infection, the leaves may become dwarfed and curled and may later fall off.

Symptoms appear on fruits as distinct, almost circular scab lesions, which at first are velvety and olive green but later become darker scabby, and sometimes cracked. Severe early fruit infections result in cracked fruits, which frequently drop prematurely.

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Disease causing organism*:* *Venturia inaequalis* (Cooke) Wint. And its conidial stage is *Spilocaea pomi*

Two races namely Ambari and Red Delicious reported from Kashmir valley. Mycelium of fungus first light in color but later turn grey in culture and brownish in host tissue. Conidiophores brown continuously or rarely septate conidiophores arise from hyphal strand or from more compact stroma.conidia are generally one celled. Ascocarp of fungus is pesudothecium (perithecium). Mature ascocarps are spherical dark brown to black and possess a short beak and distinct ostiole around which single celled setae are present. As high as 242 asci is maximum per perithecium but varies from 50 to 100. Ascospores are oval to boat shaped hyaline yellowish to olivaceous in color and two celled.

Disease cycle: The fungus primarily overwinters on infected leaves on the orchard floor. Ascospores are released in the spring at about budbreak, and disseminated by wind during rainy periods. Moisture is required in order for the spores to germinate. The time it takes for infection to occur is a function of the number of hours of leaf wetness and the temperature. Several secondary cycles of infection, arising from spores produced in primary lesions, may occur during the growing season. Leaf wetness period required 9 hours minimum and temperature for disease development is 19-20 ^{o}C.

Management:

Elimination and reduction of perithecial production

Practical application of this information was made in England where 5 % urea was sprayed on infected trees after fruit harvest at the pre-leaf fall stage. This treatment caused about 95 % reduction in ascospore discharge from fallen leaves in the next spring. Post-harvest spray of benlate 0.4 % also reduces the perithecia formation in fallen leaves.

Cultural: Flail mowing of the leaf litter on the orchard floor also hastens leaf decomposition. Prune trees to open the canopy to light, air, and spray penetration.

Fungicide sprays to prevent primary and secondary infection:

In on-season spray the protectant fungicide dodine (syllit 0.15%) and Difolatan 0.3% provide better control of primary scab on leaves and fruit than the systemic fungicides. Delan, Benzimidazoles, daxonil, mancozeb, zineb and cumin L are good for control of secondary infection. Six spray of 0.05% bavistin, Dithane M-45(first spray 0.4% and subsequent spray at 0.15%) gave 93-10% control of leaf and fruit scab.

Use of sterol biosynthesis inhibiting fungicides

Difenaconazole (score) fenarimole, mycobutanil, anilopyrimidine etc.

Calendar based spray schedule in India

In Himachal Pradesh (India) the chemical control of apple scab was suggested on the following lines:

1. One spray of 5 % urea on tree before general leaf fall in October – November (post harvest spray)
2. One spray of difolatan (330g/100L water) or Benzimidazole such as bavistin, MBC, or Topsin M 950-100g / 100 L water) at silver tip to green tip stage in March and April.
3. One spray of Dithane (indofil) M-4 at 200 g/100l water or captan at 200 g/litre water, or if not used in the preciding spray, a benzimidazole (30-50 g/ 100 L water) at the petal fall stage in April – May.
4. One of three spray of dithane M-45 (250 g / 100Lwater) at the post blossom stage in the late summer at 10-15 days interval.

In the Kashmir Valley, the calendar based spray schedule recommended to farmers is as follows:

1. First spray of mencozeb (0.3%) or Ziram at the silver tip to green tip stage (Mid-March to Mid April).
2. Second spray with captafol or captan or dodine 10-12 day after first spray (pink Bud stage)
3. Third spray with MBC or Bavistin or Topsin-M (50 g/ 100L water) 12-15 days after second spray(petal fall stage)
4. At the fruit let stage, 12-15 days after the third spray the fourth spray of mencozeb or ziram or captan or captafol.
5. The above fungicide or dithiocarbamate can be again used for fifth spray 15-20 day after the fourth spay.
6. During the fruit development stage, 25-39 days after the fifth spray the sixth spray should be given with bezimidazole fungicide.
7. If necessary, a pre harvest spray (25-30 days before harvest)can be given with Ziram, Mancozeb or dodine provide the prealling temperature temperature is not found is not above 27^{o}C

Biological control

Althelia bombacina and *Chaetomium globosum* are promising biocontrol agent against *Venturia inaequalis* used as foliar spray with calcium nitrate.

Resistant cultivars

The apple scab resistant varieties introduced in India from the united state and Canada are prima, Pricilla, sir Prize, Mac free, Coop-2, Red free, Nova Easygro, Liberta and Freedom.

Powdery Mildew

Disease causing organism: *Podosphaera leucotricha* (Ell. and Ev.) Salmon

Symptoms: Evidence of powdery mildew infection may appear on the leaves, buds, shoots, blossoms, and fruit. Symptoms of infections on the leaves most often are seen as whitish, felt-like patches of fungal mycelium and spores. These symptoms most commonly appear first on the lower surface of the leaves. Lesions may also appear on the upper surface as chlorotic spots, or cover the entire leaf with powdery, white spores and mycelium. Curling and crinkling of the leaves can occur as a result of infections along the leaf margin. Leaves effected severely by the disease may fall off prematurely. Branch terminals which are severely infected may be stunted. Buds which are infected with powdery mildew can become more susceptible to winter injury. Fruit infections on certain cultivars result in a netlike russeting.

Dissemination: In the spring, spores are produced by the powdery mildew fungus which has overwintered in the buds, and are carried by winds to vulnerable (young) tissues.

Disease Cycle: The fungus overwinters in the dormant buds that had been infected in the preceding growing season. **Powdery mildew is favoured by moderate temperatures (10-25 °C) and high relative humidity.**

Management:

- **Key times for management:** From tight cluster until terminal growth stops, particularly the period after petal fall when vegetative growth is rapid. Begin to look for signs of infection when leaves emerge from the bud.
- **Management Options:** Depending on the susceptibility of the cultivar and the impact of cold weather temperatures on overwintering inoculum survival, chemical control may be needed.

▪ **Cultural Controls:** Plant cultivars which are less susceptible to the disease. Reduce humidity in the tree canopy by pruning to increase air, light, and spray penetration.

Chemical Control

Early spring applications of fungicide (beginning no later than tight cluster) are necessary to prevent secondary spread of powdery mildew in susceptible apple varieties. Neglecting control early in the year will result in poor control during the season.

1.**Fruit** - To prevent fruit infection and subsequent russeting, apply a pink spray of Fontelis (penthiopyrad), **Nova** (myclobutanil), **Nustar** (flusilazole), **Sovran** (kresoxim-methyl), Flint (trifloxystrobin), **Pristine** (boscalid + pyraclostrobin) or **Kumulus** (sulphur). **Senator (thiophanate-methyl), karathane, Carbendazim, benomyl,triforin and lime sulphur** are also effective for the control of powdery mildew. Inspire (difenoconazole), Serenade Max (*Bacillus subtilis*) and PureSpray Green Spray Oil 13E are registered for suppression of powdery mildew.

Foliage - A single pink spray will not protect the foliage of susceptible varieties such as Jonagold, McIntosh, Granny Smith, Gala, Braeburn and Gingergold. Two pre-bloom sprays are needed for good control of powdery mildew where disease levels are high. Sprays of **Kumulus, Fontelis, Nova, Nustar, Inspire, Pristine, Sovran, Flint, Senator, Serenade and PureSpray** Green must be applied at 10-day intervals from tight cluster stage until terminal growth ceases, to keep foliage free of mildew and to reduce carry-over to the next season. Control of foliage powdery mildew is particularly important on young trees needing growth stimulation.

Cedar Apple Rust

- **Disease causing agent:** *Gymnosporangium juniperi-virginianae* Schwein.
- **Dissemination:** Spores produced on eastern red cedar are discharged following rain, and disseminated by wind currents to apple hosts. Spores produced on apple may also be carried by wind to cedars.
- **Symptoms:** Infections first appear on apple as bright yellow-orange lesions on the upper surface of leaves, petioles, and young fruit. Lesions may be bordered by a red band or a chlorotic halo. Lesions which occur on fruit are superficial and extend not more than 1/16 inch into the flesh. They occur most often on the calyx end of the fruit. On cedar the fungus produces brown to reddish brown leaf galls.


- **Disease Cycle:** Unlike some other diseases, cedar apple rust requires two hosts in order to complete its lifecycle. On eastern red cedar, the fungus causes galls to form. Spring rains cause the red cedar galls to exude horn-like structures called telia, which become swollen and jelly-like, and which dry back to dark brown threads when the rains cease. Swelling and drying of the telia occurs repeatedly throughout the spring. The telia produce teliopores, which germinate during rain to produce basidiospores. The basidiospores may be carried by the wind for more than 1 mile to vulnerable apple tissue. The spores which land on young apple tissue then germinate if there is a film of water upon the leaves for a sufficient period of time. One to two weeks after infection the lesions on the upper sides of the leaves (or fruit) produce watery orange drops, then produce small orange-brown dots (pycnia) containing pycniospores. Two weeks after the formation of the pycniospores, aecia bearing aeciospores appear on the lower surface of the leaves (or on fruit). These are released during dry weather during July and August. These are then disseminated by the wind and those that land on eastern red cedar infect them, and form mature galls after two years of infection.
  - **Management:**
  - **Key times for management:** Spores are released from cedar during rainy periods from the last week in April until mid-June, with the peak release from pink until full bloom. Lesions are first visible on the upper sides of the leaves in spring to early summer.
  - **Management Options:** The grower should be most concerned about cedar apple rust if the cultivars grown in the orchard are susceptible to the disease, if there are eastern red cedars in the vicinity, and if there are numerous rainy periods during the spring.
    - **Cultural Management Options:** Sources of infection may be reduced by cutting down nearby eastern red cedar, but it is difficult to entirely eliminate sources of infection due to the distance spores are able to be carried by the wind. Some apple cultivars are resistant to cedar apple rust, and may be grown without fungicide sprays to control it.

Chemical: Certain scab fungicides may also control cedar apple rust.

Apple cultivar susceptibility to cedar-apple rust	
	Cultivar(s)
Fairly resistant	Empire, Liberty, Macfree, McIntosh, Northern Spy, Novamac, Paula Red, Red Delicious, Spartaon
Highly susceptible	Golden Delicious, Idared, Mutsu, Russet

FIRE BLIGHT

It was the first reported by the T.J. Burrill in 1882 to cause by bacteria.

- **Disease causing organism*:*** *Erwinia amylovora* (Burrill) Winslow

- **Dissemination:** Disseminated by bees and other pollinating insects and by rain

Symptoms: Fire blight symptoms may appear on the blossoms, shoots, branches, trunk and rootstock. Blighted blossoms appear wilted, shriveled and brown. Young fruitlets are also very susceptible and appear water soaked and slightly off-colour soon after infection. Fruitlets quickly turn brown to black and eventually shrivel up.

Blighted pear shoots are black in colour, while infected apple shoots are usually a lighter shade of brown. Infected shoots (or "strikes") wilt rapidly, and often form a shepherd's crook at their tips. During warm and humid or rainy weather drops of milky to amber coloured bacterial ooze frequently appear on the blighted shoots and fruit. Blighted leaves may remain attached to the tree throughout the winter. When shoots attached to scaffold limbs or trunks are attacked, the pathogen may spread into the structural wood causing cankers. In susceptible hosts or young trees the disease may travel rapidly down branches causing girdling and death of the branches or sometimes the main trunk.



Fruits affected later are less shriveled and discolored. Infection of the vegetative shoots often results in the bending of the shoot tip to resemble a shepherd's crook.

Disease cycle: The bacterium overwinters in bark tissues along the edges of cankers caused by infection in previous years. The bacteria multiplies in the spring, the cankers exude a characteristic ooze, and the bacteria are disseminated by rain and insects to vulnerable tissues - especially open blossoms, tender vegetative shoot tips, and young leaves. The bacteria penetrates the tree at natural openings or wounds. Secondary infection arises from ooze from fresh infections. Fire blight blossom infection is favoured by moderately high temperatures and rainy or humid weather. Temperatures of 18^{o}C and above favour rapid infection whenever moisture or dew is present. Temperatures below 15.5^{o}C retard blight development. In the Okanagan, prevailing cool temperatures during the main blossom period are normally not favourable for infection. Infection is more likely to take place during secondary bloom when temperatures are higher.

Monitoring and Management:

- **Key times for management:** Bloom. The need for chemical control depends on a combination of orchard risk factors and weather conditions. Infection is most likely to occur after 200 degree hours (base 65 F) have accumulated since the first blossom has opened in the orchard. Predictive models of likely infection periods (such as the Washington fire blight risk model and the Maryblyt model) can help growers to determine when such sprays may be needed. See the New England Apple Pest Management Guide for details. Inspect orchards weekly in the summer for fresh infection. Remove diseased parts during the growing season.
- **Management Options:** Control of fire blight is aimed at reducing the level of inoculum in the orchard, reducing the susceptibility of the trees through horticultural practices, and preventing infection at critical times through the use of bactericides.

- **Cultural Control**
- **Dormant Season:** Overwintering cankers should be cut out during the dormant season to reduce sources of bacteria for the next season.
- **Growing Season:** Remove current season infections as soon as they are noticed. Prune out infected branches at least 30-40 cm below the visibly diseased part.
- **Management Practices:**
- Don't over fertilize the trees. Excess nitrogen causes vigorous shoot growth, which is more susceptible
- Do not run overhead sprinklers while blossom is present on the tree and weather is favorable for fire blight infection

- Control insects with sucking mouthparts such as aphids, leafhoppers and pear psylla. These insects can spread fire blight.
- **Chemical Control:**
- Products registered for fire blight control include the antibiotic streptomycin, fixed copper compounds (copper oxychloride), and copper sulfate (Bordeaux), as well as the biopesticides BlightBan and Bloomtime.

Table 1. Relative Fire Blight Resistance of Apple Varieties and Rootstocks

	Most Resistant	**Moderately Resistant**	**Susceptible**
Apple	Red Delicious, Liberty, Enterprise Freedom	Golden Delicious,Empire Granny Smith, McIntosh Mutsu, Spartan,Summerred Gold Rush, Nova Easygro	Braeburn, Fuji Gala, Ginger Gold Idared, Jonagold Rome,Winter Banana
Crabapple		Dolgo	Manchurian, Snowdrift
Rootstock	M.7	MM.106, MM.111, M.4	M.9,M.26,M.27,Mark Ottawa , B.9

Table 2. Relative Fire Blight Resistance of Pear Varieties and Rootstocks*

	Most Resistant	**Moderately Resistant**	**Susceptible**
Pear			Anjour, Bartlett,Bosc, Cascade, Flemish Beauty,Starkrimson,
Asian Pear	Seuri, Shinko,Singo	Kosui, Chojoro Shinsui	Hosui, Shinseiki, 20th Century
Rootstock	Old Home (OH) Old Home x Farmingdale (except OHF 51)		Bartlett seedling quince

Biological Control:

Serenade Max, Bloomtime Biological FD, BlightBan C9-1 and Blightban A506 are new biopesticides registered for suppression of fire blight on apple and pear.

LECTURE 14 DISEASE OF PEACH

Botanical name: *Prunus persica*
Family: Rosaceae
Origin: china
Uses:

- It is rich in sucrose, fructose, & glucose.
- It is rich source of protein with all amino acid.
- It also contains- carotene, thiamine, riboflavin, niacin, iron, & zinc.
- Peach are grown for both desert & processing purpose.
- It is also used for making wine, fruit juice is common drink.
- The cake after extraction of oil can also be used for various purpose.

Diseases of Peach

S.No.	**Major Disease**		**Pathogen**
1	Leaf curl		*Taphrina deformans*
2	Rust		*Puccinia pruni* – spinosae
3	California peach blight		*Stigmina carpophila*
4	Scab		*Venturia carpophila*
	Minor diseases		
6	Powdery mildew		*Sphaerotheca pannosa* var. *persicae*
7	Frosty mildews		*Cercosporella persicae*
8	Target leaf spot		*Phyllosticta persicae*
9	Bacterial leaf spot		*Pseudomonas morus-prunorum*
10	Gummosis/bacterial canker		*Pseudomonas syringae* pv. *persicae*
11	Prunus dwarf virus		Virus
12	Mosaic virus		Virus
13	Necrotic Leaf Spot		Virus
14	Peach- X		Phytoplasma like organism
15	Peach yellows		Phytoplasma like organism

DISEASES OF PEACH

Major Diseases

1. PEACH LEAF CURL: *Taphrina deformans*

In India this disease is prevalent in Himachal Pradesh, Jammu& Kashmir.

SYMPTOMS:

- The disease first appears in the early spring as the leaves begin to unfold
- The leaf blade thickens and midrib turns yellow &curl
- Finally leaf turn to reddish purple tint
- The reddish velvety surface of lamina is soon covered with a whitish grey bloom of the fungus on the upper surface
- Both the leaves & petiole may curl
- Affected leaves die & drop immaturely
- Twigs become pale green to yellow, swollen, stunted & exude gummy material
- Flowers and fruits are also infected & drop prematurely

Peach leaf curl- *Taphrina deformans*

ETIOLOGY:

- Mycelia are intercellular and it does not produce specific ascocarp.
- Asci are produced (Open ascus) individually and measure 25to 40 into 8 to11 micro meter.
- Each ascus bears eight ascospores with a diameter of 3 to 7 micro meter.

Epidemiology:

The disease is prevalent in areas where cool mist spring weather prevails and the dry hot weather hastens defoliation

Primary source of inoculum: Dormant mycelia in the affected stem
Secondary source of inoculum: Air borne conidia

MANAGEMENT:

- Removal & burning of infected shoots reduce the spread of the disease
- A dormant spray with Bordeaux mixture (1%) with an adhesive & a winter spray with Bordeaux mixture 1% before bud burst controls the disease

2. RUST: *Puccinia pruni-spinosae*

SYMPTOMS:

- Pale yellow spots appear on both the surfaces of the leaves.
- Later the spots become bright yellow.
- On the under surface numerous brown dusty pustules are seen.
- Pustules covered on the under surface of the leaves.
- Defoliation of leaf occurs.
- The fruit is rarely attacked.

Primary source of inoculum: Air borne teliospore (teliospores germinate producing basidiospores becoming wind bonre)
Secondary source of inoculum: Uredospores
Etiology: the fungus persists as perennial mycelium, in the under ground stems of anemone.
The ascidia produced on this plant during spring infect peach leaves.

MANAGEMENT:

- Cut & burn the affected leaves or plant part.
- Spray with zineb 0.2% or dusting with sulphur.

3. CALIFORNIA PEACH BLIGHT /shot hole / pustular spot: *Stigmina carpophila*

Symptoms:

- The pathogen attacks twigs, blossoms, leaves, fruits & unopened buds.
- Small, circular deep purple spot appear on the fruit.
- The spots become raised & rough.
- Dark brown, scattered lesions enlarge rapidly on the leaves.
- The diseased buds become darken color.
- Small, purplish, raised spots appear on twigs & they expand in to necrotic cankers.

Epidemiology:

Rise in day temperature & prolonged winter rains are conducive for the epiphytotic proportions of the disease.
Primary source of inoculum: dormant mycelium survive on the affected plant part.
Secondary source of inoculum: rain splash air borne conidia .

MANAGEMENT:

- Cut and burn the affected plant part.
- Spray capton 0.2% or captafol 0.2% to control the disease.

4. SCAB /freckle /black spot: *Venturia carpophila*

Symptoms:

- The disease occurs on fruit, twigs & leaves.
- Circular & dark –olivasious lesions appear on fruits.
- In sever infection the individual spots merge & form a uniform, dark olivaceous, velvety blotch.
- A thicky or corky layer of cells is produced below surface the scabbed region.
- The fruit becomes abnormal in shape & cracks.
- On the twigs, light brown oval lesions are formed which enlarge & turn dark brown.
- Dark brown, long& narrow lesions are noticed on the midrib.

Etiology:

Dormant mycelia, septate mycelia.
Primary source of inoculum: dormant mycelia in fallen leaves.
Secondary source of inoculum: spilocea type of conidia (air borne)
Infection takes place in between the cuticle & epidermis.
Epidemiology:

- 9 hour of leaf wetness period, 17-180c temperature, susceptible host.
- In fallen leaves if 200-300 pseudothecia present & leaf wetness is 9 hour, single pseudothecia produces 800-900 ascospores.

Management:

- Cut & burn affected plant part.
- Low- lying fields should be avoided for cultivation.
- Tree should be properly pruned to permit free air circulation.
- Timely application of the standard fungicide sprays controls the scab.
- Spraying of 5% urea solution to the fallen leaves.
- Incorporate fallen leaves to the soil.
- Chemical spray with scheduling times like :are
  a) silver tip to green tip- mancozeb 4g/liter
  b) Pink bud stage-carbendazin @ 1g/ liter.
  C) Fruit stage-(pea nut stage) – capton 3g/ liter
  d) 40 days before harvest –hexaconozole 1.5g /liter.
- Biological agent's like- *Althelia* species, *Chaetonium globosum*.

MINOR DISEASESL:

POWDERY MILDEW: *Sphaerotheca pannosa* var. *persicae.*

SYMPTOMS:

- Whitish powdery growth of fungus on leaves young shoots & fruits.
- The young leaves are coated with a thick layer of mycelium &they become narrow & curled.
- Terminal portion of the shoot covered by white powdery layer.
- White powdery growth later turns to pinkish & finally dark brown.
- Epicarp of fruit becomes leathery & hard.

Primary source of inoculum: dormant mycelia

Secondary source of inoculum: air borne conidia.

Management:

- Use of resistance variety.
- Cut& burn the affected plant part.
- Spraying with sulphur compounds.

6. FROSTY MILDEW: *Cercosporella persicae*.

Symptoms:

It produces pale green areas on the upper leaf surface and creamy white fungal growth on lower surface.

Primary source of inoculum: affected plant parts.

Secondary source of inoculum: air borne conidia.

MANAGEMENT:

- Cut &burn the affected plant parts.
- Application of wettable sulfur @ 3gram per liter.

7. BACTERIAL LEAF SPOT: *Pseudomonas morus-prunorum*.

SYMPTOMS:

- Small circular green spots occur on the leaves.
- Later spots become angular, deep purple to black.
- The spotted area falls and shot holes are formed.
- Sever infection leads to defoliation which devitalizes the tree.
- Circular spots are noticed on fruits. They are water-soaked initially and become black.
- Due to intense spotting on the fruits, pitting or cracking occurs in the vicinity of spots.
- Twigs canker results in the death of branch.

MANAGEMENT:

- Cut & burn the affected plant parts.
- Spraying with zinc sulphate-lime solution is affective.

LIFE CYCLE:

Soil, air splash borne bacterial cells.
Landing on host
Infection
Bacterial cells in affected debries.

8. BACTERIAL CANKER / GUMMOSIS: *Pseudomonas syringae* pv. *syringae* vanHall.

SYMPTOMS

- The disease attacks trunk, limbs, shoots, fruit spurs, blossom, dormant buds, leave & fruits.
- The bark & outer sap wood show circular to elongated, water –soaked lesions.
- Bark becomes brown& gummy.
- The girdled branches die.
- Blossom blight takes place& purple lesions appear on leaves.

Primary source of inoculum: affected plant
Secondary source of inoculum: air borne bacterial cell.

MANAGEMENT:

Cut &burn the affected plant part.
Aerial spray of streptocyclin 0.5g/ liter.
Resistant varieties -barbank, black champa, elephant heart & maripo
Life cycle:

9. PEACH MOSAIC: VIRUS.

SYMPTOMS:

- Leaves emerging during spring & summer show light green mosaic & ring spot mottle.
- They become small & deformed.
- Stunting growth of the plant and short inter nodes.
- Yellow mottling are seen on new growth flushes during spring.

VECTOR-ERIOPHYID MITE.

MODE OF SPREAD:

It transmits through grafting and also by Eriophyid mites.

MANAGEMENT:

- Use of disease free planting material.
- Exposing the planting material to 37oC for 15- 39 days.
- Apricot seedling can be used as a resistant root stock.
- Removal of host plant.
- Spraying with acaricide against mite pests will reduce the spread of the disease.

10. NECROTIC LEAF SPOT: VIRUS

SYMPTOMS:

Initially ring- spots on the leaves which later become necrotic.
Necrotic tissues later fall down and leave holes in the leaves.
MODE OF SPREAD: It transmits through grafting.

MANAGEMENT:

- Use of disease free planting material.
- Exposing the planting material to 37 degree centigrade for 15- 39 days.
- Apricot seedling can be used as a resistant root stock.
- Removal of host plant

11. PEACH "X": PHYTOPLASMA –LIKE ORGANISM.

SYMPTOMS:

The trees show varying degree of anthocyanosis, twig and shoot die-back and general decline.
Affected leaves roll upward on affected branches.
Falling of leaves prematurely.
Fruits are small, malformed and abort without proper ripening.
MODE OF SPREAD: It transmits through grafting and leaf hopper.
VECTOR: leaf hopper and it also transmit by dodder (*Cuscuta reflexa*)

MANAGEMENT:

Use of disease free planting material.
Exposing the planting material to 37oC for 15- 39 days.

Apricot seedling can be used as a resistant root stock.
Removal of host plant

12. PEACH YELLOWS / PAJA ROSETTE: PHYTOPLASMA –LIKE ORGANISM

SYMPTOMS:

- Trees show numerous upright branches growing from the main stem.
- The branches are numerous and the tree looks bush.
- The leaves are small but the basal 1 or 2 leaves are abnormally long.
- Most of the leaves show light green to yellow mottling and have irregular margins and clearing of veins.
- The trees are stunted and inter nodes are short and looks bushy.
- Premature unfolding of leaf bud is common.
- The leaves on affected trees continue to grow even after the fall of normal leaves.
- The larger leaves on affected trees are also mottled.
- Later, symptoms of wilting and die back appear, resulting in the death of plant.

Pear diseases

Introduction

Pear is one of the important fruit of temperate zone, this fruit is popular for its delicious taste. There are many diseases which badly affect this crop. Most severe of them are fire blight, powdery mil dew & crown gall of apple. Some of the major diseases are discussed here.

LIST OF PEAR DISEASES

S.No.	**Major Disease**		**Pathogen**
1	Pear scab		*Venturia inaequalis*
2	Powdery mildew		*Podosphaera leucotricha*
3	Pacific Coast Pear Rust		*Gymnosporangium libocedri*
4	Fire blight		*Erwinia amylovora*
5	Crown gall		*Agrobacterium tumefaciens*
6	Fabraea Leaf Spot		*Fabraea maculat*
7	Pear decline		*Phytoplasma disease*
	Phytophthora Crown Rot, Collar Rot, and Root		*Phytophthora* sp

. **Pear scab**

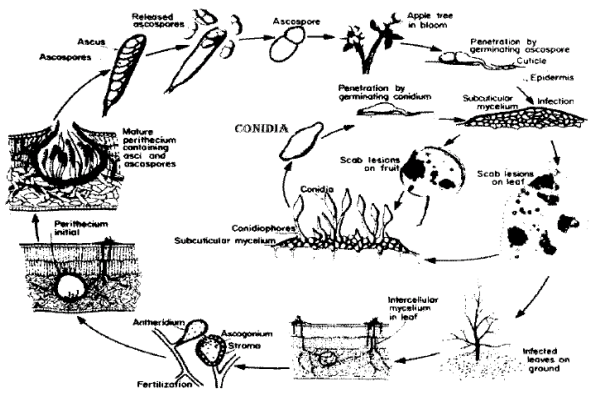
Casual organism-: *Venturia pirina,*

Symptoms: In spring, sooty spots with a soft velvet look appear on young fruit, stems, calyx lobes, or flower petals.

fruit :Young infected fruit frequently drops or is misshapen. Scab spots expand with growth until halted by dry weather or sprays. Old fruit infections often crack open. Cracks are surrounded by russeted, corky tissue and then an olive-color ring of active fungus growth. If fruit is infected late in the season, about 2 weeks before harvest, pinpoint scab spots often show up in storage a month or more later.

On leaves: olive-black spots expand with leaf growth but often cause the leaf to twist abnormally. Infected twigs show small blisterlike infections the size of a pinhead and develop a corky layer. Many twig infections are sloughed off during the summer season.

Life cycle



Etiology

- mycelia –septate, subepidermal houstiria
- Asexual spore- spilocea type of conidia
- Asexual fruiting body-

Sexual spore- ascospore

- Sexual fruiting body- psuedothecium

PSI; pathogen survive on affected fallen leaves

SSI; Airborne conidia

Cultural control:

1. Carefully discing to cover old leaves with soil, where practical, may help reduce spring

infections.
2. Pruning out infected twigs also offers some benefit.
3. Applying dolomitic lime after leaf drop in fall to increase soil pH also helps reduce inoculum the next spring.
Chemical control: spray schedule-
Spray- silver tip to green stage mancozeb @ 2g/l or chlorothalonil @ 2g/l
Spray –pink to blooming stage carbendazim @ 1.5g/l
Spray- young fruit coc @ 3g/l
Spray – maturation stage mancozeb @ 2g/l
Spray –postharvest benomyl @ 1g/l
Biological control:
***Tricoderma* species**
***Althelia* species**
***Chaetomium* species**

Powdery mildew
Casual organism- *Podosphaera leucotricha*
Symptoms –
- On leaves- whitish powdery growth on upper & lower side comprising of oidea
- On stem- whitish powdery growth
- On fruits- whitish powdery growth but in dry condition

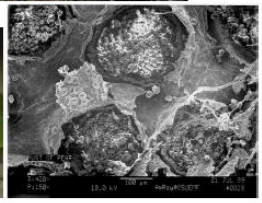
Etiology-
- Mycelia –septate, subepidermal houstiria
- Asexual spore-conidia
- Asexual fruiting body- oidium
- Sexual spore- ascospore
- Sexual fruiting body- cleistothecium
- Primary source of inoculum: dormant mycelia in infected dormant bud
- Secondary source of inoculum- barrel shaped conidia

Epidemiology-
- Warm weather condition
- Temperature- 28-32 °C
- Relative humadity- 80-90 %
- Intermittent rainfall

Management-
Cultural-
- Pruning of canker affected part & paste CoC at cut end
- Spray 5% urea on fallen leave
- Optimum plant density
- Use of drip irrigation

Chemical-
Calcium oxychloride 0.3%
Bordeux mixture 1%
Streptocyclin 0.05%
Biological-
Erwinia herbicola
Psuedomonas fluorescens

Pacific Coast Pear Rust
Casual organism-: *Gymnosporangium libocedri*
Symptoms:
Leaf: Spots fade and darken as the leaf matures or falls off the tree. Green shoots and leaves
also are attacked but not as frequently.
Fruit: Pear fruit are malformed while young and drop from the



tree. Bright yellowish to orangish spots with numerous cup-shape pustules (aecia) develop over the fruit surface. Oriental and European cultivars are susceptible. 'Winter Nelis' is severely affected, but 'Bartlett' is not.
This is a scanning electron micrograph of aecia and aeciaspores (150x
Note the reddish, yellow lesions on these young, misshapen fruit.
Numerous rust pustules (uredia) can be seen on these flowering pear leaves (*Pyrus calleryana*).
Dissemination : Spores produced on eastern red cedar are discharged following rain, and disseminated by wind currents to pear hosts. Spores produced on pear may also be carried by wind to cedars
Primary source of inoculum: telial galls on cedar plant becoming air borne basidiopsores.
Secondary source of inoculum: airborne basidiospores
Cultural control: Remove alternate hosts around the orchard.
The grower should be most concerned aut cedar pear rust if the cultivars grown in the orchard are susceptible to the disease, if there are eastern red cedars in the vicinity, and if there are numerous rainy periods during the spring.
Cultural Management Options: Sources of infection may be reduced by cutting down nearby eastern red cedar, but it is difficult to entirely eliminate sources of infection due to the distance spores are able to be carried by the wind. Some pear cultivars are resistant to cedar pear rust, and may be grown without fungicide sprays to control it.
Chemical: Certain scab fungicides may also control cedar pear rust mancozeb 2 ml per lit

FIRE BLIGHT – *Erwinia amylovora*
Symptoms:
Affected parts appear to be scorched by fire. A watery ooze may be exuded from infected plant parts. The disease may kill entire trees. Fruit which are infected early remain small and appear shriveled, dark, and 'water soaked'. They will remain attached to the cluster.

Fruits affected later are less tasted
Disease cycle: The bacteria over winter in bark tissues along the edges of cankers caused by infection in previous years. The bacteria multiplies in the spring, the cankers exude a characteristic ooze, and the bacteria are disseminated by rain and insects to vulnerable tissues - especially open blossoms, tender vegetative shoot tips, and young leaves. The bacteria penetrate the tree at natural openings or wounds. Secondary infection arises from ooze from fresh infections.

Note the blackened flowers and vascular system (part of this terminal shoot has been cut in cross section).
Hold over canker on a pear branch. These can be difficult to see on smaller branches

Last year's shoot has died quickly and must be cut out soon before more of the branch dies.

Black lesions on the young fruit and bacteria oozing from the base of the spur.
An entire tree can die in a few weeks if management tactics are not in place.

Mature fruit with discolored infection center and bacterial ooze.
Disease causing organism: *Erwinia amylovora* (Burrill) Winslow
Dissemination:
Disseminated by bees and other pollinating insects and by rain
Primary source of inoculum: Bacterial cells present on affected cankers and on cracks and cravices.
Secondary source of inoculum: Rain splash borne bacterial cells
Monitoring and Management:

The need for chemical control depends on a combination of orchard risk factors and weather conditions. Infection is most likely to occur after 200 degree hours (base 65 F) have accumulated since the first blossom has opened in the orchard. Predictive models of likely infection periods (such as the Washington fire blight risk model and the Maryblyt model) can help growers to determine when such sprays may be needed

Management Options:

Control of fire blight is aimed at reducing the level of inoculum in the orchard, reducing the susceptibility of the trees through horticultural practices, and preventing infection at critical and times through the use of bactericides.

Cultural Practices:

Reduce primary inoculum by removing infected plant material when winter pruning. Inspect orchard weekly during the growing season remove infected plant material. When removing infected plant material, cut infected branches at least 12 - 18 inches below the lowest evidence of disease. When removing infected plant material during the growing season, prune only on sunny, hot days when rain is not predicted.

Control insect vectors in the orchard. When planting new orchards, avoid susceptible cultivars. Plant well-drained soil. Maintain proper orchard nutrition in order to discourage excessive tree vigor.

Chemical:

COC (0.3%) and STREPTOCYCLIN (0,05%)

Crown gall of pear-

Symptoms

The disease first appears as small overgrowths or galls on the roots, crown, trunk, or canes. Galls usually develop on the crown or trunk of the plant near the soil line or underground on the roots. Above ground or aerial galls may form on canes of brambles and highly susceptible cultivars of pear. Although they can occur, aerial galls are not common on fruit trees.

Below ground symptoms:-

In early stages of development the galls appear as tumor-like swellings that are more or less spherical, white or flesh-colored, rough, spongy (soft), and wart-like. They usually form in late spring or early summer and can be formed each season. As galls age they become dark brown to black, hard, rough, and woody. Some disintegrate with time and others may remain for the life of the plant.

Above ground symptoms:-

The tops of infected plants may appear normal. If infection is severe, plants may be stunted, produce dry, poorly-developed fruit, or show various deficiency symptoms due to impaired uptake and transport of nutrients and water.

Causal Organism

The crown gall bacterium is soil-borne and persists for long periods of time in the soil in plant debris. It requires a fresh wound in order to infect and initiate gall formation.

Infection process:-

Wounds that commonly serve as infection sites are those made during pruning, machinery operations, freezing injury, growth cracks, soil insects, and any other factor that causes injury to plant tissues. Bacteria are abundant in the outer portions of primary galls, which is often sloughed off into the soil. In addition to primary galls, secondary galls may also form around other wounds and on other portions of the plant in the absence of the bacterium. The bacteria overwinter inside the plant (systemically) in galls, or in the soil. When they come in contact with wounded tissue of a susceptible host, they enter the plant and induce gall formation, thus completing the disease cycle. The bacteria are most commonly introduced into a planting site on or in planting material.

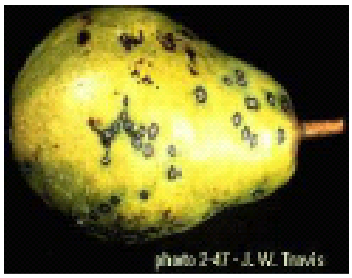
Control

1. Obtain clean (disease free) nursery stock from a reputable nursery and inspect the roots and crowns yourself to make sure they are free from galls. Avoid planting clean material in sites previously infested with the bacteria.

2. Avoid all unnecessary root, crown, and trunk wounding by careless cultivation and other machinery operation, and control soil insects. Any practice that reduces wounding is highly beneficial. Preventing winter injury (especially on pears) is also beneficial.

3. On pears, the double trunk system of training may be a useful system for minimizing losses due to crown gall. If one trunk is infected, it can be removed. The remaining trunk can be pruned leaving a full number of buds until the second trunk can be renewed. Galls on the upper parts of the trunk or on canes can be removed by pruning.
4. A relatively new biological control agent for crown gall is available for pear, pear, stone fruit, blueberry, brambles, and many ornamentals.

Fabraea Leaf Spot
Casual organnnism; - *Fabraea maculata*
Symptoms:
Leaf : spot can be found on petioles, leaves, shoots and fruits. Initial lesions on leaves are tiny, round, purplish-black spots, which quickly enlarge to 1/8 to 1/4 inch in diameter and usually have a blackish-brown center (photo 2-46). Spots coalesce and severely infected leaves fall to the ground prematurely. A small black acervulus may develop in the center of each lesion, from which conidia ooze in a creamy, white mass in wet weather.
Fruit :lesions (photo 2-47) are larger than those on leaves and cause the fruit to crack and drop. Lesions on current season's shoots may be observed as small inconspicuous, purplish-black spots. Some lesions develop into superficial cankers, but most are walled-off during the next growing season, so that cankers rarely persist in two-year-old wood.
Disease Cycle: The four-celled conidia (Entomosporium maculatum), with a distinctive insect-like appearance, are spread mainly from overwintering leaf litter, and some from twig cankers, by splashing water from rains or overhead irrigation. Wetting periods for infection may vary from 8 to 12 hours at temperatures of 50 to 77 F (10-25 C). Lesions begin to appear about 7 days after the beginning of an infection period. The disease may advance rapidly in late summer as wind and rain distribute the conidia throughout the tree. Susceptibility of leaves and fruit to infection does not decrease with maturity. Nearly all pears of European descent are susceptible to this leaf spot.



Management:
This disease is controlled with applications of protectant fungicides.
Early-season spray programs for pear scab should also control early-season leaf spot infections. Where ascospores and conidia of the fungus occur after petal fall, summer fungicide treatments are needed

Pear –decline
Casual organism:- Phytoplasma like organism **Symptoms**: Pear decline is characterized by two phases: quick decline and slow decline. Trees may wilt, scorch, and die in a few weeks or lose vigor over several seasons during which foliage gets
Early or premature foliar discoloration is a general symptoms of this disease

Cultural control:
1. Use resistant or tolerant rootstocks.
2. Use the best orchard management practices, including the best possible insect and disease control, irrigation, drainage, fertilization, and pruning.
3. Control pear psylla.
4. When grafting Asian pear trees over to European (P. communis) cultivars, graft below the union of the Asian pear with its rootstock to avoid creating a highly decline-susceptible tree.
Phytopthora Crown Rot, Collar Rot and Root Rot
(Collar rot affects the scion portion of the tree, crown rot affects the rootstock portion of the tree. Root rot affects the root system away from the crown region.)
Disease causing organisms: *Phytopthora* spp.
Dissemination: Soil born fungal pathogen. Pathogen survives in soil for several years as spores, especially in old orchard soils. May also be brought into the orchard on infected nursery stock.

Symptoms:
Cankers may be seen at or below the ground line, and may extend from the original site of infection into the root system and up the trunk to the bud union and above the bud union if the scion is also susceptible. Infected bark is brown and often slimy when wet. When the bark is pulled away, the cambium and phloem will be an orange, reddish brown color. The cankers caused by the fungus girdle the tree, resulting in poor vegetative growth and chlorotic foliage that may turn purple in the autumn. A severely infected tree may die. Trees may be killed in one growing season or may linger for a number of growing seasons.

Disease cycle:
The fungus survives in the soil as thick-walled spores (oospores) that are resistant to drought and relatively resistant to chemical treatment. The fungus may also be brought in on infected nursery stock and in contaminated irrigation water. Mobile spores (zoospores) originating from the oospores move to the tree and colonize the pear bark tissue. The fungus may build up to high levels in the soil in a short period under favorable conditions - i.e. during wet, cool periods after harvest and in spring.
Monitoring and Management:
Key times for management: The best time to manage Phytopthora diseases is during the initial stages of orchard establishment, when selecting the orchard site, planting, site preparation and rootstock selection. Management Options: While there are some fungicides registered for control of Phytopthora, management is best achieved through cultural methods.
Cultural Controls: Primary control of Phytopthora diseases is culture. When planting a new orchard, select the site and rootstocks carefully. Be sure the orchard site has adequate drainage throughout the year. When irrigating the orchard, do not saturate the soil for prolonged period is. Use rootstocks resistant to infection by the disease. Scion cultivars may also be chosen for resistance.
Chemical: Bordeaux mixture 1% or Copper oxychloride (.03%) or Mancozeb 0.25%.

PLUM

DISEASES, SYMPTOMS, ETIOLOGY, EPIDEMOLOGY, AND MANAGEMENT OF PLUM FRUIT CROP.

INTRODUCTION:

`Plum (*Prunus spp*.) is a delicious stone fruit of temperate regions, which ranks next to **Peach** in importance and production. The pleasantly blended pulp and juice of this fruit is liked by most people. Because of large varietal diversity, it can be grown in both temperate and subtropical areas. In India, plum cultivation was started by the **Europeans** in 1870 in kull valley and shimla hills, and then subsequently spread to other temperate regions of the country.

The cultivated plums belong to two species viz***. Prunus domestica*** (European plum) and ***P. salicina*** (Japanese plum).

Botanical classification: Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Rosales
Family:	Rosaceae
Subfamily:	Maloideae
Genus:	*Prunus*
Subgenus:	***Prunus***

IMPORTANCE & USES:

Plum fruit tastes sweet and the skin may be particularly tart. It is juicy and can be eaten fresh or used in jam-making or other recipes. Plum juice can be fermented into plum wine; when distilled, this produces a brandy known in Eastern Europe as Slivovitz, Rakia, Tzuica or Palinka. Dried plums are also known simply as prunes, as if 'prune' signified merely a dried plum - however, prunes are a distinct type of plum, and may have predated the fruits that we know more commonly as plums. Prunes are also sweet and juicy and contain several antioxidants. Plums and prunes are known for their laxative effect. This effect has been attributed to various compounds present in the fruits, such as dietary fiber, sorbitol, and isatin. Prunes and prune juice are often used to help regulate the functioning of the digestive system.

Dried, salted plums are used as a snack, sometimes known as *salaito* or *salao*. Various flavors of dried plum are available at Chinese grocers and specialty stores worldwide. They tend to be much drier than the standard prune. Cream, Ginsing, Spicy, and Salty are among the common varieties. Licorice is generally used to intensify the flavor of these plums and is used to make salty plum drinks and toppings for Shaved Ice or *baobing*.Prune kernel oil is made from the fleshy inner part of the pit of the plum.

The plum is infested by the following diseases;

Diseases causal organism

S.No.	**Major Disease**		**Pathogen**
1	Plum pocket		*Taphrina maculans*.
2	Wilt		*Verticillium albo atrum* (Reinke & Berth)
3	Leaf curl		*Taphrina deformans* (Berk & Tul)
4	Bacterial canker		*Pseudomonas syringae* pv.*syringae* (van Hall).
5	Bacterial leaf spot		*Xanthomonas syringae*
6	Line pattern		*Plum American line pattern virus*.
7	Plum mosaic		*Plum line pattern virus & ring spot virus* (Kennedy *et al*)
8	Creamy white spot		*Creamy white spot virus*

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1.PLUM POCKET*: Taphrina maculans*

SYMPTOMS:

- The symptoms are more prominent on fruits and less prominent on leaves and stem.
- the affected fruits having whitish circular spots on the fruits are completely covered

- Infected fruits doubling their size.
- Affected fruits fail to produce seeds and are hollow then later stages falls off from the branches.
- On the leaves in rare cases whitish coat will form & leaf falling takes place.

PSI- dormant mycelia.
SSI-Air born conidia

EPIDEMOLOGY;

The disease is prevalent in areas where cool mist spring weather prevails and the dry hot weather hastens defoliation.

MANAGEMENT;

1. Removal &burning of infected shoots reduce the spread of the disease.
2. Before bud sprout spray sulphur or copper fungicide.
3. Incorporate the fallen leaves & spray 5% urea on fallen leaves.

LIFE CYCLE:

Survive in the cracks nearby growing bud
Conidia
Infection

Modification of organism & fruiting body formation takes place

Budding takes place

- The organism produces open ascus no ascocarp. Ascospores may be 4-5.
- After release ascospores budding takes place then it will detach & produces conidia.
- These conidia survive in the cracks nearby growing bud & life cycle continues.

2. WILT*: Verticillium albo-atrum*. (Reinke & Berth)

SYMPTOMS:

- The affected limbs get defoliated in early summer.
- The first declining symptoms are seen on the lower branches.
- Roots of infected plants turn brown & die.
- No partial wilt but lower leaves yellowing.
- Occurs at flowering &fruiting stage.
- Complete loss. Loss depending on severity.
- V – Shaped yellowing of leaf margin.

ETILOGY:

Septate mycelia, V–shaped conidiophores, on which single celled conidia is formed.
PSI: dormant mycelia
SSI: conidia (unicellular)

EPIDEMOLOGY:

Warm weather loving alkaline **PH** &more sever in black clay soil, temperature-28-290, and RH-80-85%. Low soil moisture, affected soil, nematode infected soil.

MANAGEMENT:

- Cut& burn the affected plant part.
- Treat the seeds with carbendizime.
- Carbendizime 1.5 gm/liter soil drenching.
- Neutralized PH by gypsum application.
- Uproot the initially affected plants& burn.
- High application of K & low N application
- Application of Bavistin at the rate of 1.5 g / liter soil drenching & *Trichoderma viridae* reduce the disease.

3. LEAF CURL: *Taphrina deformans* (Berk & Tul)

SYMPTOMS:

- the disease first appears in the early spring as the leaves begin to unfold.
- the leaf blade thickens& midrib turns

yellow &curl.

- Finally leaf turns to reddish purple tint.
- The reddish velvety surface of lamina is soon covered with a whitish grey bloom of the fungus on the upper surface.
- Both the leaves & petiole may curl.
- Affected leaves die & drop immaturely.
- Twigs become pale green to yellow, swollen, stunted & exude gummy material.
- Flowers & fruits are also infected & drop prematurely.

ETIOLOGY:

- Mycelia are intercellular & it does not produce ascocarp.
- Asci are produced individually & measure 25to 40 into 8 to11 micro meter.
- Each ascus bears eight ascospores with a diameter of 3 to 7micro meter.

EPIDEMOLOGY:

The disease is prevalent in areas where cool mist spring weather prevails & the dry hot weather hastens defoliation.

PSI: dormant mycelia in affected stem.

SSI: air borne conidia.

MANAGEMENT:

- Removal & burning of infected shoots reduce the spread of the disease.
- A dormant spray with Bordeaux mixture (6:10:100) with an adhesive & a winter spray with Bordeaux mixture 1.2% before bud burst control the disease.

LIFE CYCLE:

The fungus is spread by wind and rain and attacks the leaves as they break bud and fruit as it begins to develop during cool, wet weather. A single layer of spore-producing tissue develops on the infected plant part, giving the blistered area a white or translucent appearance when fresh. Spores are released from this tissue from late spring to midsummer, and will remain on twigs and bud scales until the following spring.

4. BACTERIAL CANKER / GUMMOSIS*: Pseudomonas syringae pv.syringae* (van Hall).

SYMPTOMS

- The disease attacks trunk, limbs, shoots, fruit spurs, blossom, dormant buds, leave & fruits.
- The bark & outer sap wood show circular to elongated, water –soaked lesions.
- Bark becomes brown& gummy.
- The girdled branches die.
- Blossom blight takes place& purple lesions appear on leaves.

PSI: affected plant

SSI: air borne bacterial cell.

MANAGEMENT:

- Cut &burn the affected plant part.
- Aerial spray of streptocyclin 0.5g/ liter.
- Resistant varieties -barbank, black champa, elephant heart & mariposa.

5. BACTERIAL LEAF SPOT*: Xanthomonas syringae pv.pruni vauterin.*

SYMPTOMS:

- It is most commonly observed in nursery stages.
- The disease appears on leaf surface are angular dark brown spots of 0.5to 3.0 mm diameter.
- The lesions are bordered by light yellowish green halo.
- In sever condition leaves turn yellow & drop.

PSI: affected plant part

SSI: air borne bacterial cells.

MANAGEMENT:

- Cut &burn the affected plant part.
- Aerial spray of streptocyclin (0.5 g/liter).

Soil, air splash borne bacterial cells
Landing on host
Infection
Bacterial cells in affected debris.

6. LINE PATTERN: **Plum American line pattern virus.**

SYMPTOMS:

- Yellow vein banding in part or whole of the leaf lamina.
- Chlorosis of the entire leaf with stunting of plant.
- Some times green stamen petiole show chlorosis.
- Old branches exhibit aerial rotting.
- Chlorotic spots on ripened fruits.

MODE OF SPREAD: through grafting, vector is aphid.
MANAGEMENT:

- Use disease free planting material.
- Exposing the planting material at 37 degree centigrade for 15-39 days.
- Apricot seedlings can be used as resistant root stock, against plum line pattern virus.

7. PLUM MOSAIC: Plum line pattern virus & ring spot virus. (Kennedy et – al)

SYMPTOMS:

- Leaves emerging during spring & summer show light green mosaic & ring spot mottle.
- They become small & deformed.

MODE OF SPREAD:
It transmit through grafting.
MANAGEMENT:

- Use of disease free planting material.
- Exposing the planting material to 37 degree centigrade for 15- 39 days.
- Apricot seedling can be used as a resistant root stock.
- Removal of host plant.

8. CREAMY-WHITE SPOT: CREAMY WHITE SPOT VIRUS

SYMPTOMS:

- Small, pale yellow to white spots on the leaves.
- These spots coalesce& form large white areas.
- This virus is restricted to plum only.

MODE OF SPRED:
Through grafting & aphids.
MANAGEMENT:

- Use of disease free planting material..
- Exposing the planting material to 37 degree centigrade for 15-39 days.
- Apricot seedlings are used as a resistant root stock.
- Removal of host plant.

9. BLACK KNOT: **Scientific name: *Apdiosporina morbosum*, a fungus**
Species affected: Plums and cherries **Where it occurs:** throughout the state
Symptoms:
1. First year symptoms include light green swellings on twigs.
2. By the following spring these have enlarged and turned a velvety black. **Control Recommendations**:
1. Remove all knots by April 1 and burn.
2. Limit pruning to late winter.
3. Treat branches with lime sulfur at green tip, full bloom and petal fall

DISEASE OF ALMOND CROP

S.No.	**Major Disease**		**Pathogen**
1	Bacterial gummosis		*Pseumonas sp*.
2	Collar rot		*Phytophthora* spp
3	Powdery mildew of almond		*Podosphaera oxycanthae*
4	Shot hole		*Cercospora sp.*
5	Brown Rot and Twig Blight		*Monilinia fructicola*.
6	Armillaria root rot		*Armillaria mellea*

BACTERIAL GUMMOSIS : *Pseumonas sp*.

Symptoms: Circular to elongated water soaked Gumming lesion arise on the bark or outer sapwood and fruit.

Control: Clean wounds at the time of dormancy break and apply **mashobra paste**. Repeat the process on new lesions in the following months or before the rainy seasons.

Spray Streptocycline @3 g per 100 litre fof water before the one set of rains.

Spray copper oxychloride fungicide (Fytolan/Blitox-500) @ 3g per litre after leaf fall.

MASHOBRA PASTE

Streptocycline	25g
Marphorin	150g
Steric acid	425g
Lanolin	2.25g
Water	5.5litre

COLLAR ROT

Cause: *Phytophthora* spp

Symptoms : the disease is often confused with root rot. In case of root rot symptoms spread from the root while in case of collar rot the primary infection starts from collar region –which spread towards to roots. The infected collar becomes cankered, soft and spongy and a moist exudates comes out from the affected area.

Control measure:

- Remove the soil around the collar region and exposed the affected portion to sun. Remove the bark and apply chaubatia paste or brassical paint (10 g per litre of linseed oil) or coppeer oxychloride paint on healthy portion.
- Drench the trunk around 30 cm radius with Dithane m-45 (3-4 g per litre water) or copper oxychloride (7gper litre water)or Brassical or PCNB(10g per litre of water).

POWDERY MILDEW OF ALMOND: *Podosphaera oxycanthae*

- Symptoms: white mealy powder appears on the young leaves and on the new flush. The growth of infected buds , shoots and leaves is checked.
- Control: spray the plant with wettable sulphur @ 3 g per litre of water or cabendazim/topsim M@1 g per litre of water at Before blossom open
- At petal fall, two weeks after.

SHOT HOLE : *Cercospora sp.*

- **Symptoms :** Small dark lesions on the leaves are the first clue that an almond tree has shot hole disease. These spots, which only take five or six days to develop, slowly rot and become holes, making it look as if the leaves have been fired with buckshot. If left untreated, the entire tree can be defoliated .
- Shot hole disease also attacks the flowers, fruit and twigs, but the lesions on these parts of the almond tree are more difficult to see. Spots on the fruit are purplish and raised.
- Control: spray copper oxychloride @ 3 g per litre or dithane Z-78 @ 3g per litrewater before rainy season.

ALMOND LEAF SCORCH

- Almond leaf scorch was first discovered in Southern California in the 1930s. Researchers determined the disease was caused by a **bacterium in the water-conducting vessels of** almond trees. It was spread by certain **leafhoppers and spittlebugs**. **Glassy-winged sharpshooter** is a known vector of **ALS.**

- **Symptoms:** The disease appears as a marginal scorching of leaves that begins as early as June and continues to develop during summer. A golden yellow band develops between the brown necrotic edge and the inner green tissues of the leaf. Disease symptoms may appear first on one branch or a portion of one scaffold.

Brown Rot and Twig Blight : *Monilinia fructicola*. .


Hotspot" of area infected by Armillaria root rot.

Symptoms: The rot first infects the flowers, the fruit spurs and then moves on to attack the twigs. Most of the blossoms dry up and wither away but if some flowers remain on the tree, it is possible to notice a slimy brown mass that is the fungus.
Control : Spray the tree with difolatan(1.5g per water or 3g per liter of water) about three week before the fruit harvest.
Spray carbendazim fungicide (1g per litre water) at first flowering and repeat after 7 to 10 days for controlling blossom blight.

Armillaria root rot caused by the fungus *Armillaria mellea*


White mycelial fans found on roots of an almond tree affected by Armillaria Root Rot.

Upon root excavation, the tell-tale signs of Oak Root Fungus or Armillaria Root Rot became relevant. Hitting a surface root and scraping back the bark, the white mycelial fans became evident Furthermore, the roots possessed a smell similar to what we would expect from mushrooms - similar to the smell of mushrooms in the grocery store. Further bark removal and scraping back of the white mycelial fans revealed the fungal canker within the root tissue Continued excavation revealed that the crown of the dead tree was severely infected by the fungus, with white mycelial fans found on the trunk and main roots.
Disese cycle : Armillaria spp. is a basidiomycete, and can survive up to 100 years within woody debris found in the soil. Spread occurs when roots from a tree come into contact with the infested debris. Further spread can occur through rhizomorphs.
Control: Equipment should be cleaned when moved between an infected and unaffected orchards. When replanting a field that has expressed the disease, all woody roots one inch (2.5 cm) in diameter should be removed. Fallowing the ground for one or more years is also recommended. When preparing to plant, fumigate the orchard with methyl bromide and plant a resistant rootstock within the infected area. It is important to note that fumigating will only kill the fungus within the treated area, and therefore it is needed to have the optimal conditions for fumigant movement within the soil. There is currently one known resistant rootstock - the plum rootstock Marianna 2624.

WALNUT DISEASES

S.No.	**Major Disease**		**Pathogen**
1	Walnut blight of walnut		*Xanthomonas campestris* p.v. *juglandis*
2	Walnut Leaf Blotch or 'Walnut anthracnose'		*Gnomonia leptostyla*', *'Marssonina juglandis'* or *'Marssoniella juglandis'*.
3	Die back of Walnut		*Glomerella cingulata*
4	Thousand Cankers Disease of Walnut		*Geosmithia morbida*

Walnut blight (caused by *Xanthomonas campestris* p.v. *juglandis*)

Causes small brown to black spots on leaflets, leading to large withered areas. Can also cause dieback of shoots and damage to the fruits, notably blotches and holes. A large part of the crop is likely to be lost in a serious attack, especially when the male catkins are affected.

Walnut blight causes flower and nut drop. Lesions also form on nuts, leading to shriveled and/or moldy kernels or to navel orangeworm infestation.

D.C.= The bacteria will survive overwinter in apparently healthy dormant buds, leading to new infection of young growth - varieties which leaf early are most at risk.

Control : Bordeaux mixture spray may help. Defences against blight include keeping soil pH above 6, avoiding wetting the foliage with spray irrigation, guarding against excessive nitrogen feeding and pruning enough to give an open structure for aeration.

Walnut Leaf Blotch

Also known as 'Walnut anthracnose' and formally as *'Gnomonia leptostyla*', 'Marssonina juglandis' or 'Marssoniella juglandis'.

Symptom: A widespread fungus causing brown blotches on young fruits and leaves, when severe will cause the nuts to abcise (fall prematurely) after turning black and considerable leaf fall.

Another disease which favours wet weather for infection, it usually appears in late May and early June and will overwinter on leaf litter.

CONTROL : Fallen leaves should be cleared and burnt or properly composted.

Dodine is applied at the rate of 1 lb/100 gal (0.45 kg/378 liters) of water for hydraulic sprayers. The first spray should be applied in the spring when the walnut leaves are about half their mature size; then, three additional spray treatments should be applied about every 2 weeks.

Spray Bordeux (4:4:50) or copper oxychloride @2.5g per litre water and captan 3 g per litre water at leaf unfolding stage and then after two weeks and at full leaf stage.

DIE BACK

Cause: *Glomerella cingulata*

Symptoms; irregular bark brown spots are produced on leaves which involve the entire leaf causing defoliation. Blighting of twigs is also common and young plant may die.

Control: Spray dithane Z-78 or captan or copper oxychloride @ 3g per liter water before rainy season.

THOUSAND CANKERS DISEASE OF WALNUT

The walnut twig beetle (*Pityophthorus juglandis*) enters the bark, making a tiny hole. The fungus (*Geosmithia morbida*) is introduced to the walnut tree as the beetle feeds on and tunnels into the inner bark.

LECTURE: 17 STRAWBERRY (*Fragaria chiloensis*)

Introduction

Family: Rosaceae

Origin: Northern America

- Strawberries are the favored fruit of many nations of the world.
- This fruit may be found in the markets from the tropics to the polar zones in both hemispheres.
- The strawberry plant, after producing the fruit ends out a number of runners along which new plants arise at intervals.
- A single mother plant in a vigorous condition may produce from 25 to 5new plants.
- Mother plants will form new crowns and roots produce berries for a number of years, but these are usually inferior to the younger plants formed from the runners.

Diseases of strawberry:

S.No.	**Major Disease**		**Pathogen**
1	Powdery mildew		*Sphaerotheca fragariae.*
2	Leaf Spot		*Mycosphaerella fragariae*
3	Strawberry Leaf Scorch		*Leptothyrium fragariae*
4	Leaf Blight		*Dendrophoma obscurans*
5	Grey Mold of Strawberry		*Botrytis Cinerea*
6	Angular Leaf Spot (Bacterial Blight)		*Xanthomonas fragariae*
	Post Harvest Diseases		
7	Botrytis rot		*Botrytis cineria*
8	Colletotrichum rot		*Colletotrichum spp*
9	Phytophthera rot		*Phytophthora spp*

1.Powdery mildew

Symptoms

- Whitish powdery growth on upper surface of the leaf even young stem defoliation fruit cracking take place also fruit size reduction reduced fruit yield.
- Occasionally a powdery or surface mildew cause s some damage to plants.
- Casual Organism: *Sphaerotheca fragariae.*

Etiology

- Mycelium is white, septate, ectophytic and sends globose haustoria into the epidermal cells of the host. Conidiophores are short and erect.
- Conidia are one celled, oblong, and minutely verrucose with many large fat globules.
- Cleistothecia are formed towards the end of the season on the leaves, petals, stems and thorns. Cleistothecia are with simple myceloid appendages.
- Each ascus contains 8 ascospores.

Mode of spread and survival

The fungus over winter's mycelium in dormant buds and shoots which are not entirely killed. Either conidia or ascospores serve as primary inoculum. Secondary spread is through wind borne conidia. (Cleistothecia of the fungus)

Epidemiology

- Infection occurs when the air is saturated with moisture and the temperature is about 20°C.
- Optimum conidial germination occurs at 97 to 99per cent relative humidity and at temperature ranging between 17 to24°c.
- Spore production is maximum at 24 to 28°C.

Disease cycle

- Affected leaves, buds and twigs having clestothecia, in favourable conditions it produce ascus (sexual fruiting body) in that ascospores are present.
- Ascus liberates ascospores and they flight, landing on to the host surface and cause infection leads to powdery mildew. White powdery growth comprising of oidia.
- Oidia releases barrel shaped conidia and cause infection and continues asexually life cycle.
- Adverse climatic conditions the fungus switched on to sexual stage by production of Antheridium and Ascagonium.

- Gametangial contact type of reproduction once Ascogonium and Antheridium come in contact together, plasmogamy, karyogamy, meiosis followed by mitosis and ascospore formation take place.

Management:

- The diseased and fallen leaves should be collected and burnt.
- Four sprayings at 1days interval with wet table Sulphur 0.3 per cent or Dinocap 0.07 per cent or Carbendazim 0.1 per cent controls the disease effectively.
- Spraying with Phalton 0.3 per cent + Carbendzim 0.1% also controls the disease. Spraying with benomyl 0.1 per cent or triademefon (bayleton) 0.1 per cent at 3days interval controls the disease.
- Some of the resistant varieties are aawliver, abhisarika, Adolf morstman, African star, Barbara etc.
- Excess fertilization especially with nitrogenous fertilizers and crowding of plants should be avoided.

2.LEAF SPOT

Symptoms

- Leaf spot is most frequently evident on the blades of the leaflets, but may appear on the petioles, fruit, and fruit stems.
- The lesions may be seen first on the upper surface as small, deep-purple, somewhat indefinite areas.
- As the spot enlarges, the central area becomes brown, but soon turns to a definite white spot in older leaves or to a light brown in young tender leaves.
- An indefinite dark purple zone surrounds the central light area, giving the whole a birds-eyes effect.
- When the infections are bunched on the leaf, the purplish area may become confluent and extend around a number of the white spots, and if the infection is near the edge of the leaflet, the purpling often extends to the border.
- One the undersurface the symptoms are much the same as on the upper, but the coloring is less intense.
- Here the prominent veins which are touched by any of the spots take on a reddish-purple color which extends some distance beyond the infected spots.

Casual Organism *Mycosphaerella fragariae.*

Management:

- Curing of planting material
- Caprtonbal 13kg/ha soil application
- Copper Oxychloride 0.3% or Carbendazim 0.1%

3.Strawberry Leaf Scorch :*Leptothyrium fragariae*

Symptoms

- Leaf scorch lesions may appear not only on the leaf blades but also on the petioles, fruit pedicels, and on the sepals of the calyx.
- In a very early stage leaf scorch lesions resemble those produced by the leaf spot organism in that small dark purple spots appear scattered over the upper surface of the leaflets.
- It is not difficult to distinguish the two after the spots have developed.
- In the mature condition the leaf scorch spots are large and irregular in outline and never show the white central area characteristic of the leaf spot disease.
- On the contrary, the black fruiting bodies which develop in the central area give the leaf scorch disease a tar spot appearance.

Causal Organism: *Leptothyrium fragariae*

Disease Cycle

- Strawberry leaves often survive the winter, and diseased leaves may be found in the early spring bearing both the perfect and imperfect stages of the leaf scorch organism.
- Ascospores are more important than the conidia in primary infection, since they are discharged in great numbers during the early spring months when the new leaves are developing.

- Under suitable moisture conditions the ascospores germinate within 24 hours and infection takes place by direct penetration of the epidermal cells, in contrast to the stomatal infection of Mycosphaerella fragariae.

Management:

- Use Healthy planting material
- Avoid creation of un necessary wounds
- Application of fertilizer should be delayed at least 1days
- spraying with Copper oxychloride 0.3 per cent or defolaton 0.2 per cent or Chlorothalonil 0.2 per cent
- Use of resistant varieties

4.Leaf Blight : *Dendrophoma obscurans*

Symptoms

- The disease is most conspicuous on the leaves, although at times it appears on the calyx.
- Usually the spots on the single leaflet are limited to one to five or six.
- When first observed, the young spots are uniformly reddish purple and almost circular in outline. If they are near one of the main veins, the spots are elliptical.
- Later three zones may be normal green of the leaf, a light brown zone about 5 mm width, and, finally, a dark brown central area 2 to 3 mm in diameter.
- The white central area characteristic of leaf spot is never present.
- If the spots occur on a prominent vein, and especially if on the midrib, the typical V-shaped lesion is formed, with the purpling of the tissue extending fanlike to the border of the leaflet.

Caual organism: *Dendrophoma obscurans*

Management:

To spray the 1% of mercuric acetate.

5.Grey Mold of Strawberry : *Botrytis Cinerea*

Symptoms

- The disease, while regarded as a fruit rot, often starts early in the season as a blossom blight.
- In the cluster of blossoms on the main fruit stalk, one or more will show a blasted condition, usually with the disease extending part way down the pedicel.
- Later, as the berries enlarge, the disease may be observed on the tips of the calyx lobes, often confined to one or two of the lobes.
- Infection on the berries may appear at any point.
- Often the first rot on half-grown fruit appears at the base of the fruit and originates from the infected calyx.

Causal Organism*:* *Botrytis Cinerea.*

Management

- Picking and destroying old blooms and over wintered canes help in reducing the disease.
- Avoiding excess irrigation helps to check the disease.
- Fungicidal spray with triphenyl tin acetate (Brestan) 0.05 per cent is effective in its control.
- The disease is effectively controlled by spraying with ferbam 0.2 per cent or capton or benomyl 0.1 per cent or mancozeb 0.2 per cent

6.Angular Leaf Spot (Bacterial Blight) : *Xanthomonas fragariae*

Angular leaf spot or bacterial blight of strawberries is caused by the bacterium *Xanthomonas fragariae*. The disease was first reported in Minnesota in 1960, and it appears to be spreading rapidly to many strawberry-growing areas of the world with the importation of planting material.

Symptoms

- Typical symptoms of angular leaf spot appear initially as minute, water-soaked lesions on the lower leaf surface (Figure).
- These lesions enlarge to become angular spots, usually delineated by small veins.
- An important distinguishing characteristic of this disease is that lesions are translucent when viewed with transmitted light, but dark green when viewed with reflected light (Figure).
- Under moist conditions, lesions often have a viscous bacterial exudate on the lower leaf surface. When it dries, the exudate forms a whitish, scaly film.

- This exudate or film is an additional characteristic that is useful in the identification of angular leaf spot.
- Lesions may coalesce to cover large portions of the leaf.
- Eventually, lesions become visible on the upper leaf surface as irregular, reddish-brown spots, which are necrotic and opaque to transmitted light.
- A chlorotic halo may surround the lesion.
- At this stage, symptoms may be difficult to distinguish from those of common leaf spot and leaf scorch.
- Heavily infected leaves may die, especially if major veins are infected.
- Occasionally, under natural conditions, infection follows the major veins, resulting in veinal water-soaking that may or may not spread to the interveinal regions.
- Infection by *X. fragariae* may become systemic.
- The pathogen can infect all plant parts except fruits and roots and, in some cases, even the fruits have been infected, apparently only in the tissue adjacent to an infected calyx (fruit cap).
- Calyx infection can be serious. Infected tissues turn black resulting in unattractive fruit (Figure 10).

Disease Development

- Inoculum for the primary infection of new growth in the spring comes from infected dead leaves where the pathogen over wintered.
- *X. fragariae* may survive for extended periods in dry leaves or in infected leaves buried in the soil. Spread is primarily from infected leaf debris or infected crowns.
- Bacteria that exude from lesions under high-moisture conditions may provide secondary inoculum.
- Bacteria may be disseminated to uninfected plants or leaves by splashing water, such as rain or overhead irrigation.
- *X. fragariae* gains entrance into host tissue either passively through wounds or actively as motile cells that swim into natural plant openings by means of drops of dew, guttation fluid, rain, or irrigation water.

Epidemiology

- Moderate to cool daytime temperatures around 20°C,
- low nighttime temperature (near or just below freezing) and
- High relative humidity (92- 97%).
- Long periods of precipitation,
- Sprinkler irrigation to protect plants from freezing, or heavy dews in the spring also favor the disease.
- Young leaf tissue or leaves on healthy, vigorous plants are more likely to become infected than those on diseased or environmentally stressed plants.

Management

- Identification of the disease at the early stage and removal of runners reduces the disease
- Picking and destroying old blooms and over wintered canes help in reducing the disease.
- Avoiding excess irrigation helps to check the disease.
- Fungicidal spray copper oxy chloride 0.2% is effective in its control.
- The disease is effectively controlled by spraying with streptocycline 0.05%.

Minor Diseases of the Strawberry

- Stem-end Rot and Leaf Blotch.
- Verticillium Wilt of Strawberries.
- Leathery Rot of Strawberries
- Rhizoctonia Brown Rot of Strawberries.

POST HARVEST DISEASES OF STRAWBERRY

- Botrytis rot: *Botrytis cineria*
- Colletotrichum rot: *Colletotrichum spp*
- Phytophthera rot: *Phytophthora spp*

Management:

- Poly mulching avoid the fruit touches to the soil
- Avoid the over mulching

- Harvest in the fruits in cool hours and drying in shade condition
- Strawberry packing using the dry material preserve it in controlled environmental condition (-4°C)
- Before the 15 days harvest spray the benomyl 1g/ lit

LECTURE 18: Diseases of areca nut ARECANUT (*Areca catechu* L.)

INTRODUTION:

Arecanut (*Areca catechu* Linn) family Palmae is a tropical palm grown in about 2, 54,000ha with an annual production of 3, 33,000 tonnes. The palm is extensively cultivated in the states of Karnataka, Kerala, Tamil Nadu and parts of Maharashtra, West Bengal, Assam, Goa, Meghalaya and Andra Pradesh. The palm is affected by a number of diseases and disorders which affect the roots, stem, fronds, spear leaf, spadices and developing fruits. The palms from its seedling stage are influenced by many diseases. Few diseases can cause economic yield reduction or mortality of palm**.**

DISEASES OF ARECA NUT

S.No.	**Major Disease**		**Pathogen**
1	Mahali disease		*Phytophthora meadii (=P. arecae)*
2	Bacterial leaf stripe		*Xanthomonas campestris* pv. *Arecae*
3	Anabe roga (disease)		*Ganoderma lucidum*
4	Yellow leaf disease		*Phytoplasma-like organism*
5	Bud rot		*Phytophthora arecae*
6	Stem bleeding		*Thielaviopsis paradoxa*
7	Inflorescence die back		*Colletotrichum gleosporioides*
	Minor diseases		
8	Red rust		*Cephaleuros* sp.
9	Yellow leaf spot		*Fungal complex*
10	Root rot		*Fusarium* sp.
11	Leaf blight		*Phomopsis palmicola* var. *arecae*

1. MAHALI/KOLEROGA/FRUIT ROT/NUT ROT

In areas receiving heavy rain fall, mahali (heavy devastation) or koleroga (kole=rotting, roga =disease) is most dreaded disease. Butler in 1906 first recorded this
disease from Mysore. Lesli, C.Coleman (1910's) who worked extensively on this disease and developed management practices to manage the disease which are still working satisfactorily.

Symptoms:

- Characteristic symptoms include rotting and excessive shedding of immature nuts form the trees.
- The first sign of the disease is on the nuts, on which a water soaked lesions usually develop towards the base. Because of this watery rot, the disease is locally called as "Neerugole".
- Later leads to discoloration, discoloration starts browning then leads to deep browning, later dropping of nuts takes place.
- The fallen nuts show the felty, white mass of mycelium of the fungus which soon envelops the entire surface. Infected nuts loose their luster. This type of symptoms with boost like growth of the fungus, as also locally called as "Busurugole".
- The disease gradually spreads among the bunch ultimately covering the entire bunch wherein they rot and shed from the bunches.
- Fruit stalks and rachis of inflorescence are also affected. They are lighter in weight and deteriorate and are unsuitable for chewing.
- Very often, the top of the affected trees may also dry resulting in withering of leaves and bunches.

(Kole roga of areca nut) **An affected nut with white mycelial growth**

(Mahali/ bud rot disease of areca nut) **Infected palm showing characteristic symptoms of bud and crown rot diseases**

Causal organism – *Phytophthora meadii [=P. arecae* (Coleman) Peth. (Syn. *Phytophthora palmivora* var.arecae)].

Etiology:

- The mycelium is inter or intra cellular, coenocytic but forms septa in older stages.
- Haustoria are finger like, occasionally branched and sparsely produced.
- The sporangiophores are irregularly branched and the sporangia are pyriform to elliptical.
- Oospores are the sexual spores and are also act as dormant spores which survive for about 4-5 years.

Mode of spread and survival:

- Rain and wind plays an important role in the initiation and spread of the disease since low temperature and high humidity are favorable for the growth of the fungus.
- Intermittent rains with alternative sunshine are more conductive to a rapid spread of the disease.
- The close plantation of trees and plant grown in valleys gives ideal conditions for spread. Formation of oospores in the diseased nuts at the end of the season and dormant mycelia present in cracks and crevices of the tree helps the pathogen to perpetuate from season to season.

Epidemiology:

1.The optimum temperature for fungus is 18-22ºC
2.Relative \Humidity of more 95% is congenial for the development of disease.
3.Sporangia of the fungus have best caught in aeroscope slides at a height of 10-11m .
4.The fungus infects the nuts readily but not after 6 months old. Heavy rainfall, wind, low temp ,alternate sunshine and rainfall favours the disease.

Management:

1.Cleanliness and field sanitation including destruction of diseased tree tops and plant parts are foremost important in the management of the disease. Fallen infected nuts should be collected and burnt/destroyed.
2.Spraying with Bordeaux mixture 1.0% is recommended. Vegetable oils from ground nut, sesame, coconut or sunflower added to Bordeaux mixture before spraying also protect the palm from this disease.
3.Prophylactic spraying with Bordeaux mixture 1% once before the onset of south west monsoon and a second application 40-45 days later has been recommended with Metalaxyl MZ (0.2%).
4.Cover the fresh bunches after first spray with polythene bags to avoid fresh/further infection.
5.While spraying to the tree, the whole crown region should be covered.

2. BACTERIAL LEAF STRIPE

Rao and Mohan (1970) reported its occurrence from Tumkur areas of Karnataka state in an endemic form.

(Bacterial leaf stripe)
Infected leaf showing characteristic symptoms of black stripe on lower and upper surface

Symptoms:

- The initial symptoms include 1-4 mm diameter wide, dark green water soaked, translucent, linear lesions or stripes along side and parallel to the mid rib of the leaf let of its other main veins.
- The lesions may be developing at any point on the lamina, but more commonly from the base or towards the tip of the leaf let.
- The margin of the lesions is usually straight and well defined, but occasionally it may appear wavy.
- The lesions are covered with abundant bacterial exudates on the lower surface. The exudate is creamy white and slimy.
- On drying, it forms a waxy film or creamy white or yellowish flakes or fine granules or irregular yellowish masses.
- In the advanced stages, the lesions may measure 1cm or more wide and several centimeters long involving the midrib also.
- The affected midrib and veins of the leaflet get discolored and turn black.
- All the leaflets of leaf may be affected resulting in complete or partial blighting of the leaf and in severe cases the entire crown may be killed particularly in seedlings.

Etiology:

Xanthomonas campestris pv. *arecae* (Rao and Mohan) Dye

- It is soil borne, rod shaped, gram negative bacteria, monotrichous, genetic material DNA, reproduced by binary fusion.
- **Epidemiology:**
- Temperature 26 to 28^{0}C, Relative humidity 85-90%, intermittent rainfall, susceptible host favours the disease.
- **Mode of spread and survival:**
- The bacterium infects arecanut and other ornamental palms.
- The disease remains aggressive during and after the rainy season and it is of little significance during the hot dry summer months.
- The incidence is high during the months of July October when the average monthly rainfall is 130mm or more with more than 10 rainy days per month. 3-5 year old palms are highly susceptible to the disease than the older palms.

Management:

Cultural control:

1.Early identification and eradication.

2.Use healthy planting materials.

3.Antibiotics like tetracycline and its formulations are effective as prophylactic and curative treatments at 500 ppm concentration.

4.Stem injection of antibiotics has longer residual effect than foliar spray. Streptocycline 0.05% or copper oxychloride 0.3% spray can also be given.

3. ANABE ROGA/ROOT ROT/ROOT WILT/TANJAVUR WILT/GANODERMA WILT:

Symptoms;

Above ground;

1.Yellowing and browning of outer whorl of leaves. As the disease advances the inner whorl also exhibit the same symptom.

2.Leaves dries at later stage of the disease, droops and hang around the stem.

3.The impact is the flowers, and nut size reduction and dropping.

4.In severe or advanced stages, drooping of all the leaves and drop off by leaving only stem with out leaves. Discolouraiton of vascular bundles can be seen.

On trunk

1.Later stages of the disease, stem bleeding and oozing of gum takes place upto the height of 5m.

- **Below ground level on roots**

1.The roots of the infected plant become brittle, discololur and dry.

2.Sporophores and fruiting bodies can be seen on the stem portion at the collar region mostly after the death of the tree which gives the name "Anabe Roga (Mushroom like)".

3.The fungus also infects potato tubers, apple and cocoa fruits, fruits of citrus nobilis, *Artocarpus incisa* and *Agave wightii*.

Causal organism; *Ganoderma lucidum*

Etiology:

1.The fungus is heterothallic and weak parasite.

2.Vegetative spores are Chlamydospores.

3.Conidia are round, thin walled. Sexual spores are basidiospores

Primary source of innoculum:

1.Chlamydospore and dormant mycelia survive in soil, affected roots.

Secondary source of innoculum

1.Air borne basidiospores.

Mode of spread and survival;

1. It is a soil borne and survives as dormant mycelium, chlamydospores. Secondary spared through the twisting of infected roots to healthy roots (through soil root).
2.The mycelium present in the infected roots transfer to healthy once and thus spread the disease and spreads also through air.

Epidemiology:

- Neglected plantations
- Sandy loam soils
- High plant population density
- Summer stressed plantations

Management;

Cultural control:

1.Fruiting bodies of the fungus and the dead stump and roots should be collected and burnt.
2.Improving drainage facilities, avoiding dense planting of palms and adoption of clean cultivation of gardens help in checking the disease.
3.The fungus infects many plant trees including avenue trees and such host trees should be avoided in the vicinity of the areca garden.
4.The spread of the disease to neighboring trees can be prevented by digging deep trenches all round the affected palm and applying sulpher. Use drip irrigation during summer.

Chemical control: Soil drenching with calyxin 10ml/. lit or stem injection.

Biological control: Application of *Trichoderma viridae,* 100 gram per plant reduces the disease.

4. YELLOW LEAF DISEASE

Symptoms:

1.Symptoms include yellowing of leaves and shedding of both matured and immature nuts. Endosperms of diseased nuts are soft, blackish and not suitable for consumption.
2.Yellowing at the tips of leaf lets in 2or3 leaves of the outermost whorl is the first visible symptom.
3.Brown, necrotic streaks run parallel to lamina in unfolded leaves, with the development of leaves, yellowing starts form the tips of leaflets, gradually extending to the middle of the lamina.
4.One or two leaflets in any of the crown or the entire foliage may be affected by the disease. Tips of the chlorotic leaves eventually dry up.
5.In advanced stages, leaves are reduced in size, stiff and pointed, closely bunched and puckered. Finally the crown falls off leaving of are base trunk.
6.Root tips turn dark and gradually rot. Production of lateral root is reduced.
7.Affected fruits fall off. Some of the palms exhibiting foliar yellowing may produce normal nuts and all nuts in the bunch may not show kernel discoloration.
8.Blocking of xylem vessels of older leaves of diseased palms, degeneration of cortex and presence of tyloses in xylem are also noticed in diseased roots.

Causal agent: unknown etiology

Phytoplasma-like organisms.

Management:

- True Mangala seedlings and South Canara variety showed tolerance to this disease. The hybrid Saigon×mangala yielded max. Number of nuts with minimum disease intensity.
- Palms which received higher dose of potassium and magnesium recorded minimum disease intensity.
- Chlorotetracyclin hydrochloride (Aureomycin) and tetracycline chloride (achromycin) through root feeding and stem injection had no ameliorative effect on the disease.

5. BUD ROT:

Symptoms:

1.The fungus *Phytophthora palmivora*. *P meadii* causing koleroga in bunches also pass on to bud and cause rotting.

2.The first symptom of the disease is the discoloration of the spindle from the natural light green color to yellow and then brown.

3.Infection spreads to young leaves which rot rapidly. As the infection spreads inside the bud the growing point of the stem also rots resulting in the death of the palm.

4.The spindle slumps and can be drawn out with a gentle pull.

5.The outer leaves then become yellow, droop and drop off one by one leaving a bare stem. Secondary organisms colonize the rotting bud and convert it into a slimy mass which would emit a foetid smell.

Causal organism*: Phytophthora palmivora*

Etiology:

1.The mycelia are aseptate, intercellular mycelium & intercellular haustoria.

2.Zoospores are the asexual spores borne in sporangia.

3.Oospores are the sexual spores borne in oogonium.

4.Primary source of inoculum: oospores.

5.Secondary source of inoculum: zoospores.

Epidemiology:

1.This organism require cool weather condition, temperature requirement is 18-20˚ c, relative humidity is 98-100%, require cloudy weather, intermittent rainfall & high density plantation. It occurs in sever form in heavy rainfall tracts of Karnataka.

2.It generally occurs in monsoon season.

3.Fresh infection during November onwards becomes severe during succeeding months.

Management:

- Infected tissues of bud are to be scooped off and treated with Bordeaux paste.
- Destruction and removal of dead palms and also branches affected by mahali and drenching crowns of surrounding healthy palms with Bordeaux mixture 1% help in reducing the disease incidence.
- Soil application of *Trichoderma* reduces the inoculum in soil.

6. STEM BLEEDING

Symptoms:

- Both the young and old plants are affected but young palms are highly susceptible. Symptoms appear on the basal portions of the stem as small discolored depression during initial stages.
- Later the spots coalesce and cracks develop on the stem which eventually produces hollows upto varying depths along the infected portion.
- Crown of affected adult palms get reduced in size followed by reduction in yield. Finally a dark brown liquid oozes out from cracks.

Causal organism: *Thielaviopsis paradoxa* (de Seyenes) Hohn.

Primary source of inoculum: Dormant mycelia.

Secondary source of inoculum: Air borne conidia.

Epidemiology: More serious in kharif season, also more serious in case of poor drainage areas.

Management:

- Improving the drainage may help in minimizing the disease incidence.
- Root feeding with proper chemical. Application of hot coal tar or Bordeaux paste is effective in reducing the disease.

7. **Inflorescence die-back and button shedding**:

Symptoms:

- Die back of inflorescence is associated with low fruit set. About 60% of palms in the state of Karnataka, Kerala are infected by the disease causing severe shedding of buttons.
- Disease appears on the rachillae of the male flowers, then in the main rachis as brownish patches which soon spread from tip downwards covering the entire rachis causing it wilting. The female flowers of the infected rachis are shed.

- The fungus also infects the developing embryo inside the female flowers, which eventually shrivels up showing a brown discoloration.
- Under severe conditions the fungal infection proceeds from tip downwards producing the condition known as die-back.
- Concentric rings of light pink coloured conidial mass of the pathogen appear on the discolored portions of the infected inflorescence.

Causal organism: *Colletotrichum gloeosporioides* Penz.

Etiology:

- Mycelium is septate, asexual spores are conidia borne in acervulus.
- Sexual spores are ascospores borne in Perithecium.
- Primary source of innoculum: Dormant mycelia.
- Secondary source of innoculum: Conidia.

Epidemiology:

- The disease is present throughout the year, but is most serious during the dry period (Feb-May).
- Temperature requirement is 28-32˚c, & relative humidity of 90-92%,weak host.

Management:

- Summer irrigation
- Recommended N:P:K application/plant.
- Spray Carbendazim 0.1%.

MINOR DISEASES

a. **Red rust**:

- *Cephaleuros* sp. produces circular spots with sunken centers and yellow haloes on the foliage.
- Lesions are irregular on the stem. Infection destroys the epidermis.

Causal organism: *Cephaleuros* sp.the alga,

- It affects photosynthesis, yield reduces & also quality reduces.

Management:

- Early identification & destroy, thereby reducing further infection.
- Provide proper irrigation & apply recommended N, P, K.
- Trimming with better aeration.

Spray systemic fungicide Benomyl 1.5g/litre.

b. YELLOW LEAF SPOT

Symptoms:

- Yellow specks measuring 3-10mm diameter appear on the leaves.
- These spots coalesce to form larger lesions surrounded by yellow haloes.
- Advanced stages the seedlings are stunted and in severe cases the seedlings die.

Etiology: *Curvularia* sp., C*olletotrichum* sp., *Phyllosticta* sp., *Helminthosporum* sp.and ***Alternaria tenuis*** has been reported to cause leaf spot of seedlings.

Epidemiology:

- The disease is severe during summer months (Feb-Mar) and continues to infect seedlings until the onset of rains.
- Seedlings (1- 2.5year old) exposed to the sun are susceptible.

Management:

- Improving drainage both in the nursery and main field and providing shade minimize the disease.
- Application of heavy doses of manures and spraying with zineb 0.2% or Bordeaux mixture 1% reduce the disease incidence.
- Fungicides like ziram (0.2%), COC (0.3%) are also effective in checking the spread of the disease.

c. Root rot or collar rot

- The rotting is caused by fungi like *Fusarium* sp. And *Rhizoctonia* sp.
- This is usually seen in nurseries with poor drainage.
- The fungi infect roots and cause wilting of seedlings.
- Sometimes bacteria enter the stem through the collar region and rotting of bud also.

- The severity of the disease can be minimized by providing good drainage in the nursery and drenching the soil with Bordeaux mixture or cheshnut compound.

d. **Leaf blight:**

- The disease is characterized by reddish brown spots which blight the leaves.
- Later black crusty appearance will form which is little hard.
- *Phomopsis palmicola* var.*arecae* as been reported as the causal organism for leaf blight of seedlings at transplanting stage. This leads to stunted growth.

Causal organism: *Pestalotiopsis palmarum* (Cooke), *Phomopsis palmicola* var. *arecae.*
Primary source of innoculum: Dormant mycelia.
Secondary source of innoculum: Conidia borne in acervulus.
Spread: Air borne and enter through stomata.
Epidemiology: Neglected orchards, summer irrigation, root infection. Poor soil fertility favours the incidence.

Management:

- It was suggested to apply N and K followed by spraying with Zinep to check the disease.
- Irrigation should be given properly.
- Weed management.

LECTURE 19: Diseases of coconut, oil palm

Coconut Diseases

The coconut palm, ***Cocos nucifera* Linn.,** with its tall, slender, and uniformly thick stern and massive crown with large, Number of leaves, bearing bunches of nuts in their axils is one of the most beautiful and useful trees in the world (Menon and Pandalai, 1958). lnspite of its hardy nature, the coconut palm is affected by a number of diseases (Nambiar, 1994).

This perennial palm though known for its adaptability to different soil conditions, moisture stress and vagaries of climate, is often subjected to attack by plant pathogens causing various diseases (Henry Louis, 2002). Anon (1979) 173 fungi associated with coconut and Brown (1973) recorded 35 fungi from coconut leaves, in India. The roots, stem and the crown regions are attacked at different growth stages of the crop, which may result in considerable economic loss to the grower.

Besides fungal pathogens, bacteria, phytoplasma, virus and nematodes have also been reported to cause diseases in coconut (Menon and Pandalai, 1958; Nambiar, 1994; Srinivasulu et.al., 20013). In India, basal stern rot (Ganoderma wilt), bud rot, stem bleeding, root (wilt) and leaf rot are important diseases of coconut and are serious constraints to the production and productivity of the crop.

List of Coconut Diseases-

S.No.	**Major Disease**		**Pathogen**
1	Bud Rot		*Phytophthora palmivora*
2	Trunk and Root Rot Or Ganoderma-Wilt		*Ganoderma lucidum*
3	Fruit Rot Or Mahali		*Phytophthora palmivora*
4	Stem Bleeding		*Thielaviopsis paradoxa*
5	Leaf Blight Or Grey Leaf Spot		*Pestalotia palmarum*
6	Red Ring Disease		*Rhadinaphelenchus cocophilus*
7	Crown Choking		
8	Cadang- Cadang		
9	Lethal Yellowing		
10	Linking MLO And Lethal Yellowing In Coconut Palms		
11	Leaf Scorch Decline		

DISEASES OF KNOWN ETIOLOGY-

BUD ROT -(*Phytophthora palmivora*)

This is one of the serious diseases of the coconut and is fatal, since the growing part of the plant is damaged. Bud rot incidence is high in palms growing in marshy, water-logging areas and in environments that promote high humidity (above 90%). The incidence is mostly found to be severe during, monsoon when RH is very high and temperature is below 24°C. The pathogen remains dormant in the leaf base in dry weather and becomes active after receiving the monsoon showers, which indicates that unfavorable climatic conditions appear to be the primary cause of this and the fungal infection is considered to be only secondary.

Symptoms :

- The first symptom is the discoloration of the youngest leaf, withering of the central spindle of the crown, rolling and death of growing point
- The tender leaf bases degenerate into a soil mass of purified material, emitting foul smell that attracts flies.
- When the base of the bud is badly affected, the palm finally succumbs.
- Bud rot is highly infectious and is spread by the wind during rainy season.

Aetiology-

- **Mycelia:**Aseptate, intracellular haustoria, **Asexual spores:** Zoospores, **Sexual spores:** Oospores

Life cycle of *phytophthora palmivora*

- **Primary Source of Inoculation** – Dormant Mycelia/oospores, **Secondary Source of Inoculation** – Zoospores and sporangia, **Mode of action-**Through stomata

Epidemiology -

- Cool Weather loving fungi. Temperature- 18^{o}-20^{o}C. Relative.Humidity-100% Closed Plant

Population, Time of South-West monsoon, Susceptible host.

Control :

1.In the bud-rot affected plantation, regular spraying with **1% Bordeaux mixture** just before and after monsoon to adjacent healthy palms is an effective preventive or prophylactic measure. **Orchard sanitation** by removal of dry material from the crown is also essential.

2.If the disease is detected in early stage itself, application of Bordeaux paste on the crown, after thorough cleaning and removal of infected material, can check the disease.

3.The treated portion should be given a protective covering with polythene sheet to prevent washing off of the paste. It is best to remove infected palms and treat the surrounding palms.

TRUNK AND ROOT ROT OR GANODERMA-WILT (*Ganoderma lucidum*)

Trunk/root rot is caused by a root infecting fungus called *Ganoderma lucidum* which usually remains within the tissues. This pathogen also causes root rot in areca and stem decay in oil palm. Its occurrence is restricted to, sandy and sandy-loam soils.

This malady was first noticed in **Thanjavur district** at Tamil Nadu after the cyclones of 1952 and 1955 and hence called 'Thanjavur wilt'. Now it is widespread in other Districts, viz; Kanyakumari, Tiruchirapally, South Arcot and North Arcot and also - the border areas of Kerala. Ganoderma- wilt is prevalent in Tamil Nadu, Andhra Pradesh, and Karnataka mainly; and minor incidences reported in Maharashtra, Gujarat and Orissa. The affected palms die within 2 or 3 years after infection. In dead palms, brackets of *Ganoderma lucidum* and *G. applanatum* are also seen.

Symptoms :

1.Though the seat of infection is the base of the trunk/root

2.The characteristic symptom is visible on the crown,' withering and drooping of the older leaves which remain hanging around the trunk for several months.

3.The new leaves become reduced in size and yellowish in colour, the inflorescences become suppressed and the palms remain barren.

4.Bleeding patches occur at the base of the trunk and slowly extend higher up the stem and ultimately kill the plain.

5.The major symptoms are:

6.Palms show wilting due to internal rotting and crown topples.

7.Withering and browning of outer leaves, followed by yellowing and leaf drooping, flaccidity of' spindle leaves.

8.Reduction of the size of spindle, arresting the crown and fruit-set.

9.Decay of finer roots extends to bole region and slowly gets upwards into stem base.

Etiology:

- Ganoderma is a heterothallic fungi. **Mycelia-** Septate. **Vegetative spores-** Chlamydospores. **Sexual spores-**Basidiospors **Mode of spread-**Air

Primary Source of Inoculums- Chlamydospores, **Secondary Source of Inoculums-** Basidiospores

Epidemiology-

- Neutral pH, Sandy loam soil, High plant density in plantation.

Disease Management :

1.Cultural practices should be followed judiciously. Repeated ploughing in affected areas may be minimized, closer planting avoided, good drainage to be provided, adequate irrigations need to be given, providing mulches or green manuring at the basin of the palm

2.Diseased palms should be removed and burnt.

3.Bleeding patches should be chiseled completely, followed by hot coal tar application; Plate 15. Stem bleeding' (Courtesy: CPCRl).Isolation trenches (1 cm x 30 cm) may be dug up around diseased palms to prevent root contact.

4.Application of 5 kg neem cake along With sufficient organic matter and 500 gm phosphate + 1200 gm potassic fertilizer may be applied per palm per year, so as to keep proper nutrient in the soil.

5.Drenching with 40 L of 1% Bordeaux mixture and stem injection or root feeding of 2 gm Aureofungin solution + 1 gm copper sulphate in 100 ml thrice a year, for only one year may reduce intensity of this malady.

STEM BLEEDING: (*Thielaviopsis paradoxa*)

This malady was first reported from Sri Lanka in 1906 and then from India in 1922. This is most common in Kerala, South Coastal Tall1il Nadu and Goa. This is more of, symptom or expression of

abnormal condition caused by mall factors, causes damage to the trunk and reduces yield.

Symptoms:

- The first symptom is the **exudation of a dark reddish-brown fluid** through cracks of outer tissue or wounds of lower parts of the trunk.
- The tissue inside the trunk is decayed and the epidermis is destroyed.
- The fluid turns black in colour as it dries up on the bark.
- The crown becomes smaller.
- This disease covers palms of all ages but the spread is more rapid in young palms.
- Bleeding of the stem is associated with fungal infection.
- The fungus associated with the disease is *Thielaviopsis paradoxa*, which is a wood parasite, isolated from affected stem tissues.
- This parasite establishes itself inside tissues of the trunk, after getting entry through cracks and wounds on the trunk.

Primary Source of Inoculum- Dormant Mycelia

Secondary Source of Inoculum- Airborne conedia

Epidemiology :

- Kharif season. Unfavourable soil conditions play a major role. Shallow laterite soils also develop stem bleeding symptoms in palms. High relative humidity

Control :

- The rotting tissues should be cut away with a sharp chiseland the exposed surfaces paintecl, with hot coal tar or 10·96 Bordeaux paste.
- This is a serious disease caused by *Bipolaris halodes*. Normally, the leaf rot disease is found superimposed on root (wilt) affected palms.
- If cavities are found, they have to be filled up with cement for reinforcing.
- Since the pathogen is a wood parasite, mechanical injury to the infected palm, should be avoided.
- The organic matter content lot of the soil should be increased. Application of neem cake @ 5 kg/palm is beneficial.
- Improvement in drainage and soil conservation in drought areas are essential.
- Application of Bavistin in soil has been found to be beneficial in reducing infection.

FRUIT ROT OR MAHALI -(*Phytophthora palmivora*)

Fruit rot is also called 'Mahali'. It is used by the fungus *Phytophthora pulmivora* during monsoon period. It affects immature as well as mature nuts. Dropping of buttons becomes more virulent after the rains when the atmospheric humidity is high with low temperature.

Symptoms :

A water-soaked area develops near; the fruit stalk during the monsoon period. The fruit will appear dark green at first and in the fruit rot may extent into the' husk and further into the kernel cavity.

Control:

1. Fruit rot and button shading caused by fungal infection can be controlled by spraying the young bunches with 1% Bordeaux mix, during the pre- and post-monsoon periods.
2. Irrigation during summer months is particularly important for retention of buttons.
3. Regular manuring and proper cultural practices may reduce the disease incidence.

GREY LEAF BLIGHT OR GREY LEAF SPOT (*Pestalotia palmarum*):

Leaf spot disease is caused by *Pestalotia palmarum* which is widesperead in the major coconut growing countries. The incidence of the disease is usually influenced by the nutrient· status of the soil and the palm as well. Young palms are mostly susceptible in soils deficient in potash and rich in nitrogen.

Symptoms: Leaf spot symptoms develop only on the mature leaves in theform of small yellowish-brown spots on the leaflets which gradually become oval in shape with a grayish band. In advance stage; the affected portion of the leaflets shows a burnt or blighted appearance.

Aetiology :

- Septate mycelia. **Asexual fruitin body:** Conidia borne in acervulus. **Sexual fruitin body:** Pestalotia.
- **Primary source of inoculums:** Dormant Mycelia, **Secondary source of inoculums:** Air bornee Conidia

Control: 1. Removal of the older affected leaves and spraying the foliage.

2. Improvement of drainage condition and adequate application of potassic fertilizers are very essential to suppress the disease. Spraying of 1% Bordeaux mixture during pre-monsoon period will be beneficial.

RED RING DISEASE (*Rhadinaphelenchus cocophilus*)

This disease is caused by nematode, *R. cocophilus* which is an endo-parasite, mostly confined to the Western Tropics. However, this disease is not prevelent in India.

Symptoms: The leaflets of the outer whorl turn yellow, starting from the tips by browning and death of leaves. The young palms (4 to 7 years old) are more susceptible' t6 infection. The infections spread through the soil under wet conditions when the root system comes, in contact with nearby infected palm spp.

Primary Source of Inoculum: Affected soil, Affected Planting material.

Secondary Source Of Inoculum: Through Irrigation water, root root contact.

Control- Digging isolation trenches around the infected palms will check the spread of the nematode to the healthy palms. The heavily affected palms may be cut and removed.

CROWN CHOKING:

The incidence of this malady was first observed in 1964 in Assam and then in West Bengal. The analysis of soil and leaf samples indicated that the calcium content of diseased palms showed significantly high, while the boron content is in very low concentration. Young palms of the age group of 5 to 10 years are mostly affected; however, the disease is noticed in the bearing palms also.

Symptoms: The first symptom is the emergence of shorter leaves with deformed and crinkled leaflets which are associated with severe tip necrosis. Those deformed leaflets fail to unfurl and ultimately give a choked appearance to the frond. Hence, this deformity of the' palms is called "crown choking". In case of young palms, peripheral leaves crown around the bud and prevent normal unfurling of the flag leaf in acute cases, necrosis of the primordial tissue takes place and the crown dies, but not suddenly. The affected palm looses vitality slowly and succums finally within 3 to 4 years.

Control:

Application of borax at 50 g / palm to the coconut basin resulted in recovery of the affected palm (Chakravarty. et al., 1973); while Cecil and Pillai (1978) recommended 250 g borax/palm. Prolonged drought followed by certain downpour as in 1973 and 1974 are also causes of its spread. Heavy bearing, middle-aged palms are most susceptible to this malady. In certain investigation, the presence of Diplodia and Thielaviopsis colonies are detected. In affected palms, the deficiency of nutrients, particularly nitrogen and zinc are observed. Recently MLOs are detected in affected palms.

Symptoms:

1. Abnormally large crown with more number of leaves having large petioles and big size of leaflets develops.
2. Inner leaves become darker than normal, while outermost whorl shows yellowing. Afterwards, leaves become smaller in size and pale in colour and leaflets fail to unfold properly showing fan-like appearance.
3. Fronds bend abnormally from the middle and start drooping.
4. Nuts become smaller, round containing sponge-like mesocarp; some nuts form longitudinal cracks.
5. As the disease progresses, the palms become barren with a tapering stem;
6. Roots start extensive rotting and their generation becomes poor, resulting in the palms succumbs to the disease in the course of a few years.

Remedial Measures:

1. Destruction of badly affected palms may prevent spread of the disease; since presence of MLO has recently been detected in affected palms in East Godavari area.

2. Application of a mixture of river sand and farmyard manure or tank silt with normal dose of NPK can reduce the intensity of this malady and increase nut yield-)

CADANG- CADANG :

The name Cadang-Cadang signifies 'dying-dying' from the dialect of Sicol area in Philippines and reflects the slow but persistent lethal progress of the disease. This is one of the most serious disease of coconut in this country, which is also locally known as 'yellow mottle decline'. The slow reaction

of the palm is a major problem to combat the disease. This disease is a slow killer, takes 5 to 8 years to die and thus only older palms succumb. Young palms affect before yellowing stage, never bearing fruits.

Soil: This disease incidence is influenced by poor nutritional status and poor soil structure. It is assumed that this disease is due to certain micro-nutrient deficiency, particularly copper or toxicity of nickel.

Symptoms: The symptoms and type of spreading have been generally accepted as indicating virus origin and the involved organism is identified as viroid. The first visible symptom is a decrease in size of nuts, the fibrous layer becomes thinner and thinner. Irregular yellow translucent spots appear in the pinnate of young leaves and turn orange-yellow mottling as the leaves .mature and size and number or spots increase. On the lower surface of the leaves, a peculiar 'water-soaked' type of spot appears. Young leaves become short, brittle and frond as a whole become smaller and tend to remain upright position in the crown. Both male and female flowers become dwarf and the flower production usually ceases within the second year after appearance of leaf symptoms. In late stage, the central fronds become bronze-yellow, main bud dies and falls off, showing crownless. As the disease progresses, roots are generally detioriate and rotting becomes extensive.

Remedial Measures:

1. Clean culture, cutting and burning of infected palms suggested.
2. Replanting with resistant Dwarf cultivars is desirable.
3. Good soil management may suppress this malady.

LETHAL YELLOWING: (Phytoplasma Like |Organism)

Lethal yellowing is a pandemic disease of coconut palm which has destroyed thousand of palms in South Florida earlier and in recent years, this malady is most common in' Jamaica. 'the rate of spread of 'Lethal Yellowing". (LY) in Jamaica is similar to that of LY in Florida (McCoy, 1976). The term 'Lethal Yellowing' was first used my Nutman et al. (1955), to denote a specific disease of coconut palms in Jamaica and subsequently applied to diseases of identical syrnptomology in other countries. Parthasarathy (1974) observed mycoplasma-like-organisms (MLO) in phloem tissue by Electron Microscopic examination.

Symptoms :

The first symptom of lethal yellowing in mature coconut palms is the premature dropping of most of the nuts regardless in size. Next symptom is to develop necrosis of new inflorescence with blackening of tips and most of the male flowers become dead and thereby no fruit set on such' flower stalks. Next, the lower fronds turn yellow which spreads gradually to younger leaves. However, yellowed leaves are found turgid and not flaccid as in case of root (wilt) disease. Those leaves become yellow, ultimately turn brown, desiccate and hang down. Finally, the newly emerged spear leaf collapses and death of the terminal bud occurs and the top of the palm falls away within 6 months after appearance of the symptoms. Lethal Yellowing spreads not only first but it kills rapidly.

Primary source of inoculums- Infected leaf and plants.

Secondary source of inoculums- Phytoplasma transmitted by bornee leaf hoppers.

Epidemiology:

- Neglected orchard, Sucseptable host. Summer season, High vector population.

LINKING MLO AND LETHAL YELLOWING IN COCONUT PALMS

The presence of MLO within the phloem vascular tissue of coconut palms affected by LY was reported in 1972 by many workers. Firstly, VILO have consistently been detected in diseased but not healthy palm tissue. Secondly, linking MLO to LY is the antibiotic response of diseased palms, particularly tetracycline. Thus, antibiotic treatments were developed as a disease management tool.

Control of Lethal Yellowing :

I. Rapid removal of affected palms will show the apparent rate of disease spread;

2. Imported Malayan Dwarf palm which is found to be resistant cultivar can be replanted in diseased gardens.

3. Stem injection of tetracycline group anti-biotic would suppress symptoms development, since mycoplasma are known to be sensitive to tetracycline.

4. Spreading of insecticides like diazinon or dimethoate biweekly, may reduce the vector (M. crudus) population substantially and thereby reduce LY to a great extent.

LEAF SCORCH DECLINE:

Leaf scorch decline is a disorder of coconut pal ms, first detected in Sri Lanka as early as 1955. The volume of inflorescence sap collected from LSD-affected palms was reduced compared to healthy palms, but the composition of the sap remained unaltered.

Soil Condition:

Rapid tappering associated' with Leaf Scorch Decline occurs under adverse soil and environmental conditions. The growth is adversely affected, the' root system is severely damaged, tapped continuously and succumb. In laterite and gravelly soils, impeded drainage through hard pan beneath, may be an adverse soil physical factor in Leaf Scorch Decline. A relatively high rate of tappering is observed in shallow and compact soils and those have not been fertilized regularly.

Symptoms :

Necrosis on lower whorl of fronds of grown up palms and downwards curling of leaflets are the main characteristics, of Leaf Scorch Decline. After a short period, the crown is reduced in size and the trunk begins to tap. As a- result; formation of inflorescence may cease completely Extensive damage of root system and root decay are found common in affected palms. This malady is often associated with cracking of heavy clay soil and visible magnesium deficiency symptoms in leaves.

Remedial Measures:

1. Structural improvement of laterite/gravelly soil with addition of organics may improve the condition of affected palms.
2. Round bench terracing at a height of 0.5 m with coconut husks, 1 m away from the base of the palm and filling the space with porous soil, helps to induce new root formation.
3. Regular balanced manuring, including application of magnesium sulphate 1 kg/palm/year will be benefiCiaI')

20 DISEASES AND DISORDERS AFFECTING THE OIL PALM

Thirty two diseases and disorders affecting the oil palm in Africa, Southeast Asia and South America are described with their distribution, economic importance, etiology and control. Of these, nine diseases are considered to be of major economic importance, 19 are of minor importance, and four are due to nutrient deficiencies.

The major diseases causing serious economic losses are

S.No.	**Major Disease**		**Pathogen**
1	Freckle		*Cercospora elaeidis*
2	Blast		*Pythium splendens* and *Rhizoctonialamellifera*
3	Vascular Wilt		*Fusarium oxysporum* f. sp. *elaeidis*
4	Ganoderma trunk rot		*Ganoderma* spp.
5	Armillaria trunk rot		*Armillariella mellea* in Africa
6	Ganoderma trunk rot, Corticium leaf rot		*Corticium solani*
7	Marasmius bunch rot		*Marasmius palmivora*
8	Anthracnose		*Botryodiplodia palmarum, Melanconium* sp. and *Clomerella cingulata*
9	Dry Basal Rot		*Ceratocystis paradoxic*
10	Patch Yellows		*Fusarium oxysporum*
11	Crown Disease, Cylindrocladium leaf spot		*Cylindrocladium macrosporum*
12	Algal Spot		*Cephaleuros virescens*
13	Bronze streak, ring spot and little leaf in Africa;		
14	Curvularia leaf blight		*Curvularia eragrostidis*
15	Leptosphaeria leaf spot		*Pestalotiopsis spp.*

Infectious Chlorosis, upper stem rot (*Phellinus noxius*), stem wet rot, charcoal base rot in S.E. Asia and Leptosphaeria leaf spot and coconut wilt disease in S. America. Little is known, however, about the disease problems in the smaller but rapidly expanding oil palm growing areas of Thailand, Papua New Guinea, India and Sri Lanka. Infectious chlorosis, bronze streak and ring spot have a suspected virus etiology; little leaf, spear rot and stem wet rot are attributed to bacteria and leaf chlorosis, mid-crown yellowing, orange frond and hook leaf to nutrient deficiencies. The etiology of some minor disorders including brown germ, crown disease and several miscellaneous abnormalities is unknown.

Effective control measures, based on the application of various chemicals, have been devised for the leaf diseases but other than precautionary cultural operations, there are no such effective and practical control measures for the root and stem diseases. For this latter group of diseases field transplanting or resistant or tolerant varieties seems to be the best method of control. Seeds selected for tolerance to vascular wilt are being produced on a commercial scale at the Nigerian Institute for Oil Palm Research, Institute de Recherches pour les Huiles et Oleagineux in Ivory Coast and the Unilever Plantations in Cameroun Republic. These efforts need to be supplemented by breeding for resistance to the other major diseases.

COFFEE

Introduction: Coffee has a place of pride among the plantation crops in India & mainly cultivated in the hilly tracts of Karnataka, Kerala & Tamil Nadu & to a lesser extent in non-traditional areas such as Andhra Pradesh, Orissa, West Bengal, Maharashtra & North Eastern states. *Arabica* & *Robusta* are the two economic species of Coffee commercially cultivated in India. Arabica occupies an area of 1, 27,934 ha. With an average productivity of 730 Kg/ha. While Robusta is grown on 1, 42,887 ha. With an average productivity of 732 Kg/ha. Coffee being an export oriented commodity & contributes nearly Rs.1, 400 crores of foreign exchange exchequer. As an agro based rural enterprise primarily this industry is a source direct employment for about 4 lakhs in the area of cultivation apart from the providing indirect employment to several people in the processing & trading centre.

In India, though coffee is susceptible to several fungal diseases of economic importance, viral & bacterial diseases were not reported so far. Among the two commercially cultivated species, Arabica coffee is more susceptible than Robusta. Leaf rust, black rot, pink disease; anthracnose, root diseases, berry blotch, collar rot & brown-eye-spot are the important diseases which needs regular plant protection measures for improved crop production.

Integrated Disease Management (IDM) is considered as a mean by utilizing all the suitable methods in a compatible manner that minimize the pesticides use as disturbance to the environment & maintain the pathogen population level below economic damage. The current disease management programme in coffee is designated as IDM & most of the IDM components are generally practiced for the effective management of important diseases of coffee.

COFFEE DISEASES

S.No.	**Major Disease**		**Pathogen**
1.	Leaf rust		*Hemileia vastatrix*
2.	Black rot		*Pellicularia koleroga*
3.	Pink disease		*Cortcium salmonicolor*
4.	Anthracnose -a. Twig die back		*Colletotricum gloeosporioides*
	b. Stalk rot of berries & leaves		*Colletotricum gloeosporioides*
	c. Brown blight of leaves		*Colletotricum gloeosporioides*
5.	Root diseases		
	a. Brown root		*Fomes noxius*
	b. Red root		*- Poria hypolateritia*
	c. Black root		*Rosellinia bunodes*
	d. Santavery root		*Fusarium oxysporum*
6.	Berry blotch		*Cercospora coffeicola*
7.	Fusarium bark disease		*Fusarium stilboides*
8.	Nursery diseases		
	a. Collar rot		*Rhizoctonia solani*
	b. Brown eye spot		*Cercospora coffeicola*
	MINOR DISEASES		
1.	Grey blight of leaves		*Pestalotiopsis clavispora*
2.	Black leaf		*Cylindrocladium illicicola*
3.	Target leaf spot		*Myrothecium advena*
4.	Tip burn		*Myrothecium roridum*
5.	Sclerotium disease		*Sclerotium coffeicola*
6.	Coffee blight		*Phoma costarricensis*
7.	Sooty mould		*Capnodium braziliense*
	FLOWERING PARASITES		
1.	Shoot parasite		*Cuscuta reflexa*
2.	Root parasite		*Balanophora indica*
Stem Wasting Disorder(Kondli)			

MAJOR DISEASES

1. LEAF RUST/ORIENTAL LEAF DISEASE

Coffee leaf rust caused by ***Hemileia vastatrix*** Berk. & Br. Is one of the most importance diseases & pests of tropical plants. It has been considered as one of the classic diseases, since it ruined the

economy of ***Srilanka*** changed to the **Tea cultivation** & also the social habit of the people from coffee drinking to Tea. Besides India, Coffee rust has been reported from 50 coffee growing countries. Leaf rust disease was noticed in India during **1869** and in the early years it caused severe damage to the flourishing plantations sending the coffee production staggering down as no control measures were available during the period.

Symptoms: Coffee rust attacks mostly leaves & very rarely the young branches.

- Initially pale yellow circular spots measuring 2-4mm in diameter.
- Appear on the lower surface of the leaves which later turn to orange yellow powdery mass of urediniospores.
- The spots enlarge & become more irregular as they coalesce with the adjacent spots. With the aging,
- The central portions of the spots become brownish & later necrotic, whereas the middle zones of the version continue to sporulates.
- Severe infection can cause heavy defoliation & dieback of branches.

Crop loss : Rust affects the berry yield in many ways, by reducing the photosynthetic area, by occupying leaf area, inducing defoliation & reducing the vigour of the plants due to altered physiology.

- Depending on the severity of rust not only fewer flowers are formed but also the flower & the fruit fall prematurely the remaining berries after development do not reach maximum size.
- In severely affected areas the pathogen causes foliage loss up to 50% & even 70% loss of coffee berries.

CAUSAL ORGANISM, TAXONOMY & LIFE CYCLE

The causal organism of leaf rust ***Hemilia vastatrix*** has been classified under

Class- Basidiomycotina, Sub- class-Teliomycetidia, Order- Uredinals Family- Pucciniaceae.

- In nature, coffee leaf rust fungus produces only uredinial, telial & basidial stages. But the perpetuation of the fungus in nature is only by anomorphic urediniospores.
- The teliospores are produced only during unfavourable conditions & it germinates in situ under favourable conditions by producing basidiospores which are apparently functionless on coffee.
- Alternate hosts have not been reported so far. Pycnial & aecial stages of the fungus have not been noticed either natural or under control conditions.
- Uredospores act as secondary source of inoculum.
- Teliospores present in fallen leaves acts as primary source of inoculum
- Uredospores act as secondary source of inoculum.

Mode of spread & survival : One lesion produces 1.5 lakhs uredospores which are spread by rain splash & wind.

- Many animals can also carry spores over long distances.
- Infection requires the presence of water for uredospore germination & only occurs through stomata, which are on the underside of the leaf.
- Epidemics develop during the rainy season because of the necessity for water.
- Favorable factors & disease progress/Epidemiology
- Wet weather with wind during May to November,
- Intermittent & sun shine, mist or rain during dry weather from Nov-Mar thin or no over head shade is the favourable factors for the disease development.
- Under suitable conditions, the disease make its appearance after blossom showers during Mar-Apr. the foliage present at that time are mostly of previous season & the fungus remains dormant.
- Such leaves during the dry weather sporulate to form fresh urediniospores.
- The disease reaches is peak from Sep-Nov & results in severe defoliation.

Control:-

Cultural management: Various agronomic practices like spacing, shading, fertilizing & pruning operations reduce the rust infection level.

- Spacing:-Increased plant spacing decrease the relative humidity & thus the relative incidence of leaf rust. Hence avoid dense planting to minimize the rust incidence.
- Shade:- Leaf rust incidence is generally lesser under medium shade than in open or thin shade.

- Fertilizer:- Keep the vigour of the bush during the crop development period by applying balanced fertilizer, as plant yield is one of the major factors that influence the rust development.
- Pruning:- Pruning of dry & unproductive branches is done to reduce the die-back of branches & to facilitate formation of new branches. Mostly recommended before the blossom showers to reduce the initial inoculums.

Biological control: *Verticillium hemileiae* parasites of rust spores occur mostly during rainy season at high relative humidity near saturation.

- Role of a biological agent is very limited due to its failure to establish even for a short period under low humidity.

Resistant varieties

Twelve cultivars of Coffee Arabica (Sln. 1 to Sln.12) were evolved at CCRI..

Chemical control

Copper based fungicides especially freshly prepared Bordeaux mixture 0.5% has been found effective & economical for the control of leaf rust under field conditions.

Number of systematic fungicides were tested & among them oxycarboxin, carboxin, pyracarbolid, triadimefon, propiconazole, hexaconozole & epoxyconazole showed curative & eradicant effect on rust pathogen.

Spray schedule for the control of leaf rust

- Bordeaux mixture 0.5% pre- blossom (Feb-Mar), Pre-monsoon (May-June), Post-monsoon (Sept-Oct).
- Triadimefon 0.02% Pre-monsoon (May-June), Post-monsoon (Sept-Oct).
- Hexaconozole 0.01% Pre-monsoon (May-June), Post-monsoon (Sept-Oct).
- Propiconazole 0.02% Pre-monsoon May-June), Post-monsoon (Sept-Oct).
- Oxycarboxin 0.03% Pre-monsoon, Mid-monsoon (July-Aug), Post-monsoon (Sept-Oct).
- Epoxyconazole 0.0026% Pre-monsoon (May-June), Post-monsoon (Sept-Oct).

2. BLACK ROT/KOLEROGA/THREAD BLIGHT

Also called ***Koleroga*** is considered to be the second importance disease of coffee in India. Pathogen attacks on both **Arabica** & **Robusta** coffee. But the severe incidence of the disease was seen on Arabica coffee cultivars. Black rot disease was reported from almost all coffee regions of Karnataka, Kerala & Tamil Nadu coming under the influence of heavy South-West monsoon.

Symptoms: The black rot pathogen infects leaves, developing berries & young shoots.

- The most striking symptoms are blackening & rotting of the infected leaves, developing berries & young twigs.
- Affected leaves get detached from branches & hang down by means of slimy fungal strands.
- On the green berries characteristic blackening starts from a side & spreads gradually in a narrow band.
- Close examination reveals the presence of characteristic threads of mycelia running along the twigs, petioles & spreading mostly on the lower surface of the leaves.
- When the affected leaves & berries become dry, they reveal the presence of white web consisting of closely interwoven mycelium.
- Defoliation & berry drop from the infected branches occur in advanced stage of the disease.

Crop loss: Damage caused by this fungus varies from place to place & season to season.

- However, in severely diseased areas a loss of 10-20% of crop for the whole estate & 70-80%or even more on an individual bush has been recorded.
- Foliage loss by this pathogen which leads to severe die-back & destruction of wood where crop has to borne for the next should also be taken into account while estimating the crop loss.

Favourable factors/Epidemiology

- Continuous monsoon with out a long dry spell, aturated atmosphere with 95-100% RH, thick overhead shade, plants sheltered from sunlight & wind in valleys,
- Frequent or continuous mists during the monsoon are the favourable factors for the out break of the disease.

Causal organism, taxonomy

The causal organism of black rot pathogen is ***Pellicularia koleroga*** classified under

Class- Basidiomycontia Order- Polyporales, Family- Thelephoraceae.

Koleroga noxia Donk, ***Pellicularia koleroga*** Cke., are the different synonymous names proposed to this fungus.

Initiation of disease : Earliest symptoms of disease appear on the bushes which are affected during the previous season.

- Under favourable conditions infection starts at the place where the leaves come in contact with branches which harbour the sclerotia.

Spread of disease : Primary spread of the fungus is mostly by contact from leaf & bush to bush through vegetative mycelium.

- Affected leaves get detached & carried by wind to other plants & cause further infection.
- Secondary spread through the basidiospores either by wind or rain dispersal.

Collateral hosts : This fungus not only affects several plant species generally occurring in the forest but also a few economically important horticultural crops such as orange, pear, fig etc. Control

Black rot is effectively controlled by combining physical, cultural methods. The present control measure & spray schedules for effective management of the disease are as follows:

Cultural management : Maintenance of good drainage, free circulation of air & sunlight

- Thinning of the overhead shade in the black rot endemic blocks before the onset of the monsoon.
- Centering & handling of the bushes by removing criss-cross branches, dead & dry branches, suckers & dried leaves of the shade trees fallen on the canopy of the bush before imposing pre monsoon spray.
- Removal & destruction of the affected leaves & berries along with the mycelial thread in the initial stage under wet conditions.

Chemical control: Adequate coverage of Bordeaux mixture 1.0% on both surfaces of leaves & also to the developing berries just before the onset of monsoon & during the break in monsoon.

Several systematic & prophylactic fungicides were tested, among them carbendazim, carboxyl & captafol were found effective.

3. PINK DISEASE

This disease occurs on the branches.

Symptoms: Affected branches show a pink encrustation, hence the name pink disease.

- On the brown wood of infected branch longitudinal cracks develop through which pinkish encrustation bursts.
- In advanced stage, entire branch may show a pinkish encrustation.
- Cobweb like mycelia strands are seen on affected branches.
- Infected branches lose their leaves & die.

Favourable factors : Continuous monsoon, relative humidity near saturation & thick overhead shade are the favourable factors for the disease development.

Causal organism, taxonomy

The causal organism of pink disease ***Corticium salmonicolor*** B. Br. is classified under

Class- Basidiomycotina, Order- Polyporales & Family- Thelephoraceae.

Control: In endemic areas, maintain thin overhead shade bush sanitation by removing shade trees leaf litter on bushes,

- Adopt proper handling and centering of bushes and provide proper drainage to minimize build up of humidity
- Spray 1.0 % Bordeaux mixture before the onset of south-west monsoon
- If disease is noticed, remove the diseased leaves and berries and bury them and Spray Bavistin 0.03 % a.i. (120 g/ 200 l water) during break in monsoon.

4. ANTHRACNOSE:- *Colletotricum gloeosporioides*

This disease affects leaves, twigs as well as berries. Anthracnose of coffee caused by ***Colletotricum gloeosporioides***, Is a bark inhabiting fungus which is generally a weak pathogen but under certain conditions of the host & the environment becomes virulent. Causal organism, taxonomy

The causal organism is classified under the

Class- Deuteromycotina, Order- Melancoloniales, Family- Melanconiaceae.

The fungus causes three different diseases of coffee viz., twig die back, stalk rot of berries & leaves & brown blight of leaves.

a. Twig die-back or summer die-back

This disease occurs during dry weather from Oct-May & reaches its peak level after blossom showers.

Symptoms

- Yellowing or blighting of any leaf on the green wood.
- Yellowing, necrosis of nodes & internodes towards the tip.
- Twig wilts & defoliates, dies forward towards the apex & depicts a die-back appearance.
- Floral buds on the infected branches fail to open.
- Affected plants put on new vegetative growth on the primaries & secondaries near the main stem takes place.
- Affected plants in the exposed area bear the new leaves which are small, crinkled, chlorotic, thick, thick & leathery.
- Internodes are short & give a fan shape appearance.

Favorable factors

- Debility of twigs or branches due to defoliation caused by heavy incidence of leaf rust,
- Crop strain, inadequate over head shade, prolonged drought & soil moisture stress were the pre disposing factors for the disease development.
- The fungus invades the debilitated branches under the influence of low temperature, mist or dew during night & early hours.
- Control
- Pruning of badly affected plants during Feb-Mar.
- Maintaining adequate overhead shade to protect the bush from sun scalding & mulching of leaf litter around the plants for conserving soil moisture during dry weather.
- Application of balanced nutrients to maintain vigour of the plants.
- Protect the plants by spraying 0.5% Bordeaux mixture in Feb-Mar(Pre-blossom), Apr-May (Pre-monsoon) & Sep-Oct (Post-monsoon).

b. Stalk rot of berries & leaves

Stalk rot of berries & leaves are generally noticed on Arabica & also on robusta coffee during Jul-Aug under the heavy pour of South-Western monsoon conditions.

Symptoms

- Necrosis of nodes & internodes from the junction of brown & green wood top wards the apex followed by berry drop & defoliation.
- Berries & leaves drop down due to necrosis & decay of the stalk portion. Generally, the rotting stalk remains on the branch while berries are shed.
- One or two nodes from the tip of the affected branches may show total berry drop.
- Even if some berries remain, they show premature ripening towards the end of Sep or Oct & remain as lights during crop harvest.

Favourable factors

1. Low temperature, relative humidity (95-100%), surface wetness of plants due to rain or mist, Wounds on the stalk of berries & leaves & excess soil moisture during monsoon are the most favourable factors for the disease development.

Control: 1. Provide good drainage by cleaning trenches & cradle pits to remove excess water around root zone.

2. Maintain thin overhead shade.

3. Removal of mulch to expose the soil around the plants

4. Pre-monsoon spraying of Bordeaux mixture 0.5% in May-June giving a good coverage of branches & stalk of the berries.

c. Brown blight of leaves

This disease is generally seen on leaves during the hot weather. Injury caused by sun scalding or any other type of wounds on leaves predispose them for infection by ***Colletotricum gloeosporioides***.

Symptoms: Round necrotic spots measuring up to 25 mm in diameter appear on leaves.

- Two or more such spots may coalesce & the entire or a portion of it may look blighted.
- Necrotic spots are brown in colour hence the name brown blight.
- Fructifications of the fungus are as black dots on the spots on upper or lower surface of leaf.

Control: Maintain good overhead shade to avoid sun scalding of leaves.

- Spraying 0.5% Bordeaux mixture to protect the leaves from the rust fungus appears to give adequate protection against brown blight also.

5. ROOT DISEASES

There are four types of root diseases affecting coffee viz., brown root disease, red root disease, black root disease & santavery root disease. Brown, red & black root disease are observed both on **Arabica** & **Robusta**, while santavery root disease is noticed only on Arabica.

a. Brown root disease

This disease also known as stump rot & is mostly associated with the rotting stumps of shade trees. Disease spreads to neighboring plants by means of root contact of infected stumps or plants. The causal organism of brown root disease ***Fomes noxius*** Corner has been classified under
Class-Basidiomycotina, Order-Polyporales Family- Polyporacea.

Symptoms: Affected plants show gradual yellowing of leaves, defoliation followed by death of the entire plant.

- Stem near the ground level becomes spongy & soft. Root system shows development of thick brown encrustation adhered with small stones.
- The brown fungal encrustation gives the name brown root disease.
- Interior of the roots show dark brown to black wavy lines.

Collateral hosts : The pathogen also reported on shade tree like dadap & silver oak, apart from infecting commercially important plantation crops such as citrus, tea, cocoa, nutmeg, oil palm & rubber.

b. **Red root disease**

The causal organism of red root disease ***Poria hypolateritia*** Berk has been classified under
Class- Basidiomycotina, Order- Polyporales Family- Polyporaceae.

Symptoms : Gradual yellowing of leaves, defoliation followed by death of the above ground parts are the aerial symptoms which are identical as described under brown disease.

- Root system of dying or dead plants show red encrustation covered with soil & gravel adhering to it.
- The red encrustation is nothing but the fungal rhizomorph.
- The affected root appears deep red in colour when washed in water which is a good diagnostic symptom of this disease.

c. Black root disease

The causal organism of black root disease ***Rosellinia bunodes*** (B. & Br.) Sacc & ***Rosellinia arcuta*** Petch has been classified under
Class- Ascomycotina, Order- Sphaeriales Family- Xylariaceae.

Though the disease has been reported on coffee, its spread & severity is limited unlike the brown & red root disease.

Symptoms: Aerial symptoms are almost same as described under brown root disease. On affected roots, black fungal rhiozomorph or black woolly mycelium are seen. In transverse section, thread like black lines or dots can be clearly seen.

- On the stem near the ground level fan shaped black fungal mat with pellet like fructification are also seen.

Management of brown, red & black root diseases.

- Isolate the affected plants & one row of apparently healthy adjoining plants with 60cm deep & 30cm wide trench. The soil from the trench should be thrown into affected area & not to the outside.
- Uproot the affected coffee plants along with the root system & burn.
- Add agricultural lime @ 1-2 kg per pit uprooting the plants & fallow the land for 6 months before planting.
- Whenever a shade tree is felled, it is advisable to uproot the stumps as far as possible to avoid the brown root disease in future.
- Drench the soil with carbendazim 50 WP @ 0.4%/plant in the initial stage of the disease during pre & post monsoon period.
- Application of well composted organic manure @ 10-15 kg per plant would also help in suppression of pathogens.

- To trackle the spread of red & brown root disease, biocontrol approaches has been initiated using Trichoderma.
- Soil application of 3-5 kg of the mixture of bioagent *Trichoderma* in compost to the affected coffee plants in drip cycle during Sept-Oct & May-Jun in a year is found effective.

d. Santavery root disease

The causal organism of disease is ***Fusarium oxysporum*** has been classified under
Class- Deuteromycotina, Order- Moniliales, Family- Tuberculaiaceae.

Symptoms: Sudden wilting yellowing of leaves followed by defoliation & death of aerial parts.

- Roots show in transverse section, brown to pinkish discoloration of the inner portion. Scrapping the bark of the stem near the ground level shows internal discoloration.

Favourable factors: Low or high soil temperature, poor physical conditions of soil, moisture stress, inadequate shade & wounds on the roots are the predisposing factors for disease development.

Management

- Uproot the dead & dying plants & destroy.
- Treat the affected blocks with compost manure @ 10-15 kg per plant to improve the soil fertility.
- Drench the soil with carbendazim @ 0.1% or carboxin @ 0.3% /plant in the initial stage of the disease.
- Maintain adequate overhead shade.
- Apply balanced nutrients & follow good cultural operations to maintain the vigour of the plants.
- Lime the soil to raise the soil pH if it is highly acidic.

6. BERRY BLOTCH

Berry spot & cherry are the other names for this disease. This disease is confined only to the berries & has been noticed in all the coffee tracts of south India. The disease become serious when the developing berries are exposed to sun from Aug-Nov. the diseased tissue of the skin becomes dry & hard & sticks fast to the parchment & such fruits are difficult to pulpy properly, thus lowering the quality considerably.

The causal organism ***Cercospora coffeicola*** B. & Cke. is classified under
Class- Deutromycotina, Order- Moniliales Family- Dematiaceae.

Symptoms: Dark brown, irregular, slightly sunken necrotic spot on the exposed surface of the green berries.

- Necrotic spots enlarge in size & cover a major portion of berry surface.
- Skin of the affected berries show a purple halo around the necrotic spots.
- Affected tissue turns brown to black, shrivels, dries up & sticks fast to the parchment.

Favourable factors: Exposure of the developing berries to sun without adequate over head shade, hot humid conditions are the main predisposing factors for disease development.

Control: Maintain good overhead shade to avoid sun scorching of berries.

- Spray the developing berries in the endemic blocks with 1.0% Bordeaux mixture when the incidence is just noticed.

7. FUSARIUM BARK DISEASE

It is important in South East Asia, Southern Africa & West Indies.

Symptoms: The pathogen infects the collar region of the stem & produce bark & canker. Bark scaling is the most common but least damaging symptom.

- The fungus grows beneath the bark layer, which becomes flaxy in texture.
- Cankers are then produced which can girdle the trunk & kill the tree.
- Damage is also caused due to young suckers where a necrotic brown lesion develops at the base, usually close to the junction with the main stem.
- The sucker may be killed or survive to have a constricted 'bottle neck' appearance at the base, which leaves the new stem weakened & liable to break as soon as a heavy crop is carried.

FUNGUS: *Fusarium stilboides (*syn. ***Gibberala stilboides)***

Mode of spread & survival:

- The fungus is common inhabitant of coffee stem surfaces & survives saprophytic ally on dead coffee debris.
- It may also infect damaged coffee berries as a secondary invader.
- The pathogenic phase only occurs when the coffee is stressed by wounding or by climatic

conditions.

Epidemiology: Insect damage may initiate attacks. Unfavourable cultural conditions such as poor soil management, irregular pruning & drought predispose the plant to infection.

Management: Good soil management with adequate & timely mulching to conserve moisture in the top layers of the soil, proper pruning practices, improving to soil fertility, etc. reduce the infection.

- The protection of stem bases with Captan or captafol 0.4% a.i applied to trunk bases at pruning & while young suckers are maturing is also recommended.
- Pruning or other wounds should be protected with a fungicidal paint. Badly diseased trees should be destroyed.

8. **NURSERY DISEASES**

Coffee is mainly propagated through seeds. Seedlings are raised in two stages under pandel shade.

The seedlings in the nursery are affected by the following diseases.

a. Collar rot: Collar rot or Damping off disease occurs on seedlings of 1-3 months age in the nursery if the conditions are suitable for the growth of the fungus. Under favourable conditions seedling loss may go up to 10-20% depending upon the severity of the infection. Both the commercially important cultivars of coffee are susceptible to this pathogen.

The causal agent of collar rot fungus is reported to be soil inhabitant & is prevalent in all the coffee growing areas of India. The pathogen ***Rhizoctonia solani*** Kuhn. Is placed under

Class- Deuteromycotina, Order- Myceliasterilia.

Symptoms : The pathogen attacks both seeds & seedlings in the following two stages.

Pre-emergence damping off: Embryo & endosperm are invaded by the fungus before germination & the radical during germination.

On account of this, seeds rot & disintegrate.

Post-emergence damping off: Seedlings show brownish discoloration on the stem near the ground level leading to rotting of the tissue. Growing apex wilts & the seedlings collapse & die.

Favourable factors: Impeded drainage in the nursery beds resulting in excessive soil moisture, thick overhead pandel, hot & humid weather, over crowding of seedlings create a faulty environment to seedling growth & pre-dispose them for infection by the fungus.

Control: Expose the nursery soil to the sun for 2-3 months.

- Prepare raised seed beds adding jungle soil, compost & sand to drain off the excess moisture in the bed.
- Avoid excessive watering.
- Avoid over-crowding of seedlings by proper spacing of seeds while sowing.
- Provide filtered overhead shade using coir mats.
- Treat coffee seeds with carbendazim @ 2 g per kg.

b. Brown-eye-spot

Disease was reported from all the known coffee growing countries. Mostly the seedlings in the nursery & young plants in the new clearings suffer to a large extent when proper over head shade is lacking.

C.O: ***Cercospora coffeicola*** Botrytis & Cke.

Symptoms: Leaves show circular necrotic spots with a dark brown margin & light brown or pale centre.

- Necrotic spots increase in size, the central portion turns light grey due to sporulation by the fungus & collapses leaving a hole at the centre.
- Affected leaves turn yellow & pre-mature defoliation of such leaves takes place.

Favourable factors: Inadequate overhead shade in the new clearing, sudden exposure of the seedlings to bright sun shine due to removal of nursery pandal shade,

- Hot humid conditions during Apr-June & Sep-Nov are the predisposing factors for the disease development.

Collateral hosts & mode of survival

- The pathogen survives in the soil on the fallen debris as long has 35 weeks.
- It was also observed that *Bidens pilosa*, *Chenopodium ambrosoides* & *Ricinus communis* the commonly occurring weeds in coffee plantations serves as collateral hosts for this pathogen.

Control: 1. In the nursery grow plants under pandal shade to avoid exposure to sun light.

2. Provide adequate mulch to conserve soil moisture for the young plants in the new clearings.
3. Spray Captan @ 0.2% once in 30 days interval.
4. In the new clearings maintain good overhead shade & spray 1.0% Bordeaux mixture.

9. DISEASES OF MINOR IMPORTANCE

a. Grey blight of leaves

C.O: ***Pestalotiopsis clavispora***

Symptoms: Brown or grey necrotic spots up-to 1-2 cm in diameter on mature leaves. These spots enlarge & coalesce later & the leaves appear brown or grey.

- Black fructification on both sides of leaves in concentric rings is irregularly distributed on necrotic spots.

b. Black leaf

C.O: ***Cylindrocladium illicicola***

Symptoms: Small circular water soaked necrotic black spots on the leaf blade mostly on the margin of upper or lower surface.

- Spots enlarge in size & the entire leaf or half of it turns black & rot hence the name black leaf.
- Affected leaves drop down.

c. Target leaf spot

C.O: ***Myrothecium advena***

Symptoms: On leaves brown circular or irregular necrotic spots are formed.

- Concentric zonation visible on the upper surface of the leaves gives a characteristic target board appearance, hence the name target leaf spot.
- Severe infection may lead to defoliation.
- Mostly leaves near or touching the soil are affected.

d. Tip burn

C.O; ***Myrothecium roridum***

Symptoms: In nursery 5-6 months old plants show infection of first internode & also tip pair of leaves.

- The symptoms observed are water soaked brown to grey discolouration of the internodes from the tip followed by defoliation & death similar to that of die-back.
- On necrotic tissue cushion shaped fructifications with shiny black centre & white margins were observed.

e. Sclerotium disease

C.O: ***Sclerotium coffeicola***

Symptoms: Small circular necrotic spots on leaves.

- These spots gradually increase in size up to 25mm in diameter & show concentric rings of light & dark brown shades.
- Rhizomorphs of the fungus are seen on the necrotic spots.
- Mustard like sclerotia are formed on the necrotic spots.

f. Coffee blight

C.O; ***Phoma costarricensis***

- The disease affecting leaves of Coffee arabica was noticed in Karnataka.
- Severity of the disease leads to heavy defoliation.
- Wet weather, high humidity, low temperature & wounds caused by the insects under field condition are favourable for development of disease.
- Defoliation noticed was up to 30-35% & was seen at higher elevations.
- Young & mature leaves get affected.
- The disease appears to extend up to the tip portion of the tender twig also, when all the leaves on a tender branch get affected.

g. Sooty mould

C.O: ***Capnodium braziliense*** puttom.

- Sooty mould of coffee is seen whenever there is heavy attack of aphids & scale insects.
- The fungus feeds on the excreta and secretions of the insects & indirectly prevents the normal leaf functions.
- The leaves & shoots are covered with black sooty fungal growth, affecting the photosynthetic

activity of the plants. It is ectopytic and not a pathogen.

Control: By controlling the insects. Spray any systemic insecticides to prevent insects and will prevent the sooty mould.

- To avoid the fungus, spraying with 1kg fish oil resin soap + 1kg starch in 200 litres of water is recommended.
- The mouldy growth peels off when the starch dries.

10. FLOWERING PARASITES

Some flowering plants grow as parasites on coffee plants. Occurrences of such parasites are not of common observation in plantations.

a. shoot parasite

Cuscuta reflexa (dodder) or strange vine is generally observed on coffee plants either in nursery or in the estate near the fence hedge, if the latter is not kept free of this parasite.

- Dense strand of leafless yellow vines twining the plants.
- During dry weather from Nov-Jan they produce white flowers & form seeds.
- Primary infection comes from seeds & secondary spread from the neighbouring infected plants.
- This parasite gradually weakens coffee plants as it draws nourishment through haustoria & as a result host vigour is lost.

Control: 1. Clean removal of the parasite from the infected coffee plants & burning assures good control. While removing the parasite, care should be taken not to leave the piece of vine or its haustoria on the plant as they will continue to grow again.

2. Fence hedge & the neighbouring plants should be kept free of this parasite to check the secondary spread.

b. Root parasite

Balanophora indica, the root parasite belongs to the family Balanophoraceae, & occurs on roots of coffee growing at higher elevations above 1000 m MSL. Affected plants gradually decline in their vigour.

- The parasite occurs in the form of root stock composed of tuberous out growths on the lateral roots of coffee plants during the South-west monsoon.
- In the early stages of development the tubers are small round bodies hidden inside the soil.
- Flower heads begin to appear by about November.
- The affected coffee bushes do not show clear cut symptoms of attack externally except for general unhealthy appearance & low productivity.

Control: Collect the tubers by digging the soil. All tubers should be collected before flowering & destroyed.

11. STEM WASTING DISORDER (KONDLI)

This is a non-parasitic disorder resulting from the toxicity of copper fungicides sprayed on young coffee plants in the nursery during the inclement monsoon weather from May-Sep.

Symptoms: On 6-8 months old plants symptoms become apparent from Aug-Oct. affected plants show a constriction at the first or second node from the base.

- The stem portion above the constriction becomes swollen with gradual thinning of the stem below the constriction.
- The tip pair of leaves of the affected plants show copper bronze or pale yellow coloration.
- The plants become lean & lanky.
- The easily snap off at the constriction.

Management

- Strictly avoid spraying copper based fungicides in the nursery.
- To protect the plants in the nursery from diseases, spray organic fungicides like Captan, Dithane, and Foltaf etc.

12. **Nematodes (*Pratylenchus coffeae)***

Symptoms:-Affected young plants are lean and lanky.

- Older leaves become yellow and drop, leaving very few undersized, chlorotic and crinkled leaves at the tip of the stem giving a 'tufted' appearance.
- Affected bearing plants show thinner stem and have in adequate foliage to support the crop.

Control: In nursery digs and expose the soil for one summer and thoroughly dry the jungle soil

while preparing nursery mixture.

- In the main filed, uproot and burn the affected plants, dig the affected soil and expose for one year.
- Take care to keep the pits free from weeds- Plant the affected area grafted plants of Arabica on Robusta rootstock.

TEA (*Camellia sinesis*)

INTRODUCTION

Genus: camellia

Family: camellia

Tea is an ancient, cultivated plant. It is used as a beverage in south India and china. A native of south east Asia . Tea was first planted on a large scale in north India in 1834,while south India Dr.Christy experimented at Nilgiris in 1832 and commercial tea planting was started at various tea growing region like Nilgiris 1859, Kannan Devan hills 1878.

Tea research was started in north India during 1960 and in south India 1926.

In India, tea cultivation is localized in the eastern corner of Assam, Eastern Bengal and Southern extremities of western ghats. The plantation in the south are distributed in the states of Tamil Nadu, Kerala and Karnataka. India is the largest producer, consumer and exporter.

S.No.	**Major Disease**		**Pathogen**
1	**Root rot diseases**		
	a. Brown root rot disease		*Fomes lamoensis*
	b. Black root rot disease		*Rosellinia arcuata*
	c. Red root rot		*Poria hypolateritia*
	d. Armillariella root rot		*Armiilartella mellea*
	e. Inter root disease		*Botryodiplodia theobromae*
2	Blister blight		*Exobasidiun vexans*
3	Grey blight		*Pestalotia theae*
4	Black rot		*Corticium invasum, C.theae*
5	Red rust		*Cephaleuros mycoidea*
	Minor diseases		
1	Pink disease		*Pellicularia salmonicolor*
2	Sooty mould		*Capnodium* sp.
3	Leaf spot		*Cercospora theae*
4	Branch canker		*Macrophoma theicola*
5	Thread blight		*Pellicularia koleroga*
6	Stump rot		*Ustulina zonata*

1. Root rot diseases

a. Brown root disease: *Fomes lamaoensis* (Murrill) Sacc. & Trott.

- The disease arises from the decaying slumps of jungle and shade trees that have been cut and left in the soil It is widely distributed in the tropics occurring in Java, Malaysia, Sri Lanka, Sumatra, East and West Africa.
- It also attacks a number of other trees like bread fruit, cacao, coffee, rubber, etc.
- The roots of the tea bush are encrusted with a mass of earth and small stones cemented to the root by the mycelium. When aged, the mycelium acquire a black covering, sometimes with a brown powdery outer layer.
- Between the bark and the wood, there is usually a thin layer of white or brownish mycelium.
- The fructification is rarely on cultivated plants killed by this fungus.
- The disease spreads through root contacts.
- This is a faster killer than stump rot and is more common on sandy soils than clayey soils.

b. Black root disease: *Rosellinia arcuata* Fetch.

- It is a common disease of tea and occurs in India and Sri Lanka.
- This fungus is believed to originate usually in heaps of dead leaves and found in the top 5.0 to 7.5 cm of the soil especially where there is mere of dead leaves.
- It spreads rapidly in the form of strands attacking the roots of several other plants besides tea. The black strands closely adhere to the roots as loose cob-webby mass.
- These enter the bark and spread out into star- like sheets of white mycelium and easily seen after peeling the bark from the larger roots.
- The attack usually begins at the collar region. In older tea bushes it soon forms black strands closely applied to the root.

- The mycelium penetrates inside and ramifies between the bark and wood. At each point of entry it divides into number of strands which radiate over the surface of the wood and form s a white star upto 1.0 cm in dia.
- This has two kinds of fructifications, a conidial stage and a perithecal stage.
- Spread to other parts of the field are brought about by the distribution of conidia by the wind. The mycelium surrounds the stems at the surface of the soil and kills bark all round for a length of 7.5 to 10.0 cm.
- Consequently, a swollen ring of tissue is formed round the stem above the dead patch and similar ring below the latter.
- The conidia are borne on short bristle-like stalks.
- The perithecia are black, Spherical bodies about 0.5 to 1.0 mm in dia. They bear asci which in turn bear ascospores.
- The disease is spread by wind.

c. Red root rot: *Poria hypolateritia* Berk.

- It occurs in India, Malaysia and Sri Lanka.
- In India it is noticed in Assam and Tamil Nadu.
- The fungus is confined to the underground parts. When the bark is lifted characteristic, flat, black rhizomorphs ars exposed
- These strands form branched markings on the surface of the wood.
- The strands vary in colour when fresh pink to brown or black according to age.
- The root has generally a mottled appearance of red and white.
- Plants of one to two years old are killed more rapidly than older bushes^ The mycelium extends throughout the cortex and wood and may advance some distance up the stem within the wood.
- The bark is oftened and the wood may be discoloured as bluish black.
- On the bark at the colour region the conidial.
- Stage appears in the form of reddish tufts.
- The conidia are of two types, thin and thick walled.
- At a later stage perithecia appear on the bark.
- They are small, dark red bodies, rounded below and drawn into a short conical neck above. Each contains numerous asci without paraphyses.
- The asci are cyclindrical with a short stalk. They contain eight ascospores.
- The fungus lives as a saprophyte or pieces of fallen woo i of several trees.
- It spreads mostly by the rhizomorphs present in soil.
- The spores are distributed by wind

d. Armillariella root rot: *Armillariella mellea*.

- It occurs in all temperate areas but is limited to Africa and Asia in the tropics where it is more predominant in mountain areas, but it is does occur in lowland areas in Central and West Africa.
- Usually the disease becomes apparent after it has severely damaged the root systems of bushes when the foliage begins to wilt, turns chlorotic and falls, 'Death of the whole plant then follows.'
- As the parasite spreads up the roots and reaches the collar region of the plant, the bark often beneath the bark often cracks.
- Sheets of creamy coloured mycelium occur beneath the bark accompanied by flattened brown rhizomorphs.
- Rhizomorphs are also found on the outside of roots where they often grow epiphytotically in advance of infection.
- The characteristic sporophores are usually produced on the collar region of the host in advanced stages of the diseases? They occur in clumps, are pale brown and mushroom -shaped.
- Old tree stumps large root pieces or other woody material that has been colonized by the fungus provide the main sources from which The pathogen invades tea bushes or other,, perennial crops Rhizomorphs can grow through the soil to reach potential hosts Basidiospores from the sporophore are able to initiate saprophytic growth which can colonise wood.

e. **Inter root disease: *Botryodiplodia theobromae* Pat.**

- The disease usually appear from six weeks to three months after pruning.
- The roots of a dead bush does not bear any external mycelium.
- In some cases the bark is rough and abnormally thickened.
- The mycelium runs within the cells of the plant. The fructifications of the fungus are minute, black, spherical bodies which are embedded in the bark.
- They are not visible from the exterior. If the bark is slightly shaved, the spheres are cut across, black circles with a white centre may be seen.
- The fungus enters through the fine rootlets and the fungus attacks the tap root also. Soil fumigation is the best method to control, though expense.
- It is the most suited method to arrest further spread of the disease in young and high yielding mature tea bushes.
- Replanting can be done after 12 weeks as against 24 months of rehabilitation following uprooting of the dead and suspected plants.
- Vapam and metham sodium may be applied into an apparently healthy ring of bushes, 20 to 25 cm away from the collar region of the living plant to avoid phytotoxicity. Dueofume C.P. (methyl bromide + ethylene dibromide 1:1) which is supplied in 450 g ca. s is enough to fumigate 526 sq.feet.
- Isolation drenches 120 cm deep and 45 cm wide may be dug around the infected bushes to isolate them and to prevent the spread of disease.
- Lime should be added in the affected patch and also in the trench.
- The shade trees should be pruned to permit more sunlight. Digging up of dead and infected stumps and bushes and burning them reduce the spread.
- Adequate manuring should be done to keep the bushes in vigorous conditions.
- The dieback branches after pruning may be sprayed with Bordeaux mixture 1.0 per cent to prevent infection.

2. Blister blight

This disease was first reported from Assam in 1868, spreading since then to most other tea growing areas of North and South India.

It also occurs in Burma, Indonesia, Japan, Malaya, Sri Lanka and Taiwan. Since 1946 it has become severe year after year ir? most tea gardens of South India, causing heavy damage to the industry.

The succulent growth of the plants developing after pruning is highly susceptible to infection.

Temperatures above 24°C are fatal to the blisterance and disappearance of this disease.

Symptoms:

1. The first symptom is the appearance of small pale or pinkish spots on the leaves.
2. These spots are round from the very beginning and in due course enlarge in size upto about an inch in diameter.
3. Youn g shoots are very much affected.
4. On the upper surface of the leaf, the spot becomes light green in colour and depressed into a shallow cavity while the under side bulges correspondingly forming a blister like swelling. The lower bulged surface is covered by white growth of the fungus.
5. In later stages the blister turns dark brown and shrinks to flattened patch.
6. Old leaves of four weeks and above are immune and only young leaves are circular shape but becomes elongated along the midrib.
7. When many blisters occur near the margin or apex and coalesce, much distortion and curling of the leaf may be caused.
8. The infection passes on to petiole and young succulent stem which results in serious damage. On the stem, spots without blisters are formed.
9. The fungus eventually penetrates and damages the stem.
10. The leaves, and buds above the point of attack wilt end to wither.
11. The leaf yield may be reduced and the vitality of the tea bush is affected finally.
12. It is probable that under severe attack, the bush may be permanently injured and the growth impaired.

Fungus: *Exobasidium vexans* Massee.

1.The mycelium is confined to the blistered areas on the leaves.
2.They are septate and collect in bundles below the lower epidermis.
3.Later by rupturing the epidermis a continuous layer of vertical hyphae are projected on the surface of spot.
4.The fungus produces two kinds of spores viz., the conidia and basidiospores.
5.The conidia are most abundant, borne singly at the tips of long stalks.
6.They are hyaline, elliptical, straight or slightly curved and measure 12 to 21 x 4.5 to 6 ^ra. Basidia are formed on the surface in larger number but never form a continuous hytneniurn. They are intermingled with 'conidial stalks and sterile fairs.
7.Each basidium is long, club shaped with usually two short sterigmata at the end , each bearing a basidiospore.
8.The basidia are ovate to oblong, hyaline and 30 to 90 x 2.3 to 4.5Mm.

Mode of spread and survival:

1.The fungus completes its life cycle in 11 to 28 days and several generations of spores are produced in a season.
2.It produces conidia and basidiospores in the same blister.
3.Spores are air-borne.
4.The perpetuation of the fungus appears to be from the pre-existing infected bushes.
5.No dormant or resting stage is known.

Epidemiology:

1. Relative humidity plays an important role in the epidemics of blister blight.
2. If the relative humidity is below 80 per cent for 5 days, the rate of infection decreases.
3. If it is above 83 per cent for 7 to
4. 10 days, the infection is moderate to serious.
5. The disease is favoured by cool day and nights , with wet or humid conditions.
6. More severe outbreaks occur under shade or adjacent to jungle or v/ind breaks or in damp low lying areas where mist persists.
7. The succulent growth of the plants developing after pruning is highly susceptible to infection. Temperatures above 24 °C are fatal to the blister blight disease, a fact which account for the periodical appearance and disappearance of this disease.
8. Cool, moist, relatively still air favours infection.
9. Moist and shade are therefore conducive to the development of severe attacks.

Management:

1. Removal of affected leaves and shoots by pruning aim destruction of the same have been recommended.
2. Spraying the bushes with Bordeaux mixture or copper oxychloride is found to be effective. Copper fungicides have been widely used often in combination with nickel salts which have a slight eradicant effect.
3. A mixture of 210 g of copper oxychloride + 210 g of nickel chloride per ha sprayed at 5 days interval from June to September and 11 days intervals in Oct-Nov gives economic control.
4. Spraying the bushes with 420 g of copper oxychloride and 27 g of Agrimycin 100 per hectare gives better control over the disease, compared to the treatment with copper oxychloride alone at the same dosage.
5. Among the organic fungicides, chlorothalonil gives protectant and therapeutic effect. Triademorph, Mancozeb, Baycor, Bayleton and Pyracarbolid offer good disease control.
6. Disease control achieved with triademorph at 340 and 560 ml /ha is satisfactory under mild and moderate rainfall conditions.
7. Spraying schedule can be regulated according to weather conditions.
8. Dry leaves are less prone to infection than damp ones and exposure to the sun for only one hour at a temperature of 29.5 °C is lethal.
9. The formula recommended is that spraying can be suspended until the average daily hour of sunshine for the previous five days has dropped below 3 3/4 h.

10. Spraying with the systemic fungicide, (Atemi 50 SL) at 400 ml/ha or bitertanol 300 EC (Baycor 300 EC) at 340 ml/ha at weekly intervals controls the blister blight effectively.

3. Grey blight

It occurs in North and South India. In South India it occurs in Karnataka, Kerala and TamilNadu. Apart from India it has been reported from Java and Sri Lanka.

Symptoms:

1.The disease appears as minute brownish spots on older leaves which soon turn grey.

2.The "spots are mostly irregular and several of them may coalesce to form irregular grey patches. The spots have fine concentric lines.

3.Fructifications of the fungus appear as black dots in older spots on the upper surface.

4.The fungus infects plucking points and causes die-back. Generally grey blight attacks older leaves of the tea plant.

5.If young leaf is affected, the leaves are blackened and frequently the attack takes place even before the leaf is unfolded.

6.It sometimes attacks the ends of plucked shoot and kills them back for a short distance and repetition of this process have been known to result in the production of a bush of dead shoots.

Fungus: *Pestalotia theae* Sawada

Mode of spread and survival: The conidia wind borne

Epidemiology:

The incidence is more frequent on wet bushes especially if potassium is deficient.

The infection is also predisposed by sun scorch, insect puncture and plucking wounds.

Management:

Copper oxychloride 0.3% or Bordeaux mixture 1.0 per cent may be sprayed twice, once in cold weather and again in April or May to check the disease,

4. Black rot

Symptoms :

Small dark brown irregular spots appear on leaf| They coalesce to produce a dark brown patch which eventually covers the whole leaf and drop off| Before the leaf turns black the lower surface assumes a white powdery appearance.

Fungi : *Corticium invasum* Fetch and *C. theae* Bernard

Mode of spread and survival: Basidiospores carried by workers.

The disease develops rapidly when temperature is high and air is humid.

At the beginning of rainfall they germinate and produce which start fresh infection.

Epidemiology: Occur in nursery shaded with Crotalaria,'Bosidiospores germinate only in wet weather or when leaves are covered with dew.

Management:

Prune in December end, remove the prunings immediately, burn after drying.

Collect all dead and dried leaves. Spray a copper fungicide in third week of April.

5. Red rust

1.The trivival name of this disease is a misnomer.

2.The cell contents of the genus, *Cephaleuros* are orange red, hence the misapplication of the name rust.

3.The disease is widespread and important in India, Sri Lanka, Africa and America.

4.It attacks all kinds of tea both young and old when vitality is impaired.

5.It is occurring on tea in many parts of India.

Symptoms:

- On the leaves the alga may sometimes exist as parasitic or sometimes epiphytic while in the stem it is normally parasitic producing cankers and killing the tissues.
- The leaf infection can be seen throughout the year in an acute condition while the stem infection escapes except at certain periods.
- The leaf infection of red rust does little damage but it is important in that it serves as a source of stem infection.
- The alga occurs as orange yellow, roughly ciruclar patches on the upper surface of the leaf. The patches may "be few or numerous, crowded or scattered and may occupy any part of the leaf. They are rare on the petiole.

- Under favourable conditions the alga penetrates the leaf tissues
- The penetrating filaments may extend laterally between epidermis and adjacent layers and also downwards between palisade cells.
- The filaments never penetrate leaf cells but get nourishment by osmosis.
- The host cells in contact get killed and their contents turn brown and dry up Ultimately the alga itself ceases to grow, cells die and a crater-like depression is left surrounded by an elevated ring.
- On the stem the pathogen occurs as red hairy patches
- The new shoots arising from infected wood show lack of vigour or even cease to grow prematurely.
- As a result of infection the host bark is removed in successive layers and where this fails, the parasite penetrates deeper, into the cortex and may ultimately cause the death of the shoot.

Causal agent: *Ceplaleuros mycoidea* Karst, Red rust also attacks *Tephrosia* sp. and *Desmodium gyroides* grown as green manure and shade. ".

Epidemiology: Rainy season is best suited for propagation of alga. :

Management:

- The algal parasite may be tackled in two ways.
- The first one is achieved by the removal of all infected portions by spraying Bordeaux mixture.
- The other approach is by increasing the vigour of the bushes since it is considered that there is a direct connection between lack of vitality of the bush and the virulence of the disease.
- Improving the nutrient status of the soil by application of nitrogen, phosphorus and potassium fertilizers is important.
- Destruction of affected plant parts should be done.

6. Minor diseases

Pink disease: *Pellicularia salmonicolor* (Berk. & Br.) Dastur

1.A number of fine silky threads united into a thin film appear first on stem. It is found on leaves. Fungus forms pink fructifications over affected stems.
2.Young branches on the outside of the bush lose their leaves and die-back.
3.The pink concentrations crack into small fractions at right angles.
4.They are generally confined to lower side of branches. Bark killed in patches.
5.When the branch increase in thickness it grows only in areas where bark is to dead. So branch become irregularly swollen.Pink tissue become white when old.
6.Basidiospores are wind-borne.
7.The disease first appears on borders adjacent to jungles. Addition of potash promotes recovery. Very difficult to eradicate by removal of affected plants.

Sooty mould: *Capnodium sp*.

1. A black film of mould sometimes appear on stem or upper surface of leaves.
2. The film is superficial and its presence is usually related to the presence of scale insects.

Leaf spot/Bird's eye spot: *Cercospora theae* Van Breda.

1. This is a minor leaf disease causing the so called bird's eye spot on young leaves.
2. The spots are 3.5 mm in dia, brown in the centre and reddish or dark brown at the edge.
3. The disease has been reported to cause severe attack after heavy rains.

Branch canker: *Macrophoma theicola* Fetch is the causal agent.

1. This is a disease affecting stem and produces characteristic cankered appearance.
2. The disease appears during the early part of the monsoon as small, slightly sunken, oval patches on the bark of young bi inches.
3. These patches grow in the cambium, spreading rapidly between the bark and the wood.
4. The barsc above the affected cambium quickly dies, turning black and fall off.
5. The black patches of dead bark crumbles off and the unaffected white wood underneath is exposed.
6. In slight attacks, the affected patches are completely callused within a few months and after one or two only a sight scar remains.
7. During the attack, the pycnidia or small fruiting bodies are produced under the bark and these

may be covered over by callus.

8. Where the callus formation is incomplete, spores from these pycnidia may give rise to subsequent attacks.
9. Repeated attacks of stems result in encircling the stem and finally killing them out. Prolonged drought renders the bark susceptible to Macrophoma.

Thread blight: *Pellicularia koleroga* Cke.

1. Sterile white threads or strands pass along the branches and spread into a fine web like film on the under surface of the leaves.
2. This may cause browning and death of the leaf cells.

Stump rot / Charcoal rot: *Ustulinia zonata* (Lev.) Sac:.

1. It is prevalent in most of the tea growing areas.
2. It attacks cocoa, coffee, rubber and other woody plants.
3. The disease causes tea bushes to die in patches.
4. The diseased bushes dry as if suffering from drought.
5. The leaves wither, turn brown and drop off. Generally the bushes die gradually by becoming thin by the fal' of leaves and sometimes then dry up suddenly with leaves intact.
6. New shoots rarely arise from be-low once wilting sets in.
7. The disease spreads to the surrounding bushes in wide circles.
8. The roots do not show any external mycelium. Brownish or whitish mycelium with fan shaped fructifications can be seen when the bark is removed.

LECTURE 21: Diseases of cocoa,

Botanical name: *Theobroma cacao*
Family: Streculiaceae
Chromosome number: 2n=20
Native: Amazon valley of South America

Introduction:

It was introduced in India for commercial cultivation in early sixties. Cocoa variety of the forester group came into cultivation in historic times. It is a tree, hardy and vigorous and which is why they now form the greater part of all cocoa grown. It is a rich source of fat (37%) and protein (7%). It also produces theobromin. It is used in beverage industries. Cocoa is used in bakery for chocolate preparation, ice cream , biscuits etc.

DISEASES

S.No.	**Major Disease**		**Pathogen**
1	Seedling die - back		*Phytophthora palmivora*.
2	White thread blight		*Marasmius scandens*
3	Black pod disease		*Phytophthora palmivora*
4	Charcoal pod rot		*Botryodiplodia theobromae*
5	Witches broom		*Crinipellis pernicios*
	Minor diseases:		
1	Pink diseases		*Pelicularia salmonicolor*
2	Stem canker:		*Phytophthora palmivora*
3	Cherella rot		*Colletotrichum gloeosporioides*
4	Vascular streak		*Oncobasidium theobromae*.
5	Cacao swollen shoot virus		CSSV

Major diseases:

1) Seedling die –back

Causal organism: *Phytophthora palmivora* (Butler)

Seedling die back is severe on young seedlings during rain period. It has been observed in the cocoa nursery in Karnataka, Kerala & Tamilnadu.

Symptoms:

1.This disease is more severe on one month old cocoa seedlings although the disease is noticed in 1 to 4 month seedlings.
2.Infection may start from the tip of the stem or from the cotyledon stalk or from the collar region.
3.The disease appears as dark brown to black, water soaked, and linear lesions.
4.The lesions extend to leaves through the petiole resulting in wilting and subsequent defoliation of the seedlings.
5.Defoliations and die back of the seedlings are noticed during advanced stages of the disease.

Etiology: *Phytophthora palmivora*

- The mycelium is aseptate and 7 micro mm in diameter.
- Sporangiophores are simple or branched.
- Sporangia are inverted pear shaped terminal &.Zoospores is 8 to 10 micrometer.
- Oospores are spherical and measures 35 to 45 micrometer in diameters.
- Primary source of inoculum are oospores
- Secondary source are zoospores and sporangia

Epidemiology:

- Cool weather.
- Acidic ph
- Temperature of 18 to 25 degree

Management:

- All the infected seedlings in the nursery should be removed and destroyed.
- The disease can be controlled effectively by providing adequate drainage and soil drenching with Bordeaux mixture 1.0% or copper oxychloride 0.3%.
- A combination of seed dressing & soil drenching with coccid at a concentration of 0.91 kg in 45 litre of water effectively controls the pre and post emergence seedling death.

- Application of bio-agent *Trichoderma viridae* to soil along with FYM.

2) **White thread blight**:

Causal organism: *Marasmius scandens*

Symptoms:

- The young branches of the affected plants contain white mycelial threads of the fungus which spread longitudinally and irregularly along the surface of the stem.
- On the leaf lamina it spreads in the form of a much branched fine threads.
- The fungus invades the cortical tissues which eventually turn dark brown to black. The diseased leaves also turn dark brown.
- The dead leaves in a branch eventually get detatched from the stem but are found suspended by the mycelial thread in a row.
- The extensive death of the young branches & suspended leaves in rows are the common field symptoms of white thread blight.

Mode of spread & survival:

- The disease spread from plant to plant & to different branches of the same plant through the mycelium.
- The dead leaves with the mycelial mat can be easily carried by wind on to the leaves &stems of the healthy plants & initiate the disease.

Epidemiology:

- High humidity, less aeration and sunlight due to thick shade are the pre disposing factors for the occurrences of white thread blight disease.

Management:

- Damage can be reduced by removal of the dead materials & pruning of affected parts.
- Shade regulation & some structural pruning of branches are necessary to reduce the humidity in the canopy & the disease.
- Paste with coca at cut ends.
- Bio agent *Trichoderma viridae*

3) **Black pod disease:**

Causal organism: *Phytophthora palmivora* (Butler)

Symptoms:

- First sign of the disease is appearance of brown spot on the pod.
- The brown discolorations rapidly spread in all directions.
- The discoloration spreads over the whole pod.
- Internal tissues of diseased pods become brown.
- Infected beans become discoloured.

Mode of spread

- Primary source of inoculum is oospores.
- Secondary source of inoculums is zoospores and sporangia..

Mode of spread & survival:

The spread is by splashing rain, insects and rodents and by contact between healthy and diseased pods. Ants have been found to spread the disease.

Epidemiology

Closer spacing between trees , damp locality and cool damp weather favor the rapid spread of the disease.

Management:

- Avoid inter crop with areca
- Proper spacing
- Affected pods should be destroyed.
- Regular removal & destruction of infected pods at weekly intervals.
- Proper pruning of cocoa tree is also essential to minimize the shade.
- Spraying just before the onset of the monsoon with Bordeaux mixture @1% or coc 0.3% @ intervals of two weeks.
- Bio agent *Trichoderma viridae*

4) **Charcoal pod rot:**
Causal organism: *Botryodiplodia theobromae*
The disease is severe during summer months.
Symptoms
- The infection appears as dark brown to black spot on any place on the pod surface & spreads rapidly.
- The beans may not develop fully & get mummified.

Etiology:
Fungus: *Botryodiplodia theobromae*.
Pycnidia are upto 5mm in diametre.
Conidia are hyaline and thin walled, becoming thick walled, dark brown and one septum.
Management:
- Avoid intercrop with areca
- Proper spacing.
- Affected pods should be destroyed
- Sprayin g with Bordeaux mixture 1 % is recommended to control.
- Spray mancozeb 0.25%
- Proper pruning of cocoa tree is also essential to minimize the shade
- Bio agent *Trichoderma viridae*

5. **Witche's broom**
Causal organism: *Crinipellis perniciosa*.
Symptoms: more and more axillary bud production. Pale yellowing. Broom like appearance.
Mode of spread & survival: basidiospores which cause infection are released during night and spread through wind.
Management:
- Young blooms before the production of sporophore should be removed.
- Varieties like scavina-6 & hybrids of this variety are resistant.
- Avoid inter crop with areca
- Proper spacing

Minor diseases:
1) Pink disease:
Causal organism: *Pellicularia salmonicolor*
Symptoms:
The first visible symptom is the appearance of salmon pink encrustation of fruiting bodies of the fungus of the bark of the stem.
Etiology:
The mycelia of the fungus are hyaline, thin walled and sparsely septate, hyphae are 7-15micromtre in diameter, the asexual spore is hyaline.
Management
- Avoid inter crop with areca.
- Proper spacing.
- The disease is controlled by reducing over head shade, proper pruning to improve aeration inside the garden.
- Painting the cut ends with Bordeaux paste & regularly spraying the trees with Bordeaux mixture1% during rainy season.

2) **Stem canker**:
Causal organism: *Phytophthora palmivora*.
Symptom:
- Reddish brown liquid oozes out from the lesion which later dries upto form a rusty deposit.
- Tissues beneath the out lesion appear as reddish brown discoloration.
- The cankers girdle the main stem or branches & the pods in them wilt the leaves are discoloured.

Mode of spread:
The infection spread from peduncle and then to the cushion and bark .
Management:

- Infected pod should be removed & destroyed.
- Disease can be controlled in the early stages by the excision of diseased bark followed by wound dressing with Bordeaux paste.

3 Colletotrichum rot:

Causal organism: *Colletotrichum gloeosporioides*.

Symptom: Infected stalk becomes shrunken. The internal tissues of the pod become discoloured. Abundant pinkish slimy mass of conidial is produced on the lesions under high humid conditions. Ultimately the diseased pod turns brown to black & remains on the tree as mummified fruit.

Management:

- Infected pod should be removed & destroyed.
- Disease can be controlled in the early stages by the excision of diseased bark followed by wound dressing with Bordeaux paste
- Spraying with carbendazim 0.1% or mancozeb 0.25% controls the disease.

4. Vascular streak die-back:

The causal organism *Oncobasidium theobromae*.

In India, VSD has recorded only from kerala state

Symptoms:

- The first visible symptoms of VSD is the yellowing of a single leaf in the second or third flush from the twig with sets of green patches scattered over the yellowish lamina.
- Such leaves fall off prior to the older leaves of the same branch.
- The bark in the leaf fall region of the branch becomes rough due to swelling of lenticels.
- The auxillary buds of the fallen sprout and then rapidly die.
- At the later stage, die back symptom appear on these branches as the result of infection the xylem vessels turn brownish which appear as streaking with in the vascular tissues.
- Hence the disease is known as vascular streak disease.

Management:

- One of the most important cultural practices recommended for controlling VSD, apart from the use of resistant genotypes is regular pruning of infected branches.
- Monthly spray of Hexaconazole 0.1% has been found to offer good protection against the VSD.
- Nursery losses from VSD can be controlled by use of plastic roof over nursery

Cocoa swollen shoot:

Symptom:

Family: *Caulimoviridae* Genus: *Badnavirus* Species: *Cacao swollen shoot virus* Acronym: CSSV

Some of these recommendations

- Space trees properly,
- Weed regularly,
- Cut down and remove diseased trees, etc.
- They simply let the infected areas lay fallow for three years and then cleaned it back up and the Capsid was gone.

2.1 Diseases of cashew

There are several diseases attacking cashew in Tanzania, over a dozen fungal diseases have been reported. Five most important diseases include:

S.No.	**Major Disease**	**Pathogen**
1.	Powdery mildew	(*Oidium anacardii* Noack)
2.	Leaf and nut blight disease	(*Cryptosporiopsis sp*)
3.	Anthracnose	(*Colletrotrichum sp*)
4.	Dieback	(*Phomopsis anacardii*)
5.	Cashew wilt	(*Laetiporus sp*)

2.1.1 Powdery Mildew disease of cashew

Powdery mildew disease of cashew is incited by *Oidium anacardii* Noack. The powdery mildew disease of cashew is characterized by the formation of an ash-white covering on the surface of attacked tissue. The pathogen infects young growing tissue on all aerial parts of the cashew tree, including shoots, leaves, flowers, apples and nuts.

Powdery was basically controlled by use of Sulphur dust, but due to likely environmental acidification problems, alternative fungicides have been tested and registered for use in Tanzania.

2.1.2 Leaf and nut blight disease

Leaf and nut blight disease is a fungal disease caused by *Cryptosporiopsis sp*. The disease symptoms portrays angular lesions, dark tan with a dark reddish brown margin, often vein limited and containing conidiomata. Lesions subsequently enlarge and coalesce causing blighting and defoliation. Older lesions become papery, silver/grey in colour and develop shot-holes. During fruit setting, infection on young nuts causes rapid blackening and abscission, resulting in significant yield losses. Infection of older nuts results in a characteristic dark, slightly sunken, 'tar spot' like lesion that frequently extends onto the apples.

The disease is best controlled by a combination of approaches including cultural, resistance and use of fungicides.

2.1.3 Anthracnose

Anthracnose a fungal disease incited by a *Colletroctichum gloeosporoides* Penz. [Deuteromycetes; Melanconiales]. The fungus attacks all young and tender vegetative organs together with nuts and pseudofruits /apples. Infected shoots as well as flowers dry out cling-on and appear shriveled and curled at the edges.

The disease is best controlled by a combination of approaches including cultural, resistance and use of fungicides.

2.1.4. Dieback disease

Dieback disease is a fungal disease caused by *Phomopsis anacardii* Early & Punithalingam [Deuteromycetes; Sphaeropsidales]. However damage caused by insect attack (*Helopeltis spp or Pseudotheraptus wayi*) are considered as predisposing factors to dieback infection. The fungus attack young and tender shoots and flowers.

The disease is also best controlled by a combination of approaches including cultural, resistance and use of fungicides

2.1.5 Cashew wilt

Field studies conducted with effect from 2003 revealed that there are two types of macro fungi namely *Laetiporus* and and*Ganoderma spp*, which are commonly associated with cashew wilt. Currently, farmers are advised to remove all L*aetiporus* fruiting bodies as soon as they are seen around the vicinity of target trees. It is advisable that farmers should routinely inspect their trees with effect from onset of rains, so as to remove the fruiting bodies in good time.

Anthracnose

CONTROL OF DISEASES

The major diseases of cashew are as follows:

1. Dieback or Pink Disease - This disease is caused by fungus *Corticium salmonicolor* B. that usually occurs during the rainy season. Affected shoots initially show white patches on the bark; a film of silky thread or mycelium develops. Later, the fungus develops a pinkish growth which are the spores that make the bark split and peel off. Affected shoots start drying up from the tip.Control Measures: All possible sources of innoculum should be removed. Affected shoots are pruned and burned. Cut surfaces must be protected by applying Bordeaux moisture paste. The tree should also be sprayed with fungicide at manufacturer's recommended dosage.

2. Anthracnose - This disease is caused by fungus *Collectorichum gloeospo*ides that usually infect tender leaves, shoots, inflourescences, young fruits (apples) and young nuts. This disease is most prevalent when there is excessive rainfall coinciding with the appearance of new growth and flowering. Infected parts in its early stage show shiny, water soaked lesions which later turn reddish-brown. At the lesion site, resinous exudation can be seen. As the disease progresses, the lesions enlarge in size, all affected tender leaves wrinkle, and the young apples and nuts become shrivelled. Inflorescences become black.

Control Measures: Remove all infected parts (source of innoculum) before spraying the tree with fungicide at manufacturer's recommended dosage of application.

3. Damping-off - This disease is caused by fungus Fusarium. This disease normally occurs in the nursery and effects cashew seedlings especially when the soil medium gets too wet. Control Measures: Seeds for planting should be treated with Arasan 75 at the rate of 1/4 tsp per ganta of seeds before sowing. Soil media for potting should be

Lecture 23: RUBBER OF DISEASES

S.No.	**Major Disease**	**Pathogen**
1	Bird's eye spot	*Helminthosporium heveae* Petch.
2	Powdery mildew	*Oidium heveae*
3	Leaf fall, Seedling blight and stem canker	*Phytophthora palmivora* Butler
4	Seedling blight	*Rhizoctonia solani* Kuhn
5	Pink disease	*Corticium salmonicolor*
6	Root rot disease	*Phellinus noxious*
7	Sooty mold	*Meliola* sp.
8	Leaf and seedling blight and wilt	*Fusarium oxysporum* f. sp. *vasinfectum*

Bird's eye spot:

C O: *Helminthosporium heveae* Petch.

Symptom:

- Affected rubber leaves have numerously-scattered small, circular spots with transparent centers with distinct brown borders, looks like birds eye.
- Young leaves are blackened and wrinkled, older leaves have necrotic lesions that result to shot holes caused by tissue drop-offs.

Etiology

- In culture, growth of this fungal pathogen is cottony white that later turns to light brown.
- Conidiophores single or clustered, tail, brown; stomata often present; conidia develop laterally through pores beneath septa while apex conidiophore is still growing, often appearing in whorls, single, subhyaline to brown obclavate, pseudoseptate, with prominent basal scar; conidia measures 65-170 x 9.5-10 mm with 3-6 septations under 100x.

Management

- Bordeaux mixture 1%
- Mancozeb 0.25%
- Giving shade to nursery

Powdery mildew caused by *Oidium heveae*

Symptom:

- White, cottony, hairy or powder-like borders along the lesions.
- The shiny filamentous colonies of Oidium are clearly visible on both sides of the affected freshly-fallen leaves.
- High severity of powdery mildew are common during and after over wintering or during flushing of tree.

Etiology

- This fungus is an obligate pathogen and can not be grown in culture.
- It produces thin and membranous characterized by oval or barrel shaped conidia or oidia borne in chains on short conidiophores. The mycelium is ectophytic, septate have subepidemial haustoria.

Management

- Wettable Sulphur 0.2%
- Carbendazim 0.1%

Sooty mold caused by *Tripospermum* sp.

Symptom:

- Sooty molds on rubber foliage is seasonal and depend largely on excreta and honey secretions of scale insect and other insects. Honey dew like excreta are favorable to the growth of the fungus.
- It is not a pathogen. |It is purely ectophytic growing on the surface and never invade the host tissue. Sooty growth covers the green chlorophyll and hence greatly hinder the photosynthetic activity of the host plant.

Management

- Control the insects with any of the suitable systemic insecticides.
- Spray 1% starch solution on the fungal growth which dries up to form flakes and falls off leaving healthy green plant surfaces.

Leaf and seedling blight and wilt

Caused by *Fusarium oxysporum* f.sp. *vasinfectum*

Etiology and Symptoms:

- In culture, cottony whitish to yellowish, conidiophores simple and branching.
- Macro conidia several-celled slightly curved or bent at the pointed ends, multi septate (3-7), pointed ends, typically canoeshaped,hyaline, measuring 25-50 x 4-6 mm under 100x.
- Clusters of single-celled micro conidia in chains are also abundant.
- It infects both budded rubber and seedlings in nurseries and trees in plantations.
- Early symptom shows the presence of irregular, brown lesions, which later enlarge.
- As the diseases progresses, the infected leaf eventually withers and a pinkish, shiny, cottony growth is evident on the infected area beneath the leaf surface.
- In young budded seedlings the pathogen causes seedling/shoot tip blight.

Management

Drench the nursery with Bordeaux mixture 1% and use the same spray mixture for seedlings also.

Seedling blight, black stripe, and stem canker *Phytophthora palmivora* Butler

Symptoms:

- Seedling blight caused by Phytophthora palmivora is noticeable especially during rainy season under nursery condition.
- Typical symptom of seedling blight show the leaf blades with few blotches that soon enlarge and coalesce.
- In severe cases, yellowing with defoliation will happen and eventually dieback takes place.
- Phytophthora leaf blight indicated by the chlorosis at leaf margin with eventually advances until a brown colored lesion develop and becomes water soaked. It is more commonly observed in field plantations.
- Black stripe, stem canker and bark splitting also frequently occur in rubber plantations.
- The typical symptoms of black stripe are sunken with slightly discolored areas on the tapping panel.
- Later, vertical fissures appear in the renewing bark; when these are removed, dark vertical lines are visible; presence of discolored or black lines in the tapping cut; clogging of the latex flow resulting to massive spilling of latex; cause uneven renewal resulting to burns and depressions on the tapping panel. For stem canker, the sunken canker is the best diagnostic symptom.
- As the cankers become older, they become brown with a shredded appearance.
- In bark splitting or cracking, there is a massive spilling of latex and when scraped, pinkish to reddish discoloration is observed.
- Reddish discoloration is observed that becomes black at a later stage.
- In the matured trees, the pathogen causes dropping of prematured leaves leading to defoliation and the disease also called as 'Phytophthora leaf fall'.

Etiology

- This fungus belongs to the Phylum Oomycota, Family Pythiaceae grows abundantly on V-8 agar.
- The colonies are white, aerial, and cottony in culture.
- The sporangia are characterized by lemon-shaped and doubled papillate structures which measure from 34.5 – 57.5 x27.5 -49.0 mm under 100x and oospores with 22 - 28 mm.

Management

- Prophylactic spray with Bordeaux mixture 1%
- Zinc sulphate 0.2%

Seedling blight caused by *Rhizoctonia solani* Kuhn

Symptom:

- This disease infects mostly the seedlings.
- Symptoms start from the tip of the leaf with a chlorotic lesion. Mycelial growth of the fungus are easily seen at the lower or underside part of the leaves.

- Seedling blight of rubber caused by a complex of possibly R. solani (hyphal strands below right) associated with the presence of nematodes inside infected stem of budded rubber seedling. Discoloration and rotting of vascular tissue can also be noticed.

Management

- Seed treatment with carbendazm 2g\kg seed
- Give drenching spray with carbendazim 0.1%

Pink disease: *Corticium salmonicolor*

Symptom

- The symptom shows fungal salmon pink incrustations on the fork region of the tree or branches where moisture is easily trapped.
- The white silky threads (mycelia) of the fungus appear and, under favorable conditions, spread around the branch giving a thick cobweb effect.
- This is more visible during rainy season.

Management

- Affected plants are to be pruned and burnt, cut ends are pasted with Bordeaux mixture .
- Spray Triademorph 0.1%

Root rots disease- *Phellinus noxious*

Symptom

- Brown root rot caused by Phellinus noxius, have rhizomorphs found in the infected roots that form a continuous fungal skin, tawny brown, becoming almost dark with age.
- The diseased roots develop a very rough and irregular surface through a thick layer of soil adhering to them.
- In early stage, the rot is pale brown; later, brown zigzag lines appear. At a fairly advanced stage, the brown network of lines can also be seen on the wood surface beneath the bark.
- The fruit body is a hard, dark brown bracket fungus which is dark gray on the underside.

Management

- Application of lime 2.5tones\ha

Lecture 24: BEETLE VINE
Scientific name: *Piper betle*
Family: - Piparaceae
Origin: - Western Ghat of India
Introduction: Beetle vine is a cash crop of India. It has been referred in the ancient Indian literature dating the back of 340bc it was said to be popular among Aryas. Beetle vine is an important, traditional and ancient crop of India currently more than 200 cultivar are cultivated in several states of India for its leaves which are used for chewing purposes. The cultivators and consumers name the cultivars after their localities, villages and town. Thus the cultivar with prefix Desi in their names invariable refers to the cultivar Bangla in West Bengal, cultivar Kapoori in Maharastra and cultivar Desevari in Madhya Pradesh. The traditional nomenclature is thus confusing and attempts to clear the confusion were made. On the basis of photochemical constituents beetle vine cultivars have been divided in to five types of these, Bangla and Kapoori are the major types.
Importance of Beetle vine : It is mainly used for the chewing purposes along with areca nut and lime and most of the medicinal and Ayurvedic medicine preparation and also biting of any poisonous insects or snack healing capacity it has and also used in curing of fever, headache, liver disorder, and cold, cuff and kidney disorder and also cure the Astama.
DISEASES

S.No.	**Major Disease**		**Pathogen**
1	Leaf rot		1. *Phytophthora parasitica* f. *Piperina* **(Dastur)**
2	Pythium foot –rot		2.: *Pythium vexans* (De Bary)
3	Leaf spot		3.: *Colletotrichum capsici* (Petch)
4	Powdery mildew		4.: *Oidium piperis* (Uppal, Kamat and Patel)
5	Bacterial leaf blight		**5.**: *Pseudomonas betlicola* **(Patel, Kulakarni and Dhande)**
6	Fusarium wilt		**6.**: *Fusarium oxysporum* **(Scchlecht)**
7	Root-knot disease		7.: *Meloidogyne incognita*

1 .LEAF ROT
Causal Organism; *Phytophthora parasitica* var.*piperrina*, *P*. *nicotianae* var. *parasitica* f. *piperina* **(Dastur)**
Symptoms: Symptoms appears only during the rains when both temperature and atmospheric humidity are highly & favorable.
On leaves:
1.The first symptoms of the disease are the development of a brown to blackish and then it becomes soft & deliquescent in appearance under the continuous humid condition.
2.As when disease advance spot rapidly increase in diameter under moist condition and extends to the major part of the leaf causing a soft rot.
3.The rot may extend to the petiole & in some cases to the stem also.
4.On the lower side of the infected leaf in wet conditions a white cottony growth appears at the light colored margins of the spots as well as this white growth is due to sporangia & sporangiophores of the fungus coming out through stomata disintegrated lower epidermis.
5.If wet conditions are not continuous and if rain lasts only for a day or two with intervening dry warm periods the diseased areas develop concentric zones of development due to alternate favorable and unfavorable periods of growth.
6.One or more than one spots may be found on a leaf at any position in the plant may be attacked but those within 2-3 feet of the ground level are more commonly affected than others leaves.
7.It also infect root system and causes root rot or wilt.
Epidemiology : The Sporangia develops only at 20-310C when relative humidity is of 100%.
Etiology
1.Mycelia is aseptate, zoospore are borne in sporangia.
2.oospores are sexual spores borne in Oogonium.
3.Primary source of inoculum: Oospores
4.Secondary source of inoculum: Zoospores

MANAGEMENT

1.Cuttings for plantation purposes should be obtained from healthy orchards. All the affected parts of the plant should be carefully cut and destroyed.

2.Spraying the foliage with fungicides before and during rains gives effective protection. Leaves can be harvested only ten days after any spray.

3.Affected vines are dipped in 1% Bordeaux mixture, sprayed twice a month. Also spraying of 1.5% concentration of *Azadirachta indica* (Neem) extracts.

2. PYTHIUM FOOT ROT

Causal organisms: *Pythium vexans* **(de Bary)** *P. piperinum* **(Dastur)***P. splendens* var. *hawaianum*

SYMPTOMS:

1.Affected Plants droop, the upper succulent parts of the vines wilt as if from want of water.

2.The green parts then turn pale yellow & later brown, the leaves shrivel and of the plant dies. The basal part is rotten & can be easily pulled; out owing to the destruction of the roots.

3.The symptoms and control measures of the foot-rot disease caused by the species of *Pythium* and *Phytophthora* are more or less similar and have been described under foot-rot due to *Phytophthora parasitica* f.sp. *piperina*

Primary source of inoculum: oospores borne in oogonia

Secondary source of inoculum: zoospores borne in sporangium

Spread: Air borne and Soil borne zoospores

Epidemiology:

1.The fungi required high soil moisture and the soil temp of 22 to 24°C avoid low lying area and reduce the planting density for the proper penetration of light to reduce the inoculums load.

Sporangiophore and sporangia

Encystment

MANAGEMENT

1.Use of non–nitrogenous manures, e.g. Bone meal or super phosphate, judicious use of irrigation water & admission of sufficient sunlight.

2.Control of the diseases can be accomplished by applying Bordeaux mixture 1% to the infested soil.

3.Dipping the cuttings in Bordeaux mixture 0.5% for 1 hour before planting could effectively control the disease. Chaurasia suggested foliar spray of tetracycline@500ppm concentration to control the foot rot caused by *Pythium* sp.

3. LEAF SPOT

Causal Organism: *Colletotrichum capsici* ***(Petch)***

Symptoms

1.On Leaves: the leaf spot is irregular in shape & size, light to dark brown surrounded by diffused chlorotic yellow hallow marginal leaf tissues becomes black, necrotic &gradually spreads towards the leaf centre.

2.Occasionally diffused yellow, halo also develops

3.in the anthracnose stage circular, black lesions that occur rapidly increase in size and girdle the stem culminating in the death of the vine.

4.Fungus produces the asexual fruiting body Acervulus. Then fungi move to the spike on individual plants

Etiology:

1.The fungi are having septate mycelia with inter and intracellular haustoria.

2.Sexual spores are the ascospores borne in ascus and the asexual spores are Conidia borne in sporangia.

3.They mainly survives as a Dormant mycelia and spread as a air and soil borne conidia.

Primary source of inoculum: Ascospores borne in ascus and chlamydospores. Sexual fruiting body is perithecia

Secondary source of inoculum: Air and soil borne conidia

Spread: Air borne and soil borne conidia

Epidemiology: The fungi are a required Temp of 30-320C, and relative humidity of 90-95%and the susceptible host.

MANAGEMENT: At initial stage, affected leaves, spikes should be collected and destroyed. Early identification of the disease and spray with carbendazim).1% or Companion (0.2%) is found to be

effective.
2.Low nitrogen application with increased potassium make the plants resistance to this disease. Application of *Trichoderma viridae* to the soil along with FYM. Destruction of dead, refuse and spraying the plants with Bordeaux mixture 0.5%. Cuttings for planting should be taken from diseased free vines.

POWDERY MILDEW:

Causal organism: *Oidium piperis* ***(Uppal, Kamat and Patel)***

Symptoms: 1. early leaf infection appears as the formation of circular light grayish white powdery patches or spot which gradually enlarges soon powdery mass of fungal growth powders first on the lower surface of the leaf. Under ideal conditions both the leaf surfaces get covered by the white floury mass of fungal growth.
2. This is followed by the yellowing of the leaves & then becoming brittle, resulting in early leaf falls.
3.The growing shoots are also affected in severe cases the whole crop may be destroyed.Impact is photosynthesis reduces and yield reduces.

Control measures: 1. Application of wettable sulphur 0.3% is effective in controlling the disease. The control of powdery mildew by spraying with Bordeaux 0.5% partially controls the disease and also by the application of 0.5% suspension of colloidal sulphur.
2.The spraying of Arsenium album @2000 potency also recommended to control the *Colletotricum* leaf spot diseases of piper beetle.

4. BACTERIAL LEAF SPOT:

Causal Organism: *Xanthomonas campestris* pv. *beticola* **(Asthana and Mahmud)**

Symptoms:

1.The first symptoms of the disease in affected orchards are diminutive.
2.Pale yellow spots, rapidly turning dark purple appears on a along or between the veins on either leaf surface.
3.The spots in farmer positions are roughly circular or angular while in latter, they are irregularly elongated or branched like fern leaves.
4.Only in case of advanced decay, the lesions are visible on the both surfaces. The infected leaves gradually turns yellow and falls.

Etiology: The bacteria are Gram –ve monatrichous, Rod shape, single celled Aerobic Bacteria.
Primary source of inoculum: Bacterial cells in affected debris
Secondary source of inoculum: Air borne bacterial cells
Spread: Splash borne and air borne

Epidemiology: 1. The bacteria require of 30-32oC and relative humidity of 80-85%, Cloudy weather and intermittent rainfall with a Susceptible hosts.
2. The bacteria survives in affected plants and spread through rain splash and air borne bacterial cells, and enter through wounds are hydathode.

Management:

1.Neem formulation spray 0.3% during the month of Oct-Nov. This will also reduces the population of nematode when applied through soil irrigation water,
2.Control the diseases by irrigating the gardens a week before planting with Bordeaux mixture 1%. Spray streptomycin @ 2000 ppm or neomycin.
3.Cut and burn the affected plant parts. Vacitracin @ 2000 ppm & Polymycin @ 1000 ppm effectively controls the leaf spot. Foliar spray of *Azadirachta indica* extracts @ 3.0 %.

5. BACTERIAL LEAF BLIGHT

Causal Organism: *Pseudomonas betlicola* ***(Patel, Kulakarni and Dhande)***

Symptoms:

1.Water soaked area appears on the lower surface and yellow halo appears on the corresponding upper surface.
2.Elongated brown spots of variable length appear on the vine in severs infection, stem canker &large areas of leaf lamina are covered causing blight leaf.

Mode of spread: It is a Soil borne gram –ve bacteria lopotrichus, they are facultative saprophytes (6-8 months in affected plant roots, debris.). They survive in the infected planting material as facultative saprophytes.

Spread irrigation water, Soil borne bacterial cells and enter through wounds.

Management:

1.Application of Bordeaux mixture 0.5% OR copper oxy chloride.O.3% effectively control the disease. Spraying of streptomycin @2000ppm conc. Or tetracycline @ 2000ppm conc.

FUSARIUM WILT

Causal Organism: *Fusarium oxysporum* (Scchlecht)

Symptoms: Initially the crop shows the symptoms like yellowing. After the vine is going to severally infested and turns brown color.

2.Then start browning of leafs and drying of vines and ultimately going to died.

Etiology: 1. The pathogen produces Chlamydospores as a vegetative resting structure.

2.The fungi survive as chlamydospores borne terminally or intercalary and spread through air borne Micro and Macro conidia.

Management:

1.Application of Bordeaux mixture 0.5% is effective to control the disease.

2.Foliar spray of *Azadirachta indica* leaf extracts @3.0% conc. *Allium satium* clove extract @ 20% conc. Incorporation of bio-agent, |*Trichoderma viridae* to soil along with FYM also manage the disease effectively.

6. SCLEROTIUM WILT:

C.O: *Sclorotium rolfsii* (Sacc)

Symptoms:

1.Beetle vine of all ages are vulnerable to the infection particularly at the collar region.

2.White cottony mycelia growth creep over the infected or of the stem and soon much small mustard like sclerotia appearance in the soil near the collar region of the vine.

3.At the stage the vine wilts, dries off and leaves droops. The decay of stem below and at soil level, where dense, white cottony mycelial mass found at the site of entry and wilting of the arial organs.

4.Numerous Sclerotia develop on the rotting stem and the soil around the infected plants. There is abundance of mycelia out the infected tissue.

5.In the host, the mycelium is both inter and intra cellular and destroys the middle lamella result in soft rot. The plants are susceptible at any stage of their growth.

6.The sclerotia are produced in plenty and are responsible for perpetuation and dissemination of the pathogen.

Etiology: Dormant mycelia and sclerotial bodies present in the affected host debris and in soil. The fungi survival as sclerotial bodies and spread through air borne mycelia strands.

Management: 1. Application of mustard oil cake, ammonium sulphate, sodium nitrate and ammonium phosphate reduce the mortality percentage. 2. Earthing up of the vines to cover the sclerotia to a depth of 75 mm to control the disease. Ploughing to a depth of 22 to30cm also proved equally effective.

3. Incorporation of bio-agent, |*Trichoderma viridae* to soil along with FYM also manage the disease effectively.

7. NEMATODE DISEASE

Causalorganism: *Meloidogyne incognita*

Symptoms: 1. Root-knot disease caused by *Meloidogyne incognita* and *Meloidogyne javanica* are the most common.

2. The affected plants show growth reduction and yellowing and abnormal thickening of leaves with necrosis commencing from the tip and margins of leaf and extending inwards.

3. The disease causes reduction in quality and quantity of leaves, sometimes leading to serious wilt disease that greatly affect the growth of plants and produce heavy losses to the farmers. Heavy losses due to root knot disease therefore require chemical method of control.

Management:

1.Soil sterilization with 4% formaldehyde .Cultivate the crop with nematode free soil.

2.Apply neem cake or oil cakes will reduce the nematode infestation.

3.Application of Carbofuran 1.5 kg/ ha of soil.

LECTURE 24 DISEASE OF SENNA (*Cassia angustifolia*, family: legumianaceae)

INTRODUCTION:

Is a small perennial under shrub. Senna is used in medicine cathartic. It is especially useful in habitual constipation. The plant also contains sennasoids C and D. It is an imporatant medicinal crop which can be grown for its leaves and pods for the extraction of different types of sennosides present in pods and leaf...

DISEASES OF SENNA (*Cassia angustifolia*, family: legumianaceae).

S.No.	**Major Disease**	**Pathogen**
1	Damping off	*Rhizoctonia bataticola*
2	Leaf spot	*Alternaria alternata*
3	Leaf spot	*Cercospora* spp.
4	Leaf blight	*Phyllosticta* spp.

1) DAMPING OFF: *Rhizoctonia bataticola*

SYMPTOMS:

Initially water soaked lesions on the collar region of the plant. Brown discoloration then epidermal layer collapse. Seedlings topple down.

ETIOLOGY:

- Septate mycelia, sub epidermal haustoria
- Asexual spores are absent and Mycelial strands act as a conidia
- Sexual spores: Basidium (Basidiospores)
- Vegetative structure: Sclerotial bodies

EPIDEMIOLOGY:

- Warm weather, soil temp 28°-32° C. Optimum moisture, neutral pH
- Primary Source of Inoculum :sclerotial bodies
- Secondery Source of inoculum: Soil borne mycelial strands

TAXONOMY:

K: Fungi:

D: Deuteromycota, C: Deuteromycetes, O: Mycelia sterilia , F: ? , G: *Rhizoctonia s*p: *bataticola*

LIFE CYCLE:

- It is a Deuteromycetes fungi produces sclerotial bodies, these are sorghum seed like vegetative structures, resting structures and long surviving structures.
- When there is congenial conditions these sclerotial bodies germinate penetrate to the host and causes disease.
- The affected host having mycelial strands again they germinate and cause infection that how disease cycle continues.

MANAGEMENT:

- Affected debris destruction
- summer ploughing
- Crop rotation
- Soil sterilization
- Biological agent
- Carbendazim 0.1% or Mancozeb 0.2% soil drenching.

2) LEAF SPOT: *Alternaria alternata*

SYMPTOMS:

Concentric round spot on the leaves. Spot size increases and covers the entire leaves leading to blightening of leaves

ETIOLOGY:

Septate mycelia, either conidia or conidiophores are colored

EPIDEMIOLOGY:

- Nutritionally poor soil,
- temp 28-35°C, RH 85-90per cent,
- Susceptible host.

Primary Source of Inoculum: Dormant mycelia
Secondery Source of inoculum: Air borne conidia

LIFE CYCLE:

- Pseudothecium present in the affected plant parts serves as a primary source of inoculum.
- Favorable climatic condition it will release ascospores and land on to the host, causes infection and these are responsible for primary infection
- Conidia are borne on conidiophore on the affected host and release to cause infection by asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place to produce ascospores in pseudothecium.

TAXONOMY:

Kingdome: Fungi
Division : Deuteromycota, Class : Deuteromycetes, Order : Moniliales, Family : Dematiaceae, Genus : *Alternaria*, Species : *alternata*

MANAGEMENT:

- Collect and destroy affected plant parts
- Increased nutritional status
- Reduce plant population
- Mancozeb 2.0% as aerial spray

3). LEAF SPOT: *Cercospora* spp.

SYMPTOMS:

- Brown color spots on lower surface of the leaf.
- In severe cases, blightening takes place. Leaf falling, severe in neglected crop.

ETIOLOGY:

- Septate mycelia,
- Inter cellular mycelia and intracellular haustoria.
- Asexual spores- whip like conidia on conidiophores,
- Sexual spores- Ascospores borne in ascus and which are situated in Pseudothecium
- Vegetative structure is dormant mycelia.

EPIDEMIOLOGY:

- Temp 30-32°C, RH 85-90 per cent, cloudy weather, poor management.

Primary Source of Inoculum: Dormant mycelia.
Secondery Source of inoculum: Air borne conidia.

LIFE CYCLE:

- Pseudothecium is the primary source of inoculum presenting the affected debris.
- During favourable climate it produces ascospores and causes primary infection.
- In the affected host whip like conidia are present on conidiophore and cause infection by asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where male gametangium is antheridium and female is ascagonium.
- After gametangial contact plasmogamy, karyogamy, mitosis followed by meiosis and ascospore formation takes place.

MANAGEMENT:

- Collect older leaves and burn.
- Avoid more density of plants.
- Proper nutrient management.
- Mancozeb 2g/lit.

4) LEAF BLIGHT: *Phyllosticta* spp.

SYMPTOMS:

- Oval shape water soaked spots on lower surface of leaf. Then moves to upper surface.
- Spot size increases, center portion of spot turns whitish grey color.
- Spots coalesce and blightning takes place.

TAXONOMY:

Kingdome: Fungi. Division: Deuteromycota
Class: Deuteromycetes:
Order: Sphaeropsidales
Family: Sphaeropsidacea:
Genus: Phyllosticta

MANAGEMENT:

- Avoid more density of plants.
- Proper nutrient management.
- Bordeaux mixture 0.1% or captafol 0.2% as spray

Lecture : 25 NEEM: *Azadirachta indica*
FAMILY: Meliaceae
INTRODUCTION:
Neem is one of the most valuable and the least exploited of tropical trees. It is commonly know as neem tree. Every part of the tree from its roots, trunk, bark, leaves, flowers, fruits , seeds, sap, and gum are known to have some use and have a place in the traditional folklore and medicine.
LISTS OF DISEASES:

S.No.	Disease		Pathogen
1	Powdery mildew		*Oidium azadiractae (Erysiphae)*
2	Root rot		*Ganoderma lucidum*
3	Leaf web blight		*Rhizoctonia solani*
4	Leaf spot		*Pseudocercospora subsessilis*
5	Bacterial wilt		*Pseudomonas azadiractae*
6	Angular leaf spot		*Xanthomonas azadiractae*

Bacterial diseases:
1):
2):
1) POWDERY MILDEW: - *Oidium azadiractae (Erysiphae*)
Symptoms: 1. Grayish powdery growth on the upper surface of the leaves and the powdery growth seen on young leaves. 2. Leaves wrinkle and defoliate.
3. On older mature leaves necrotic patches. Powdery growth on twigs, flower and on fruits also in severe conditions
4. Fruit dropping is the common symptom. Powdery growth reduces the photosynthetic area, thus reduces the growth and yield drastically
Etiology: Septate mycelia, Sub epidermal haustoria. Asexual fruiting body: Oidium Sexual fruiting body: Cleistothecium
- Primary Sources of Inoculums: Dormant mycelia, Cleistothecium.
- Secondary Sources of Inoculums: Air borne conidia (barrel shaped)
- Survival: Pathogen in the affected debris

Epidemiology: Warm weather, Temp. - 28-32°C, R.H: 80-85%. cloudy weather, susceptible Host.
LIFE CYCLE OF POWDERY MILDEW
1.Affected plant parts having cliestothium as primary source of inoculum.
2.Favorable climate, ascospores released from cleistothecium.
3.Ascospores fly and land on to the host surface.
4.Causes infection by producing subepidermal haustoris and the induces powdery mildew symptom.
5.Powdery growth comprising of oidia.
6.Oidia releases barrel shaped conidia after maturity and the asexual life cycle continues
7.During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, meiosis and produces ascospores, ascus in cleistothecium.

Management: Avoid dense planting. Proper nutrient management (higher K application) . Crop rotation with non host crops
- Chemical : Prophylactic spray 3-4 times with wettable sulphur 0.3% or carbendazim 0.1% or calixin 0.15% at 10-15 days interval (aerial spray)

2) Root rot: *Ganoderma lucidum*
Symptoms: Lower leaves yellowing and gradually yellow progresses upward and drooping of branches take place. Later leaves bent or fall down**.**
On stem: longitudinal cracking and through this crack gummy oozing Basidiocarp (mushroom like) formation. Root rotting after the death of the tree.
Etiology: Septate mycelia, Inter and intra cellular Haustoria
Primary Sources of Inoculums: Basidiospores, Chlamydospores (survival)
Secondary Sources of Inoculums: Dormant mycelia (present in wounded exposed roots)
Epidemiology: Warm weather, Temp. - 30-32°C, R.H - 80 - 90%, pH - Slightly alkaline, Susceptible Host, Root to root contact

Management: Maintain Proper plant density .Application of clay soil . Summer irrigation. Root feeding with Calixin @ 20 ml/100 ml of water. Remove and burn severely affected plants. Apply *Trichoderma* spp. to the soil

3) Leaf web blight: *Rhizoctonia solani*

Symptoms: Water soaked lesions on the leaf, stem and twigs. Affected leaves are blighted. Mycelial growth and dark brown sclerotia are seen on affected parts

Etiology:

1.Mycelia spate, binucleate, branched at right angle Club or ovate basidium
2.Basidiospores produced on sterigmata. Septa at the base of origin of branches
3.Asexual spores - Mycelial strands (act as Conidia, air borne)
4.Sexual spores - Absent (Unknown), sometime basidiospores
5.Vegetative structures - Sclerotial bodies (Survival)
6.Primary Sources of Inoculums - Sclerotia (resting structure)
7.Secondary Sources of Inoculums - Mycelial strands (air or water borne)

Taxonomy:

Kingdom: Fungi.Division: Deuteromycota: Class: Deuteromycetes Order: Mycelia Sterile: Genus: *Rhizoctonia*: Species: *solani*

Epidemiology: Temperature: 28-32^{0}C RH: 65-80% Susceptible host

Management: Field sanitation. Seed treatment with Bavistin @ 1.5 ml/lit. Summer ploughing. Crop rotation with non host crop . Biological agent –*Trichoderma* spp. Neutralize the soil pH. Soil drenching with COC 0.3%.

LIFE CYCLE: It is a Duteromycetes fungi produces sclerotial bodies these are sorghum seed like Vegetative and resting structures.

Congenial conitions sclerotial bodies germinate and produce mycelial strands. Mycelial strands act as conidia and causes disease.

LIFE CYCLE: Rhizoctonia solani germination mycelial sclerotial strand body Landing on host infection

4) Leaf spot: C.O: *Pseudocercospora subsessilis*

Symptoms: The leaf spots are first noted on older, fully expanded leaves as brown,subcircular to irregular lesions with a dark brown border. Upon enlargement, leaf spots coalesce to form large, dark-brown necrotic areas ultimately followed by abscission of the leaves.

Etiology: Septate mycelia, inter and intracellular haustoria.

Primary Sources of Inoculums: Dorment mycelia (affected debries), Ascospores

Secondary Sources of Inoculums: Air born conidia

1.Asexual spores – Conidia (air borne) Sexual spores - Ascospores
2.Vegetative structure: Mycelial strands

Epidemiology: Warm weather, Temp.: 28-32°C. R.H: 85-90%. Susceptible Host

A) Upper leaf surfaces B) corresponding lower leaf surface

LIFE CYCLE OF LEAF SPOT:

1.Affected plant parts having Pseudothecium as primary source of inoculum during favourable climate this will produce ascus in that ascospores are present because of lack of pressure inside the ascus they burst open and fly on to air and land on to the host, causes infection and causes leaf spot of neem .
2.In the affected host conidia are present, they produces conidiophore and cause infection by flight b asexually.
3.During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place by this inoculum is reproduced.

Management:

1.Removal of alternative weed hosts, crop residues around main plot.
2.Select healthy planting material.
3.Application of less N & more K induces disease resistance.
4.Spray systemic insecticide – dimethoate 0.2% or imidacloprid 0.03%..

Bacterial diseases:

1) Bacterial wilt: *Pseudomonas azadiractae*

Symptoms: The bacteria multiply rapidly inside the water conducting tissue of the plant.

1.The results in rapid wilt of plant, while the leaves stay green.

2.If an infected stem is cut crosswise, it will look brown and tiny drops of yellowish ooze may be visible. In severe cases, falling of leaves takes place.

Etiology: Gram –ve bacteria, rod shape, white/yellow colonies, non spore forming, facultative saprophyte, lophotrichous

- Primary Sources of Inoculums: Affected plant debris
- Secondary Sources of Inoculums : Soil and water borne bacterial cells
- Entry: Through wounds

Epidemiology: Severe in Sep-Oct Temp - 28-320C RELATIVE HUMIDITY - 90% Neutral pH Susceptible host

Management: Use healthy planting material and disease free area. Cut and burn the affected portion. Regular Pruning reduces the disease. Maintain NP and increase K application. Drip irrigation avoids spread of the pathogen

- Chemical: COC 0.3% and Streptocycline 0.05%

2) Angular leaf spot: *Xanthomonas azadiractae*

Symptoms: Initially water soaked angular spots on the leaf, later it turns into pale yellow colour oily appearance.

Later death of the cell takes place. Blightening and dry of leaf and defoliation

Etiology: Microscopic, unicellular, binary fusion, monotrichous, Motile, Gram –ve, rod shape,

- Primary Sources of Inoculums: Affected plant debris (corky area of the leaves)
- Secondary Sources of Inoculums: Rain splash and air borne (spread), bacterial cells
- Entry: through stomata

Management:

1. Use healthy planting material and disease free area, Cut and burn, Pruning, Maintain NP and increase K application, drip irrigation

1.Chemical: COC 0.3% and Streptocycline 0.05%

Lecture 26 BELLADONNA – *Atropa belladonna*

Introduction:

Atropa Belladonna (balck or deadly night shade) is a perennial shrub that grows upto 4.5 feet tall with oval leaves, greenish purple flowers and with black globular berries.

Active constituent of *Atropa belladonna* are atropine hyoscyamine and scopolamine.

Atropa belladonna is used as decoction (tea like), ointment, as smoke.

Diseases of belladonna

S.No.	Disease	Pathogen
1	Root rot/wilt	*Fusarium solani*, *Pythium butleri* and *Phytophthora nicotianae* var. *nicotianae*
2	Leaf spot	*Cercospora atropae*
3	Damping off	*Pythium ultimum*, *Rhizoctonia solani* and *Phytophthora parasitica*
4	Downey mildew	*Peronospora* spp.
5	Leaf necrosis	*Ascochyta atropae*
6	. Mottle virus	virus

1. **Root rot/wilt: *Fusarium solani, Pythium butleri* and *Phytophthora nicotianae* var. *nicotianae***

Symptoms of *Fusarium solani* affected plants:

- All the stages of the Plant are affected.
- In young seedling, the fungus causes pre and post emergence damping off of seedlings.
- Drooping and yellowing of older branches and leaves. In the advance stages, drying of whole epical portion are also seen..
- The tissue at collar region above and below the soil surface become brown and appear quite distinct from healthy tissue
- Older plants when affected invariably wilts .

Causal Organism :	*Fusarium solani* :
Etiology :	Septate mycelia, intravascular
Vegetative spores :	Chlamydospore (resting spores)
Sexual spores :	Ascospore
Asexual spore :	Micro and macro conidia
Primary Source of Inoculum :	Chlamydospores in soil and in crop debris
Secondary Source of Inoculum :	Soil and air borne micro and macro conidia

Life cycle

Causal Organism :	*Rhyzoctonia solani*
Etiology :	Septate mycelia, sub epidermal haustoria
Vegetative spores :	Sclerotial bodies
Sexual spores :	Absent
Asexual spore :	Mycelial strands(sterile fungi)
Primary Source of Inoculum :	Sclerotial bodiesin soil
Secondary Source of Inoculum :	soil borne Mycelial strands
Epidemiology :	Warm weather,Temp.28–32oC, optimum moisture, succepteble host Neutral pH

Management:

- Destroy affected debries and summer plouging.
- Avoid dence planting.
- Use healthy plot and disease free planting material.
- In a nursery fumigation of the soil with methyl bromide and treating the seeds with Captan @2gm/kg of seeds.

- Crop rotation (after three years crop of belladonna, rotation may be followed by planting the field) with a crop like rye or wheat.

2. Damping off: *Pythium ultimum, Pythium debaryanum, Rhizoctinia solani* and *Phytophthora parasitica.*

SYMPTOMS

Roots of affected seedling or sprouts show water soaked lesion at the base below soil level and exhibit rotting, reddening, drooping down and falling of leaves.	*Pythium ultimum*
Causal Organism :	
Etiology :	Aseptate mycelia intercellular mycelia and intracellular haustoria
Vegetative structure:	Dormant mycelia
Sexual spores :	Oospore
Asexual spore :	Zoosporeand Sprangia
Primary Source of Inoculum :	Oospore
Secondary Source of Inoculum :	Air borne zoospore
Epidemiology :	Cool climate,Temp.18-220C, RH90:95%, susceptiblehost.

Causal Organism :	*Rhizoctonia solani*
Etiology :	Septate mycelia, sub epidermal haustoria
Vegetative structure :	Sclerotial bodies
Sexual spores :	Absent
Asexual spore :	Mycelial strands(Sterile fungi)
Primary Source of Inoculum :	Sclerotial bodies
Secondary Source of Inoculum :	soil borne Mycelial strandsand sclerotial bodies
Epidemiology :	Warm weather,Temp.28-320c, optimum moisture, susceptiblehost, Neutral pH

Management:

- Use healthy seeds.
- Follow raised bed method.
- Reduce seedling density.
- Application of biological agents (*Trichoderma* spp.).
- Soil Drenching with mancozeb (0.25%) .

3. Cercospora leaf spot

Symptoms:

Round to angular, brown spots with chestnut colored margins on both side of leaves. The conidiophores produced on the spots are olive brown and tuft whip like many celled conidia can be seen on the conidiophores.

Causal Organism: *Cercospora atropa*

Etiology: Septate mycelia, Inter and intra cellular haustoria .

- Asexual spore: Conidia
- Sexual spore: Ascospores
- Vegetative structure: Dorment Mycelia
- Primary Source of Inoculum: Dormant Mycelia.
- Secondary Source of Inoculum: Air borne conidia.

Epidemiology:

- Warm weather,30-32°C.

- Relative Humidity 85-90%.
- Poor nutritional management.
- Susceptible Host.

Management:

- Select healthy plot and use healthy planting material.
- Crop rotation with non host crop.
- Application of biological agents (*Trichoderma* spp.)
- Spray mancozeb 0.25%.

4. Downy mildew: *Peronospora parasitica*

Symptoms:

- Initially small dots like structure are seen on the lower surface of leaves that later developed in to pustules, that further increase in size and produces downy growth.
- In advanced stage the leaves wither away.
- Whitish downy growth consist of enormous amount of sporangiophores, sporangia and mycelia..

Causal Organism: *Peronospora parasitica*

Etiology:

- Aseptate mycelia, sporangiophore are at acute angle, inter cellular mycelia and intracellular haustoria.
- Asexual spores: Zoospores and sporangia.
- Sexual spores: Oospores.
- Primary Source of Inoculum: Oospores present in debris.
- Secondary Source of Inoculum: Zoospores

Epidemiology:

- Temperature 18-220C
- Relative humidity 95-99%
- Susceptible host.

Management:

- Burn the affected debries,
- Crop rotation with non:host crop,
- Proper nutrition management
- Aerial spray of Copper oxy chloride 0.3%

5. Leaf necrosis: *Ascochyta atropae*

Symptoms:

- Greyish, white irregular spot with slight depression on the upper surface of leaves.
- The spots coalesce and become necrotic causing defoliation and death of the plants.

Causal Organism: *Ascochyta atropae*

Etiology:

- Septate inter and intracellular haustoria.
- Asexual spores: Conidia, Vegetative spores (Chlamydospores), Dormant mycelia.
- Sexual spores: Ascospores.
- Primary Source of Inoculum: Dormant mycelia and chlamydospores in soil
- Secondary Source of Inoculum: Air borne Conidia

Epidemiology:

- Cool weather. (Temp. 18-220C)
- Relative Humidity 90-95%
- Poor management
- Susceptible host.

Management:

- Collect and Burn the affected leaves,
- Avoid high density planting.
- Crop rotation with non:host crop,
- Proper nutrient management.
- Aerial spray of Mancozeb 0.25%

6. BELLADONNA M0TTLE VIRUS

Symptoms:

- The characteristics symptoms are slight clearing of viens and crumpling of the leaves, followed by a light or dark green mottle, together with blistering and distortion of the leaves and stunting of the plants.
- Vectors are not known.
- Primary Source of Inoculum: Affected planting material, collateral hosts

Management:

- Use disease free seeds
- Destroy the affected plants by burning or burying them deep in the soil.
- Equipments should be washed thoroughly.
- Soil solarization or fumigation with methyl bromide helps to reduce virus spread through soil.

HEMP

- Introduction: It is a tall medicinal annual herb, 1.2-4.8m height with erect angular stem. It is largely cultivated in temperature countries for its strong fibers.

List of diseases of hemp:

1.Leaf spot: *Cercospora cannabina.*
2.Wilt: causal organism: *Fusarium* spp..
3.Phyllody: causal organism: Phytoplasma.

1.Leaf spot*: Cercospora cannabina*

Symptoms: On leaves: Characteristic dark brown spots.

- Round to oval an irregular in shape spots enlarge with concentric rings.
- It become necrotic leading to withering & drooping.

Etiology: Mycelia: septate. Intercellular mycelia and intracellular haustoria

- Asexual spores: whip like conidia
- Sexual spores: ?
- Primary source of inoculums: Dormant mycelia.
- Secondary source of inoculums: Air born conidia.

Epidemiology: Temperature: 28-30^0 C Relative humidity: 85-90% Cloudy weather. Susceptible host.

Management: Cultural: Cut the affected leaves. Recommended N:P:K Drip irrigation.

Chemical: Mancozeb 0.25% or Carbendazim 0.1%.

Wilt: causal organism: *Fusarium*spp.

Symptoms: External: Older leaves yellowing, upward drooping, leaf epinasty.

- Internal: Brownish black discoloration, blocking of vasicular bundle.

Etiology: Mycelia septate, intercellular and produces intracellular haustoria.

- Asexual spores: micro and macro conidia born in sporodochium.
- Sexual spores: ascospores
- Primary source of inoculums: Chlamydospore
- Secondary source of inoculums: micro and macro conidia.
- Spread: through irrigation water, soil.

Epidemiology: Temperature: 28-30^0 C Soil: sandy soil. pH: Acidic 5.5-6.5 Soil moisture: optimum.

Life cycle: Perithecium is a sexual fruiting body. It has ascus, when it matures it produces ascospores.These ascospores flight on the air & by chance factor lands on the host.

- It enters the host through natural openings. It starts infection process.
- The host shows wilt symptoms & produces micro and macro conidia & again lands on the host like asexual life cycle continues.
- If conditions are adverse like high or low Temperature, high or low Relative humidity it starts sexual life cycle.
- Plasmogamy, hook formation, crosier formation, karyogamy, meosis, mitosis takes place & produces ascospore. Like sexual life cycle runs.

Management:

Cultural: Summer ploughing. Soil sterilization. Affected plant up root & burn. Neutralize the soil PH, Recommended N:P:K Crop rotation.

- **Chemical:** Carbendazim 0.1% (Soil drenching)
- **Biological:** Apply *Trichoderma viridae.*

Phillody: causal organism: Phytoplasma.

- Symptoms: Proliferation of floral parts. Adherence of vegetative shoots formed by converted stamen & carpel.

Etiology: It is prokaryotes, pleomorphic, obligate parasite, reproduction by binary fusion.

- Primary source of inoculums: Affected plant
- Secondary source of inoculums: vector.
- Spread: Leaf hopper vector

Epidemiology: Temperature: 28-32^0 C warm weather. Relative humidity: 80-85

Management: Initial identification & burn. Control vectors. Spray lannate 0.2%, Indoxicarb 0.2%, Imidacloprid 0.05% at 15 days interval.

Lecture 27 **Camphor (***Cinnamomum camphora*)

Introduction

Tree, young branches glabrous, terminal and axillary buds covered with bracts forming a small cone, young branches with clusters of scars from fallen bracts. Leaves broadly ovate, 7-10 cm long, 3-5 cm wide, and triple veined, with domatia in axils of main veins, glabrous, apex sharply acute, petioles slender, relatively long . Flowers are axillary, glabrous inflorescence shorter than leaves; sepals 1.5-2mm long, glabrous externally, pubescent within; staminoid and filaments pubescent. Camphor oil preparations have been used both internally and externally for a variety of ailments, ranging from respiratory problems to rheumatic pain. The principal use of camphor is to reduce cough.

DISEASEs OF CAMPHOR

S.No.	Disease	Pathogen
	POWDERY MILDEW	*Microsphaera alphifoides* (Griff) *: Erysiphe cinnamomi*
	Verticelium wilt	*Verticillium* spp
	Leaf spot	*Pseudomonas* spp
	Leaf blight	*Alternaria* spp.

1. POWDERY MILDEW: *Erysiphe cinnamomi*

SYMPTOME:

- Whitish grey colour powdery growth on upper surface of leaf, powdery growth enlarges.
- In severe condition, it may move to lower surface.
- Leaf slowly cupping, later leaf dropping takes place.
- Powdery growth on stem. Powdery growth consists of oidia and mycelia strands.
- The stem and petioles in later stages are also affected and are covered with a dirty white mycelia and oidia.
- With the advancement of the disease, the leaf lamina develops complete or partial chlorosis and the affected leaves eventually dry up

ETIOLOGY:

- Septate, ectophytic mycelia with sub epidermal haustoria.
- Asexual spores are barrel shaped conidia bearing in chains.
- Sexual stage is Ascospores in ascus and the fruiting body is cleistothecium

PRIMARY SOURCE OF INOCULUM: Dormant mycelia, cleistothecium present in crop debris.
SECONDARY SOURCE OF INOCULUM: Barrel shaped conidia.(Oidia)
SPREAD: Air borne

- The optimum Temperature for the spread of the disease is 28 to 300
- Requires Warm weather.
- This disease is more at the time of September- October months
- Relative humidity required is 80 to 85 %

MANAGEMENT:

- Remove affected plant parts and destroy.
- At early infection stage spray with wettable sulphur -0.3% followed by, spraying with carbendazim -0.1%t, calixin -0.15%.
- Crop rotation with non-host crop.
- Low nitrogen and increased K application reduces the incidence of disease.

VERTICILLIUM WILT: *Verticillium* spp.

SYMPTOMS:

- Affected plants are stunted in growth and leaves develop dark green patches followed by interveinal and marginal yellowing.
- Leaves wilt, dry and eventually fall.
- A brown discoloration can be seen in the xylem vessel on cutting through the stem and roots .
- Low partial wilt but lower leaf yellowing, V shaped yellowing of leaf margine .No epinasty but lower leaf drys off.

ETIOLOGY:

Septate mycilia, V shaped conidiospores on which single celled conidia is formed.
Mode of spread: The fungi survive in the soil on diseased plant debris and infect healthy plant by

contact with root. Furrow irrigation, organic manure and tillage spread the pathogens.
Primary Source of Inoculum: Dormant mycelia and chlamydospores in soil and crop debris.
Secondary Source of Inoculum: Conidia
EPIDEMIOLOGY
Disease spread at the temperature of 28 to290 C. Relative humidity 80 -85 %. Low soil moisture, alkaline pH, affected soil, susceptible host, black clay soil. Low nitrogen reduces disease severity.

MANAGEMENT:

- Crop residues should be ploughed deep and clean seeds to be sown.
- Polyethylene mulching reduces wilt effectively.
- Neutralize pH by applying gypsum.
- Destroy the affected plant parts by burning.
- Crop rotation with non host crop is to be followed.
- Biological agent such as *Tricoderma viridae* application.
- CHEMICAL: Carbendazim 0.1% as both soil drench and seedling dip.

LEAF SPOT : ***Pseudomonas* spp.**

SYMPTOMS:

- Disease affect the aerial part of the plant.
- Spots on the leaflets are water soaked, round, oval or irregular.
- Several such spots may coalesce to produce a blighted appearance.
- No yellowing, healthy plant sudden wilts due to faster spread of the disease.
- No epinasty. Vascular browning, white or milky white colored oozing are common.
- Complete plant dries up

ETIOLOGY: Gram –ve bacteria, lopotrichus, rod shaped, unicellular bacteria, reproduction by binary fusion.

Mode of spread and survival:

- They are present on the plant debries and the seeds.
- Infection usually occurs through leaf stomata .

Primary Source of Inoculum: Affected self sown crop, soil.
Secondary source on inoculum: Soil born bacterial cells through irrigation water.

EPIDEMOLOGY:

- High humidity that is 85 -92 % and free water facilitate disease development.
- The optimum Temperature for disease development is 24 to 27 0 c.
- High soil moisture is needed with Neutral pH.
- Affected sandy loam and sandy clay soils.

MANAGEMENT:

- Clean seed offer better control.
- Seed treatment with Streptomycin 0.05% is affective.
- Provide good soil drainage, wide row spacing, Host destruction, eradication of weeds.
- Use clay loam soil Crop rotation with non host crop
- Avoid movement of water from infected to healthy area.

LEAF BLIGHT : *Alternaria* spp.

It is a weak parasite affects on older leaves.

Symptoms:

- The infection starts with the minute dots on the leaf with irregular chlorotic areas on the tip portion of the leaves , then circular to oblong concentric black velvety rings appear in the chloroted area.
- Then the lesions develop towards the base of the leaf. The spot join together and spread quickly to the entire leaf area leading to blight.
- Sometime a yellow hollow develops around each lesion.
- As disease advances, spot size increases and complete blightening takes place and leaves gradually die from the tip downward.

Mode of spread:

- They spread mainly through air born spores.
- Prophylactic sprays with Mancozeb 0.25% gives good control of the disease.

- Warm weather with humid condition caused by rain or heavy due helps in the spread of the disease and is favorable for the development of the conidia.

Primary Source of Inoculum: *Dormant mycelia,*
Secondary Source of Inoculum: *Air borne conidia.*
Epidemology:

- The optimum Temperature for the development of disease is 28 to 32°C .
- Relative humidity is 85 to 90 %. Nutritionally poor soil, Susceptible host favours the disease.

Management:

- Recommended NPK & FYM application.
- Use disease free planting material.
- The disease can be controlled by three foliar sprays with Mancozeb 0.25%.
- Use of biological agents like *Trichoderma viridae.*

DISEASES OF PYRETHRUM
Pyrethrum: *Chrysanthimum cinerarifolium*
Pyrethrum refers to several Old World plants of the genus *Chrysanthemum* which are cultivated as ornamentals for their showy flower heads. It is also the name of a natural insecticide made from the dried flower heads of *C. cinerariifolium* and *C. coccineum*. Pyrethrum was used for centuries as an insecticide
It is a member of the daisy (or aster) family, Asteraceae. They are perennial plants with a daisy-like appearance and white petals.
MAJOR DISEASES

	Disease	Pathogen
1.	Pyrethrum fusarium wilt	*Fusarium oxysporum* f.sp.*solani*
2.	Leaf spot/bloch	*Septoria chrysanthemella*
3.	Root rot	*Sclerotinia minor*
4.	Ray blight	*Phoma ligulicola* var. *inoxydablis,*

1. PYRETHRUM FUSARIUM WILT
Causal organism: Fusarium oxysporum* f.sp.*solani
SYMPTOMS:
EXTERNAL SYMPTOMS

- Initially the older leaves starts showing yellowing then as disease advance the yellowing progresses to upper leaves.
- If the organism produces more toxin then leaf margin necrosis takes place.

INTERNAL SYMTOMS
Infected roots show black to brown discolouration, blocking of the vascular bundle by the fungal mycelia and chlamydospores, micro and macro conidia leads to drooping of the plant.
IMPACT of the disease dropping, wilting, stunting and reduce tillering. In advance stage majority of the tillers wilt and result in death of entire plant. Movement of nutrients and water from below groundceases and plant starts showing wilting.
Aetiology:

- Mycelia is septate, inter and intracellular haustoria[absorbing organ].
- Asexual spores are Micro and macro conidia.
- Sexual spores are Ascospores born in ascus present in perithecium where as the Vegetative spores are Chlamydospores

Primary source of innoculum is Chlamydospores and the infected planting material.
Secondary source of innoculum is Soil borne micro and macro conidia.
Spread: the fungal spores spreads through irrigation
EPIDIOMOLOGY:

- The organism causes disease when temperature is 28-320C
- Relative Humidity 80-90%
- Sandy loam soil with Acidic pH(5.5-6.5) and
- Susceptible host, low soil moisture and the affected seed.

MANAGEMENT:
Cultural method

- Summer ploughing is done and Infected plant should be removed and destroyed
- Use healthy seed and treat the seed with **carbendazim 2g\kg of seed**
- Neutralize the soil pH by applying lime (200-300g\plant)
- Avoid excess nitrogen application
- Crop rotation with non host plant eg: Graminaceae
- Chemical: Drench the soil with **carbendazim 0.1% **
- Growing of resistant variety, KKL-1

2. Leaf spot\blotch: *Septoria chrysanthemella*

SYMPTOM:

On young leaves

- Initially circular to irregular blackish brown spot on leaves
- later spot surrounded by yellow hallow.
- In severe infestation, the leaves remain small and curling takes place
- The dead leaves hang on the stem for some time

AETIOLOGY:

- Mycelium is septate inter and intrecellular haustoria,
- Sexual spores are Ascospores borne in pseudothecium.
- **Primary source of inoculumis** Ascospores (pseudothecium)
- **Secondary source of inoculums** is pycnidiospores

Mode of spread is infected debris in the soil and rain splash.

EPIDEMIOLOGY:

- The organism requires cool weather with the temperature of 18 to 200 C
- Relative humidity 95 to 99%
- Cloudy weather and Intermittent rain fall

MANAGEMENT:

- Collect the affected plants and burn.
- Regular Irrigation
- Spraying of systemic fungicide such as **carbendazim 0.1%**
- **Mancozeb 0.25%** as aerial spray for effective control.

3 .ROOT ROT: *Sclerotinia minor*

Symptoms:

- The organism colonize at epidermal layer at collar region of plant, discoloration of collar region, thinning at collar region leads to girdling
- Then the plant start drooping and drying then finally rotting takes place.

AETOLOGY:

- Mycelia is Septate, sclerotial bodies are vegetative structures strands
- Sexual spores are ascospores borne in apothecium

EPIDEMIOLOGY:

- The organism requires Warm weather condition with temperature of 30-320C
- Relative humidity of 70-80%.

Primary source of inoculums : Sclerotial bodies present in affected debris

Secondary source of inoculum is Mycelial strands.

MANAGEMENT:

- Host destruction
- Crop rotation with graminacea family
- Low level of N application and increase K application
- Chemical: carbendazim 0.1% as soil drenching

Minor disease

Ray Blight *Phoma ligulicola* var. *inoxydablis*,

SYMPTOM:

- Necrosis of the ray florets of the flowers
- Distortion of developing stems of pyrethrum plants and necrosis in the growing tips are symptoms of a severe form of ray blight caused by ***Phoma ligulicola* var. *inoxydablis***

- Affect all above ground parts of the pyrethrum plant.
- The disease does not affect roots, but the pathogen is able to survive as epiphytic mycelium around root cuttings

Diseased bud affected by *Phoma ligulicola*

Etiology: mycelium is septate, asexual spores are pycnidiospores borne in pycnidia.

MANAGEMENT:

- Healthy seed used for sowing
- Crop rotation with graminacea family
- Affected plants cut and burn
- Chemical: carbendazim, 0.1% as soil drenching

Lecture 28 CROTALARIA

Ethnic Community Of Puralia: Plant: as tonic to pregnant women and to facilitate child birth ; tribes of HAZARIBAGH(Bihar) : Root : In urinary complaints; ORAON : Plant: against snake bite.

Phytography: Creeping herb or sub erect under shrub,30-60cm high; stem and leaves softly haired; leaves subsessile, simple, thin, 5-7.5cm long, obovate to ovate to oblong, stipules forming a broad wing; recemes lateral, leaf opposed,2-3 flowered ; flowers bracteate, yellow,1.25cm, calyx densely silky; pods stalked, 3-4.3 cm long, linear to oblong, 30-40 seeded. Seeds contain Usaramine

Diseases of Crotalaria

S.no.	Disease		Pathogen
1	Fusarium wilt		*Fusarium udam*
2	Stem rot		*Sclerotium rolfsii*
3	Anthracnose		*Colletotrichum crotolariae*
4	Cercospora leaf spot		*Cercospora crotolariae*
5	Damping off		*Corticium vagume*
6	Gray Mould		*Botrytis cinerea*
7	Alternaria leaf spot		*Alternaria sp*.

Furasium wilt:

External Symptom: It is a fungal Disease.

- Lower leaf yellowing and drooping of apical/arial parts
- On mature plants, brown colored streaks appears on the side of the main shoot with few white branches while remaining survive.
- **Internal Symptom** : **V**ascular bundle discoloration, later turns to brown to black colour.
- Mycelial strands can be seen in vascular bundles.

Etiology : Septate mycelia, intercellular mycelia.

- Asexual spores are Micro and macro conidia, on sporodochium
- Vegetative spores are Chlamedospores (dormant spores)
- Sexual spores are ascospores borne in ascus.

Primary source of inoculum:- Chlamedospores, dormant mycelia in crop debris and soil..

Secondary source of inoculum:- Micro and macro conidia through soil borne and through irrigation of water

Epidemiology: Soil temperature 25-28^{0}C, Relative humidity 80-85% , Low soil moisture Acidic pH 5. 5 to 6.6, Susceptible host

Management : Use healthy seeds and treatment with Captan. 3 gm/kg of seed.

- Neutralize the soil pH.
- Affected plant parts should be cut and burn.
- Chemical- carbendazim 0.1% for soil drenching.
- Crop rotation with graminaceous crop like sorghum.
- Biological agent *Trichoderma viride* application after nutralizing the soil PH

Stem rot: *Sclerotium rolfsii*.

- It is a fungal Disease and soil borne organism.

Symptoms: Sclerotial bodies are sorghum like structures then they germinate and multiplies by producing mycelia.

- It colonises and girdle the seedling after infection.
- Once the epidermis destroys, the stem become yellow and root length reduces.
- Finally the death of plant.

Etiology: Septate mycelia, sclerotial bodies are vegetative structures.

- Asxeual spores: mycelial strands act as a conidia
- Sexual spores: ascospores borne in Apothecium.
- Primary source of inoculum: Sclerotial bodies.
- Secondary source of inoculum: Mycelial strands and through irrigation water.

Epidemiology: - Warm weather, soil temperature 30-33ºC, relative humidity 65-70% susceptible host. Sandy loam /red soil.

Management :

- Cut and burn affected plant parts.
- In main field provide good drainage to reduce the soil moisture.
- Chemical application soil drenching with Bordeaux mixture 1% or COC 3gm/ltr or metalaxyl 1.5gm/ltr.
- Biological agent *Trichoderma viride*.
- Low density planting and follow raised bed method.
- Drip irrigation.
- Reduces N application and increase K application

Anthracnose

Anthracnose has been a conspicuous disease in crotalaria for the last few years and is caused by the fungus *Colletotrichunv crotalariae* Petch. The disease is most commonly found on *Crotalaria striata* and *C. spectablis* probably more pronounced on the latter. The stems of the plants are attacked from the soil surface upward, and the bark is killed and sloughs away. The plant dies gradually, shedding the lower leaves, the shedding advancing upward. The entire plant finally succumbs, sheds all its leaves, and turns brownish black. The fungus produces fruiting structures and spores abundantly over the cankerous areas on the stem. These areas are also overgrown in most instances with a Fusarium species, which assumes a secondary more or less saprophytic rôle. This disease spreads from one plant to another and advances rapidly from the central source of inoculum. Where it occurs, it is severe in its attacks, but generally the loss is not great.

CERCOSPORA LEAF SPOT

The cercospora leaf-spot disease is caused by *Cercospora crotalariae* Sacc. Both *Crotalaria striata* and *C. spectabilis* are attacked by this disease, but it is not serious on the former. On the latter, however, it assumes considerable proportions and during the latter part of the summer has caused almost entire defoliation. The spots appearing on the leaves are more or less scattered. At first they are dark colored, slightly sunken, and irregular in outline, increasing in size as they grow older, often to a centimeter in diameter, and a large percentage develop whitish centers. The fungus fruits prolifically on both surfaces of the spots. The spots on C. striata are much smaller, usually round, sunken, and of tannish-brown color. This disease may be found also wherever the host plant is grown.

DAMPING-OFF

In the spring plantings of crotalaria there is considerable damping-off, caused by *Corticium vagum* B. and C. This trouble does not appear to be limited to any specific species of the host plant. The fungus attacks the seedlings at the soil line, girdling them, and as a result the plants are killed in very typical fashion. This disease is more pronounced in low, wet places, and a great amount of damage occurs during periods of wet, cool weather.

SOUTHERN BLIGHT

Southern blight, caused by *Sclerotium rolfsii* Sacc, is rather common and is well distributed throughout Florida, attacking crotalaria wherever it is grown, appearing more or less common on the more widely grown species, such as *Crotalaria striata* and *C. spectabilis*. The latter has experienced the greater losses. The fungus attacks the plants at almost any time during their development from the seedling stage to seeding, girdles the plants at the soil line, and eventually kills them, after which they turn brown, and if the plants are past the seedling stage they usually remain standing, The fungus produces innumerable small, round, brown sclerotia on the stem of the plant and in its immediate vicinity at the soil line.

GRAY MOLD

Gray mold, caused by *Botrytis cinérea* Pers., has been very conspicuous during past seasons on *Crotalana spectdbilis*. In the vicinity of Gainesville, Fla., this disease has caused losses averaging 3 to 5 per cent of the plants. The fungus attacks the plants following blossoming time, being prominent on the stalks and seed, pods, and commonly forms spots on the leaves. It usually attacks the stems at the point of union of stem and peduncle of the seed pods, where brown lesions are formed. The lesions eventually girdle the entire stem. As the lesion develops in both directions from the original infection the killed area rapidly dries out and the bark breaks away from the woody portions of the stem. These lesions often involve from 2 to 10 inches of the stem, and after the lesion occupies an

inch or more of the stem area the fungus develops conidia in abundance on the area involved. The seed pods are usually infected from either end, from which the fungus overgrows the remaining portions of the pod and develops fruiting bodies. The areas on the leaves are not so numerous, although they are often 2 centimeters or more in diameter and covered with fruiting bodies. During 1929 this trouble was more conspicuous and caused greater losses than any of the other diseases of crotalaria Avith the possible exception of Cercospora leaf spot.

ALTERNARIA LEAF SPOT

Alternarla leaf spot, found occasionally on declining leaves, is caused by Alternarla sp. It is not conspicuous or of economic importance and is worthy of mention only.

HELMINTHOSPORIUM LEAF SPOT

Helminthosporium leaf spot, caused by Hélminthosporium, sp., has been collected a very few times and has not been found to be of any importance on any of the various species of Crotalaria grown. It is reported primarily because of its occurrence.

List of Diseases of costus

S. No.	Disease		Pathogen
1	Rhizome rot		*Phytophthora solani*
2	Pythium rhizome rot		*Pythium spinosum*
3	Leaf blight		*Curvularia paradisii*

There are no major pests which affect this crop. However, the following are some diseases which are observed to affect the crop.

1. **Rhizome rot**

   It is caused by *Phytophthora solani* and develops very quickly from July to August. In the rhizomes kept in storage after the harvest. Initially, the symptom starts from the tip of the injured portion on the rhizomes. Subsequently, the rhizomes become light brown and gives off an offensive odour.

   Properly harvested rhizomes without injuries can be stored for a long time. No chemical control has been worked out.

2. **Pythium rhizome rot**

   The disease is caused by *Pythium spinosum*. In this disease, the infection in the plant starts from the injured portion of the rhizomes and in later stage the rhizome turn dirty brown in colour, the leaves become yellowish brown and finally dry off.

   The prudent selection of rhizomes from the healthy crop and dipping the rhizomes in fungicidal solution like benlate, Bavistin or Dithane Z-78 has been recommended to control the disease.

3. **Leaf blight**

   It is caused by *Curvularia paradisii*. It is very sever from July to September. The symptoms develops on the leaf laminae as small spherical to irregular spots, light brown in colour, and in the advance stage they become dark brown. The upward curling of young leaves is very common. In the advance stages, all the leaves fall off, leaving bare stem in the field. This pathogen can be effectively controlled by spraying 0.3% Dithan M-45 at fortnightly intervals.

L**ecture 29 DISEASE OF DATURA**

S.No.	Disease		Pathogen
1	Leaf spot of Datura		*Alternaria tenuissima*
2	Leaf blight Datura		*Alternaria alternate*
3	Root rot Datura		*Sclerotium rolfsii* Sacc. and *Corticium solani*
4	Leaf blight and fruit rot Datura		*Alternaria cressa*

Leaf spot: this disease was found on the leaves of *Datura stramonium, D. Metel, D. Innoxa*. A large number of plant growing in experimental plantation were found to suffer by the disease.
Cause: *Alternaria tenuissima* (Fr)Wiltshire
Symptoms: the infection cause severe defoliation resulting in considerable economic loss. Spot are characteristically dark brown, round to oval or slightly irregular, coalescing and formed large necrotic area.

Leaf blight Datura

Datur innoxia growing in experimental and commercial plantation was found to suffer from leaf blight disease.

Cause: *Alternaria alternate*

Symptoms: Early infections of the disease appear as water soaked circular spots on the leaves. In later stage the spot coalesce, become dull yellow and turn light brown due to the death of infected tissue. Concentric ring appears on the dead tissue of old spots. A single spot on a leaf cause curling of entire leaf in advance stage of infection. Wilting of the entire branches occurred when two or three leaves of branches are affected.

Control: No disease management for the disease reported. However, fungicidal spray using dithiocarbamates, such as Dithane Z-78 or dithane M-45would be useful for control the disease.

Root rot Datura

Cause: *Sclerotium rolfsii* Sacc. and *Corticium solani*(Peril and Delacr) Bourd and Glaz
Symptoms: infected plants showed yellowing, gradual wilting resulting in the death of plants. Root and foot rot diseases shows almost similar symptoms were observed in experimental plantations. The disease affected plants of all ages, more destructive on young plants. Seedlings showed damping off and were killed within a week. In mature plant older leaves showed yellowing as the disease advanced, severe rotting occurred leading to death and disintegration of plants.

Disease management: usual disease management includes disinfestations of planting material, adjacent of soil pH and fertilizer regim. Cultural methods, such as deep burial of infected crop rotation are often beneficial. Use of soil fumigant suchas formalin, methyl bromide is also beneficial. Pentachlorobenzen is considered to be useful to control fungus.

Leaf blight and fruit rot Datura:

Datura metel and *Datura stamonium* growing in the experimental plot were found affected by this disease. Leaf blight and pod blight were reported on *D. metel* from Israel. Similar disease found on *D. stramonium* in Luknow, India.

Pathogen : *Alternaria cressa* (Sac) Rands

Symptoms: the infection is first observed on leaves as small necrotic spots. The infection later spread to the fruits resulting in fruit blight and rot.the mycelium penetrate beneath the seed coat in most infected seeds.

Disease management: excellent control of the fungus was achieved by disinfection with Thiram suspension.

Disease of Dioscorea

S.no.	Disease		Pathogen
1	Rust		*Puccinia diocorea* Kom.
2	Leaf spot		*Cercospora Dioscorea*
3	Leaf blight		*Glomeralla Cingulata* (ston) Spauld
4	Tuber rot		*Aspergillus niger* van Tieghlm

Rust of Dioscorea

Cause : *Puccinia diocorea* Kom.

Symptoms: the rust infection is observed during the month of October – November on *D. deltoidae*. The symptoms consiste of minute scattered pustules of the fungus on the leaf surface. Both uredal and telial stage of the fungus are observed on infected plants.

Leaf Spot of dioscorea

Cause: *Cercospora Dioscorea* Ellis and Mart.

Symptoms: The fungus produces circular spots which are surrounded by dark border. The spots enlarge into irregular in size. Abundant spores are produced on the infected leaves. Under humid condition the disease is found to spread through mycelia (Koch, 1964). This result in severe disease incidence.

Leaf blight of Dioscorea

Cause: *Glomeralla Cingulata* (ston) Spauld

Symptoms: The disease symptoms appear as light brown, small cicular spots on the upper surface of the leaves. The spot increase in size in later and coalesce forming reddish or dark brown to black patches of blight symptoms.

Disease management: spraying with dithane Z-78 or copper fungicide can control leaf blight of dioscorea species.

Tuber rot of Dioscorea

Tuber rot of *D. floribunda* in nursery beds, field storage or transports in common problem

Pathogen: *Aspergillus niger* van Tieghlm.

Symptoms: initial symptoms of the disease are purplish brown necrosis of tissue. Rotted tissues of the tuber are soft and wet. Decay is associated with fungal with black masses of spores. Under humid condition black masses on the tuber develop rapidly.

Disease management: the tuber rot in nursery beds, field and in storage can be prevented by dipping tuber piece in 300 µg solution of benlet or dusting with 0.3 per cent powder.

Lecture 30 MINT: *Mentha sp.* Family: Labiatae

Introduction: It is the primary source of menthol and other constituent are menthon, methyle acetate, terpenes. Mints are aromatic, almost exclusively perennial, rarely annual, herbs. They have wide-spreading underground rhizomes and erect, square, branched stems. The leaves are arranged in opposite pairs, from simple oblong to lanceolate, often downy, and with a serrated margin. Leaf colors range from dark green and gray-green to purple, blue, and sometimes pale yellow. The flowers are produced in clusters ('verticils') on an erect spike, white to purple, the corolla two-lipped with four subequal lobes, the upper lobe usually the largest. The fruit is a small, dry capsule containing one to four seeds.

LIST OF DISEASES OF MINT.

S.No.	Disease	Pathogen
1	**Powdery mildew**	*Erysiphe cichoracearum*
2	**Wilt**	*Verticillium albo-atrum*
3	**Rust**	*Puccinia menthae*
4	**Leaf spot**	*Curvularia lunata*
5	**Leaf blight**	*Alternaria* spp
6	**Stolon rot**	*Rhizoctonia bataticola*

1) **POWDERY MILDEW**: C.O: *Erysiphe cichoracearum*

Symptoms: Small chloratic spots appear on the upper surface of leaves.

- The corresponding lower surface showing brownish discolouration prior to the appearance of powdery patches.
- Later appearance of white /grey colour powdery growth on both upper &lower surface of leaves It leads to heavy defoliation

TAXONOMY: K: Fungi D: Ascomycota C: Ascomycetes O: Erysiphales F: Erysiphaceae G: Erysiphe SP: *cichoracearum*

Etiology: External septate mycelia, Haustoria sub epidermal. Septate mycelia produces conidiophore on which barrel shaped conidia are borne in chains

- Asexual spores: Barrel shaped conidia borne on Oidium. Sexual spores: Ascospores borne in Ascus. Asci are situated in Cleistothecium. Asexual fruiting body: Oidium Sexual fruiting body: Cleistothecium.
- **Primary Sources of Inoculum**: Dormant mycelia and Short period cleistothecium.
- **Secondary Sources of Inoculum:** Air borne barrel shaped conidia.

Epidemiology: Warm weather: Temp: 28-32°C. R.H: 85-86%. Cloudy weather. Susceptible Host

Life cycle of powdery mildew life cycle

1. Affected plant parts having cliestothium as primary source of inoculum during favourable climate this will produce ascus in that ascospores are present because of lack of pressure inside the ascus they burst open and fly on to air and land on to the host, causes infection and causes powdery mildew of mint.
2. In the affected host conidia are present, they produces oidium and cause infection by flight asexually.
3. During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place by this inoculum is reproduced.

Management: Crop rotation with non host crops, altering the date of sowing, proper nutrient management. Avoid dense planting.

Chemical: Prophylactic aerial spray- Wettable Sulphur 0.3% or Carbendazim 0.1% or Calyxin 0.15% at 10-15 days interval

2) **Rust**: *Puccinia menthae*

Symptom: Brown rusty pustules on the lower surface of leave.

- The spots initially circular, slightly elevated and later coalesce to form irregular spots.
- Chloratic streaks on the upper surface, telial stage is characterized by swelling on the upper portion

of the stem.

- Defoliation and death of the leaves can be seen in severely affected plants (Leaf blighting)

Taxonomy: Kingdom: Fungi, Division**:** Basidiomycota **Class:** Basidiomycetes, Order**:** Uredinales **Family:** Pucciniaceae **Genus:** *Puccinia* **Species:** *menthae*

Epidemiology: Temperature 17-27oC RH: 90-92% Long day hours 1-2 hours dew period in morning

Etiology: Septate mycelia, Intercellular mycelia Intracellular haustoria

- Asexual Spores: Uredospores in Uredium Sexual spores: Teliospores in Telium

Management: Crop rotation with non host crop. Spray mancozeb 0.25%. Hexaconazol 0.1%

3) **LEAF SPOT:** *Curvularia lunata*

SYMTOMS: Small unclear brown spots scattered over the leaf lamina. The minute spot increase in size, forming big spherical or irregular patches.

EPIDEMIOLOGY: Nutritionally poor soil, Temp 28-32^{o} C, RH 85-90per cent, Cloudy weather susceptible host.

- Primary Sources of Inoculum : Dormant mycelia
- Secondary Sources of Inoculum : Air borne conidia

ETIOLOGY: Septate mycelia, inter and intracellular haustoria. any one of the conidia or conidiophore is coloured

- Asexual spores-Air borne conidia on conidiophore, sexual spores- Ascospores
- Vegetative structure is dormant mycelia.

Life cycle: Affected plant parts having Pseudothecium as primary source of inoculum.

- Favourable climate it will release ascospores they flight on to air and land on to the host, causes infection and causes leaf spot of senna.
- In the affected host conidia are present, they produces conidiophore and cause infection by flight b asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place by this inoculum is reproduced

MANAGEMENT: Collect and destroy affected plant parts, increased nutritional status, and Reduce plant population

- Biological agent *Trichoderma* spp. Mancozeb 0.25% as aerial spray

4) **LEAF BLIGHT**: *Alternaria alternata*

SYMPTOMS: Lower most leaves first infected &disease later develop on upper leaves.

- The infected leaves shows round to oval to irregular or slightly irregular dark brown spots on the upper surface of the leaves with concentric rings.
- Spot size increases and covers the entire leaves Later Blightening & detaching of leaves

ETIOLOGY: Septate mycelia, coloured muricate conidia

EPIDEMIOLOGY: Nutritionally poor soil, temp 28-32oC, RH 85-90per cent, susceptible host.

- Primary Sources of Inoculum : Dormant mycelia
- Secondary Sources of Inoculum : Air borne conidia

TAXONOMY: **Kingdom:** Fungi, **Division:** Deuteromycota, **Class:** Deuteromycetes **Order:** Moniliales **Family:** Dematiaceae **Genus***: Alternaria* **Species***: alternata*

MANAGEMENT: Collect and destroy affected plant parts, Proper nutritional management. Reduce plant population,

- Mancozeb 0.25% as aerial spray

5) **Stolon Rot**: C.O: *Rhizoctonia bataticola & Sclerotium rolfsii*

Symtoms : Aerial symptoms: Initially yellowing of leaves & stunted growth. Advance stages the plants wilts followed by death of above ground parts.

Below ground symptoms: Stolons exhibit pinkish brown lesions initially. This gradually turns into dark brown lesions.

- Later turns to dark brown to black patches that increase in size resulting in soft decay.

Etiology: Septate mycelia, sub epidermal haustoria Asexual spores: Mycelial strands

- Sexual spores: Basidium (Basidiospores) Vegetative structure: Sclerotial bodies

EPIDEMIOLOGY: Warm weather, soil temp 28-32oC. Optimum moisture, neutral pH

- Primary Sources of Inoculum : Sclerotial bodies present in the debris
- Secondary Sources of Inoculum : Soil borne mycelial strands

TAXONOMY: Kingdom: Fungi **Division:** Deuteromycota, **Class:** Deuteromycetes **Order:** Mycelia sterilia **Family:** Mycelia sterilia Genus*: Rhizoctonia* **Species***: bataticola*

LIFE CYCLE: The fungi produces sclerotial bodies these are like sorghum seed like vegetative structures.

- When there are congenial conditions the sclerotial bodies germinate and causes disease the affected host having mycelial strands again they germinate and cause infection that how disease cycle continues.

MANAGEMENT: Affected debris destruction, summer ploughing, Crop rotation, Soil sterilization

- Biological agent *Tricoderma* spp.
- Carbendizim 0.1% or Mancozeb 0.25% as soil drenching.

6) **WILT**: *Verticilium albo-atrum* - Complete loss disease

Symptoms: Aerial symptoms: Initially lower leaves starts V shape yellowing. Dwarfing unilateral development of the branches. Etiolating of leaves leading to wilting death.

Internal symtoms: Light tan colour discolouration of vascular bundles.

Etiology: Septate mycelia inter and intra-cellular haustoria, produces V shaped conidiophore on which round shaped small conidia are borne. Vegetative structures: Sclerotial bodies Sexual spores: Ascospore

Asexual spore: Micro and macro conidia

Primary Sources of Inoculum: Dormant mycelia

Secondary Sources of Inoculum: Soil and air borne micro and macro- conidia

Epidemiology: Temp. 30-32oc, RH-90-92%, alkaline pH, Black Clay soil, low moisture, susceptible host

LIFE CYCLE OF WILT

- Perithecium is a sexual fruiting body. It has ascus, when it matures it produces ascospores.
- These ascospores flight on the air and chance factor lands on the host.
- It enters the host through natural openings.
- The host shows wilt symptoms & produces micro and macro conidia & again lands on the host like asexual life cycle continues.
- If conditions are adverse like high or low Temperature, high or low Relative humidity it starts sexual life cycle.

Management:

- Collect and burn affected plant parts. Use soils free from nematode. Crop rotation with non host crops. **Application of biological agents *Trichoderma*** spp. Soil drenching with carbendazim 0.1%

OPIUM *Papaver somniferum L.* (2n=22)

Uses and importance: Opium *(Papaver somniferum)* commonly called opium poppy, is an annual herb belonging to the family papavaraceae.

It grows up to a height of 60-120 cm. It is an important medicinal plant. The source of over 40 alkaloids including psychoactive agents. A great boon to psychiatry for the treatment of mental and nervous diseases and to medical research. The commercial product *opium* is an additive narcotic obtained from the seed capsule of the opium poppy, the source of a number of very valuable alkaloids like morphine, codeine, narcotine, papaverine and thebain. Other minor alkaloids include aporeine, codamine, cryptopine, guoscpopine, hydrocotarinine, laudanine, narcotoline, neopine, oxynarcotine and papaveramine. The seeds are also reported to contain a high % of linoleic acid which lowers blood cholesterol in the human system. The alkaloids, morphine and codeine, are widely used as sedatives to relieve pain and induce sleep, in addition to their use against cough. Opium is a very valuable but dangerous drug. It should be used in very limited quantities and under the strict supervision of o physician. In India, this plant is mainly cultivated for its latex and seeds come as a by product. These seeds are quite a rich source of fatty oil and protein and, in many countries of Europe, employed as a major source of cooking oil. The seed is also an important culinary item in India. It is extremely used in the preparation of native confectionery, pastries and bread. In some places, the young plants are also consumed as a leafy vegetable. This is one medicinal

plant which is very lucrative. A crop raised properly, in one hectare area, fetches about 1 lakh rupees. But its cultivation has to be done under the strict control of the central excise department and it cannot be cultivated everywhere. It can be grown only in those areas specified by the government of India.

DISEASES of opium :

Major disease

S.No.	Disease	Pathogen
1	Downy mildew	*Peronospora arborescens*
2	Damping off	*Pythium dissotocum*
3	Root rot	*Macrophomina phaseolina or Fusarium semitectum*
4	Powdery mildew	*Erysiphe polygoni*
5	Capsule rot	*Embellisia phragamospora*
6	Leaf blight	*Helminthosporium papaveris*
7	Soft rot	*Erwinia papaveris*
8	Poppy mosaic virus	
9	Cabbage-ring spot	
10	Beet-yellow	
11	Bean yellow mosaic	

Major diseases:

Downy mildew -*Peronospora arborescence* (Berk.) de Bary.

SYMPTOMS: In India it is noticed during a middle of February, When the crop is fully grown.

- It is also noticed during November-February. It appears on seedling and such affected seedling s are killed outright.
- The leaves near the tips and margins are covered with pale brown spots.
- On the under surface grey-violet fungal growth is seen.
- Under favorable conditions the disease spreads and affected leaves dry up and become papery and brittle.
- In severe cases of attack entire leaf is killed. Infection may spread to inflorescence and stem also. Yield loss from 7-65%.

ETIOLOGY: Mycelia- Aseptate

- Asexual spores – Barrel shape conidia borne on sporangiophore in asexual fruiting body sporangia
- Sexual spore- Oospores borne in oogonium
- Sporangiophores are erect and very long. They are 7-10 times dichotomously branched and the ultimate branches are fine, curved, sharp, diverging almost at right angles, pointed at the tip.
- At the tip bears a single round –oval conidium **.**Sporangia are hyaline or pale violet.
- Oospores are round yellow, thick walled surrounded by an irregularly thick and reddish brown wall

MODE OF SPEAD AND SURVIVAL:

Primary source of inoculum: Oospores, affected debris.

Secondary source of inoculum: Zoospores spread through wind, water splash

The fungus infects *Argemone mexicona, A. platyceras Meconosis sp. Papaver dubium, P. argimone* and *P. rhoeas*.

The disease is carried from one season to another by means of thick walled oospores. It is not seed borne. Mycelia fragments on capsule may serve as source of infection

EPIDEMIOLOGY: Temperature 22-24^{0}C Relative humidity- 90-95% intermittent rain fall susceptible host.

MANAGEMENT: All disease plant should be uprooted, collected and destroyed.

- Seed treatment with apron 35SD (metalaxyl) at 5g/kg +3 sprays of metalaxyl (ridomyl 25WP) 0.1% at 20, 60 and 80days of sowing.
- Foliar spraying with mancozeb 0.25% also controls the disease.
- The poppy line Vo.141 is found to be highly resistant to the disease.

Minor diseases:

Damping Off- This disease was reported in India from Lucknow during the incidence ranged from 40-60%.

SYMPTOMS:

- Pre-emergence& post-emergence damping off occurs in opium. Severely affected seedlings show decay of root and collar region.
- Diseased seedlings die in 3-5days after attack.
- Mycelium of fungus is white and coenocytic, sporangia are filamentous, slightly inflated with discharged tubes.
- Oogonia may be terminal or intercalary, spherical and 19-24 micrometer in diameter. Antheridia 1-3 micrometer
- Oospores are single, plerotic, 17-20micro meter in size with 1.3micrometer thick walls.

ETIOLOGY: *Pythium dissotocum* Drechsle.

Mycelia: Aseptate, Asexual spore- Zoospore, Sexual spore- Oospores borne in oogonium

MODE OF SPREAD AND SURVIVAL:

Primary source of inoculum: Oospores, affected debries.

Secondary source of inoculum: Zoospores

EPIDEMIOLOGY: Temparature: 22-24ºC High relative humidity: 90%, High density seedlings Low lying areas

- Increased moisture-80-90%, susceptible host.

MANAGEMENT: Raised methods for sowing, Line sowing with proper spacing,

- Soil sterilization with 4% formaldehyde upto depth of 30cm,
- Seed treatment with captan -2g /kg or Mancozeb-2g /kg of seeds

Root Rot - *Macrophomina phaseolina* (Tassi) Goid. It is prevalent in parts of Bihar and U.P.

SYMPTOM: Affected plant begins to wither and dry up from the base. The stem at the collar region shows blackening and shredding of root barks. The affected plants dry up; the disease is noticed in patches. Large number of minute and black sclerotia can be seen on affected root barks.

MODE OF SPEAD AND SURVIVAL: imary source of inoculum : sclerotial bodies

Secondary source of inoculum: Mycelia

ETIOLOGY: Mycelia- septate Asexual spores: Absent Sexual spores : Basidiospores

- Vegetative structures: Sclerotial bodies
- Fungus hyphae are colorless, branched and 8-9micrometer in diameter later they become brown.
- Sclerotia are black and measures 150 micro meter in diameter.

MANAGEMENT: Seed treatment with carbendazim 2 g/kg and provision of proper drainage facilities are the important control methods.

Powdery Mildew- *Erysiphe polygoni* DC.

Introduction: Powdery mildew is an endemic disease wherever the opium are grown in the world. The disease has been reported from the American continent, Europe, Africa, Australia and Asia.In India, the disease is most common in North India.

Symptoms: The fungus attacks all the green plant parts at all stages of plant growth.

- The fungus produces white to grayish powdery patches on the affected plant parts including fruits but young leaves are most susceptible and develop small whitish patches both on upper as well as lower surface.
- These patches grow in size and coalesce to cover large areas on the leaf lamina. Malformation and discoloration of the affected leaves are also common symptom, resulting in distortion.
- Similarly, powdery patches are produced on the stem, tendril, flowers and young fruit branches.
- Diseased vines appear wilted and the stem portion turns brown.
- The infected blossom and berries turn dark in colour, irregular in shape and brittle.
- In advance stage of infection, berries may develop cracks and such berries do not develop and ripe.

ETIOLOGY: *Erysiphe polygoni*

- Mycelia is septate, external thin mycelia, haustoria is sub epidermal, obligate parasite.
- Asexual spores are barrel shape conidia borne on oidiophore in chains asexual fruiting body oidia.
- Sexual spores are ascospores inside the Ascus in the ascocarp Cleistothecium.

MODE OF SPREAD AND SURVIVAL:

Primary source of inoculum : Ascospores, Dormant mycelia.

Secondary source of inoculum: oidia

- It survives as dormant mycelia and as Cleistothecia on the shoots and buds from season to season.

- The disease spreads by the air- borne conidia.

EPIDEMIOLOGY: The disease occurs in severe from Oct- Nov in North India and Feb- June in South India.

- Disease is favoured by warm sultry weather and retarded by sunshine.
- Warm winter temperature from 20 to 33.50C has been found to be the cause for epidemic in Hyderabad.
- Disease development is adversely affected by rain.

MANAGEMENT:

I. **Cultural practices:** The proper air circulation through the canopy and prevent excess shading help in reducing the disease. Orchard sanitation is also important in reducing the disease pressure during the growing season.

II. **Chemical control:** Fungicides like sulphur, dinocap, benomyl, are used commercially although not as extensively as sulphur, to control the disease.

- The use of fungicides for control of powdery mildew should begin during early stages of development. Spray schedules of 7-10 days are usually required for effective control by sulphur.
- Dinocap has 10-14 days schedule while; sterol biosynthesis inhibiting fungicides are commonly used at 14-21 days schedule.

Capsule Rot- *Embellisia phragmospora*. (Van embess)

SYMPTOMS: Symptoms can be seen on mature and tender leaves.

- Large circular, irregular, water soaked lesions, dirty black in color appear on the margins of mature leaves.
- Lesions can be seen in the centre of the leaf on either side of the midrib.
- In some cases, large lesions extending the entire length of the leaf can also be seen. The exposed portions of the tender, unopened leaves may also rot.
- The leaves become shredded and remain attached to the pseudostem.
- Grayish patches of irregular outline and size with brownish margins are found at the base of the leaf sheath.
- The basal portion rots causing the pseudostem to break away at the collar region even at the slightest disturbance.
- The infection spreads to the underground parts and become decomposing mass.
- Small light brown lesion on green, tender fruits which falls off in 3-6 days after infection leaving the small fruits stalk on the bare of inflorescence, finally rotting occurs.

MODE OF SPREAD AND SURVIVAL:

- **Primary source of inoculum:** Chlamydospores, Infected plant debris.
- **Secondary source of inoculum:** Sporodochium, conidia (macro & micro)
- The fungus is soil borne and survives in the form of chlamydospores.
- Soil PH 6-7 was favoured.

EPIDEMIOLOGY: This disease found in MAY-AUGUST coinciding with South -West monsoon.

- Temperature-21-26^{0}C, high rainfall, high soil moisture, more relative humidity.

MANAGEMENT: The disease is controlled by spraying with mancozeb 0.2% or zineb0.2%.

Soft Rot: *Erwinia papaveris (Ayyar)* Magrou.

SYMPTOMS: The disease is characterized by external blackening and internal disintegration, accompanied by the discoloration of the mid rib of the leaves.

- The disease commences at the apex and extents downwards and the whole plant is turned into a slimy mass.

ETIOLOGY: **CO: *Erwinia papaveris***

- It is a gram – ve, single celled, peritrichous bacteria
- The bacterium is rod shaped 0.5-2.5×0.5 micro meter in size, strictly aerobic, , non acid fast,
- Non-Sporulating, Non-capsulated with 2-8 peritrichous flagella.

MODE OF SPEAD AND SURVIVAL: Primary source of inoculum: Affected debries.

Secondary source of inoculum: Bacterial cells.

EPIDEMIOLOGY: Optimum temperature for growth is 30^{o}C. Thermal death point lies between 50-60^{o}C

- The bacterium can retain its viability on poppy seeds for over 20months.

MANAGEMENT: Copper oxy Chloride (COC) 0.3%

Poppy Mosaic-*VIRUS*

- The aphid, *Myzus persicae* is the vector which transmits the mosaic disease.
- The minimum acquisition feeding period is one min.
- The minimum inoculation feeding period is also one min.
- Single aphid is efficient in transmitting the virus.
- The virus is non persistent type.

SYMPTOMS: Yellow + green patches on leaves, stunting, flower drop, yield reduces. This virus is very sensitive

MODE OF SPEAD AND SURVIVAL:

Primary source of inoculum: Affected host plants, weed host& self sown crops**.**

Secondary source of inoculum: Virus particle

EPIDEMIOLOGY: Summer season, High temperature, susceptible host, improper management leads to development of this disease.

MANAGEMENT: Initially spray Dimethoate -0.1% after 15 days and Imidacloprid 0.05% at another 15 days and neemazol 0.5% later.

Lecture 31 : DISEASES OF *SOLANUM KHASIANUM*

1**. Powdery mildew** will be noticed during prolonged dry and warm period, Bavistin (I g/l) may be sprayed to control this disease.

2. **Collar rot** or *Fusarium* wilt can be overcome by keeping the field clean and planting the crop in a well drained soil. Dipping the roots of the seedlings in a 0.1 % solution of Bavistin for 1 hour and drenching the seed-beds with 0.25% of copper oxychloride or 0.1 % of Bavistin solution can control the disease.

3. Sometimes the plants are attacked by **mosaic,** caused by three different viruses, which leads to stunted growth and chloratic leaves. Such plants are better removed and destroyed.

4. **Bacterial blight** is not a serious disease on this crop. However, under severe incidence, a treatment with the solution of 30 g of Streptocyclin and 30 g of Copper sulphate dissolved in 500I of water per hectare controls this disease.

5. **Leaf-blight** is caused by *Pythium butleri* and is not a serious problem in this crop.

Seedlings may also be attacked by damping-off disease while growing in the nursery-beds. To control this, the seeds are treated with Bavistin @ 3g /kg of seeds. Drenching the seed-beds 2-3 days after sowing and again when 50% of the seeds have germinated, with 0.1% of Bavistin or 0.25% of copper oxychloride solution, helps to check the further spread of the disease.

6. The occurrence of the chlorotic stunt disease and its association with the root-knot nematode *(Meloidogyne javanica),* and the wilting of plants due to *M. incognita* have also been reported.

DISEASES OF TEPHROSIA

S. No.	Name of disease		Pathogen
1	Root rot, collar rot	:	*Armillaria mellea*
2	Collar rot	:	*Calonectria theae* var. *crotalariae = Cercosporella theae*
3	Leaf spot	:	*Camptomeris tephrosiae*
4	Leaf spot	:	*Cercospora* sp
5	Collar rot web blight	:	*Corticium salmonicolor*
67	Leaf spot	:	*Cylindrocladium tephrosiae*
8	Root rot collar rot	:	*Fomus lignosus*
9	Root rot collar rot	:	*Fomes noxious*
10	Root rot	:	*Fusarium* sp
11	Root rot collar rot	:	*Irpex subvinosus*
12	Damping off foliar blight	:	*Pellicularia filamentosa = Rhizoctonia solani*
13	Root rot collar rot	:	*Pellicularia koleroga*
14	Collar wilt	:	*Phytophthora parasitica* var. *nicotianae*
15	Root rot collar rot	:	*Poria hypolateritia*
16	Damping off	:	*Pythium aphanidermatum*
17	Foliar blight	:	*Rhizoctonia bataticola*
18	Foliar blight damping off	:	*Rhizoctonia dimorpha*
19	Root rot collar rot	:	*Rosellinia arcuata*
20	Root rot collar rot	:	*Rosellinia bundous*
21	Root rot collar rot	:	*Sclerotium rolfsii*

Root and stem

Root and stem rot have been the biggest disease threats to *Tephrosia vogelii* culture. Of the 52 species of fungi reported on *Tephrosia*, about 33 species are known to induce damping off, or root and collar rot. Of the 23 pathogen occurring on *T. vogelii*, 14 induce these types of diseases.

The majority of fungi capable of inducing rot in *T. vogelii* are wood decay organism, including *Armillaria mellea, Fomes lignosus, F. noxius, Irpex subvinosus, Poria hypolatteritia, Rosellinis arcuata and R. boundes*. Coffee, rubber and tea crops are affected seriously by these pathogens. *Tephrosia* species, including *T. vogelii* are also highly susceptible. In tropical plantation where *Tephrosia* used as shed and cover crop for coffee, rubber and tea seedlings, long term cultivation and periodic cutting of the *Tephrosia* plant predispose them to infection by the wood rotters. These

organism probably would not constitute a threat to open field planting of *T. vogelii* grown as annual crop.

Damping off of young seedling is a major problem in the establishment of stands of *T. vogelii* in Puberto Rico. Ruppel and others demonstrated that *Pythium aphanidermatum*, *Rhizoctonia dimorpha* and *R. solani* were the chief organism involved. In test in 1963 damping off was controlled to some extent by a combination of pelleting the seeds with thiram and shallow (1.25 and 2.54 cm or ½ to 1 inch) planting. In further tests with various fungicide, an furrow application of a 1 :1 EC mixture of pentachloronitrobenzen (PCNB) and 5 ethoxy -3- trichloronitromethyl-1,2,4, thiadiazole (OM 2424) at 4 pounds active per acre gave promising results. Additional tests are needed at different dosages level to ascertain the efficacy of this fungicide combination.

A new **collar rot** disease was detected in 1964 in nurseries of *T. vogelii* in Puerto Rico. The disease was named as *Phytophthora* wilt for its predominant system and causal organism *P. parasitica* var. *nicotianae*. Plant of 10 to 12 weeks old showed a severe wilt of the foliage. In 2 to 3 days leaves become yellow and die. Basal stem of affected plant exhibit a dark brown, somewhat wet lesion at the soil level. Control measure have not been studied; however statistically significant difference were found in the disease reaction between various breeding lines of *T. vogelii*. In the field certain line were completely eliminated by the disease, while adjacent line remain healthy. It seems likely that resistance to the *Phytophthora* disease can be incorporated in desired line through a selective breeding programme. Fungi inciting other root and stem rot of *T. vogelii* include *Calonectria theae var. crotolaria*. *Corticium salmonicolor, Pellicularia koleroga* and *Sclerotium rolfsii.*

Root and stem rot are difficult disease to control, because most of the causal organism persist for long time in the soil. Chemical seed and soil treatment with fungicide, a general field sanitation program and a normal rotation plan should help to keep disease in check.

FOLIAR

Thanetophorus cucumeris, Rhizoctonia solani, Rhizoctonia bataticola, and *Rhizoctonia dimorpha* are capable of inciting foliar blight in *T. vogelii.* Similar symptoms are induced by these organism. Angular greyish green, water soaked areas appear at the apex or margin of the leaflets. As the lesion advance the oldest part become tan necrotic. The leaflets eventually become twisted, dried, and shriveled. Under extremely moist conditions, affected leaflets and stem may be enveloped with a webby, extrametrical mycelium. Hard, small, dark brown sclerotia often look like small soil particle scattered over as source over the plant. These hard reproductive bodies help the fungus to persist in the soil and serve as source of primary inoculum for future crops. Control of foliar blight with alternate sprays of Bordeaux mixture and zinc ethylene bis (dithiocarbamate) zineb has been reported. Hansford reported two reported two leaf spot diseases of *T. vogelii*. One was incited by *Cylindrocladium tephrosiae*, which induced lenticular white to pale buff, dark colored interveinal spots on upper surface of leaflets. The other was incited by *Camptomeris tephrosiae* which inducted lenticular, yellow to brown spots on leaflets. A *Cercospora* sp. also has been reported to cause a leaf of *T. vogelii*

Lecture 32 POST-HARVEST DISEASE

Introduction

The losses due to Post –Harvest diseases of Fruits particularly in subtropics and tropics are enormous. Losses due to Post-Harvest diseases are not exactly known in India. However, there is a colossal wastage under our poor marketing and transit facilities. Keeping in view the importance of fruits in our diet concerted efforts is required to minimize losses which can save at lease 20% of our fruit.

I) Banana

1. Anthracnose: *Collectotrichum musae*
2. Black Tip: *Botryodiplodia theobromae*
3. Cigar-end Disease*: Verticillium theobromae*
4. Pink mould Rot*: Trichothecium roseum*
5. Fusasial Rot: *Fusarium moniliformae*
6. Banana Scab: *Phoma poleyana*
7. Freckle and Black spot*: Macrophoma musae*

1. Anthracnose

Symptoms : Fruit – It occurs on the ripened fruit on the ripen fruit small minute black dots and sunken discoloration Ripening stage is susceptible for this disease because of less phenol content and black increased reducing sugar.

Causal organism: *Collectotrichum musae*

Etiology: - Mycelia – Septate.

Asexual Spore – Conidia bon in acervulus

Sexual spore - Ascospore born in Perithecium

Epidemiology: This organism appears on ripening fruits. Green fruits are free from this Disease. It is common in Sep-Oct month.

- Temperature : 28-320 C
- Relative Humidity : 90-92%
- Week and Susceptible Host
- In increased soluble sugar concentration it is a carbon source of organism and will multiplied.

Primary Source of Innoculum: Ascospore born in perithecium Fruiting body.

Secondary source of Innaculum: Conidia born in acervulus.

Spread: Through winds

2. Fusarial Rot: *Fusarium moniliformae*

- Complete loss, Soil born.
- Symptoms of fruits: Produce small sized bunches less number of fingers and fail to ripen.
- Etiology: Mycelium – Septate.
- Asexual spores: Micro and macro conidia born on sporodochium.
- Sexual Spores: Ascospores bon in ascus – Ascocarp is perithecium.
- Vegetative Stage: Chlamadospores responsible for long time survival.
- Primary source of innaculum: Chlamydospores present in affected debris soil.
- Secondary Source of innaculum: Micro and Marco Conidia.
- Spread: Through irrigation water through agricultural operations.
- Mode of entry: Through wounds – Natural roots one root.
- Epidemiology: Temperature – 25-300C
- Soil moisture: - 50%
- Soil pH: - Acidic pH 5.5-6.8
- Soil type: Sandy loam Congenial for spread of the disease and susceptible host.

3. Cigar end Disease: *Verticillium theobromae*

Symptoms: Brackish discoloration is covered by whitish mycelia.

It occurs in green stage in the bunch i.e it occurs on green fruit starting from tip of the fruit.

Grape

	Post Harvest Disease		
6	Anthracnose/ Bird eye spot		*Elsinoe ampelina*
7	Botrytis Bunch Rot or Gray		*Botrytis cinerea*

	Mold		
8	Blue mould rot		*Penicillium digitatum*
9	Stalk end rot		*Aspergillus niger*
10	Rhizopus rot		*Rhizopus nigricans*

POST HARVEST DISEASE OF GRAPES

1. **Anthracnose/ Bird eye spot: *Elsinoe ampelina***
2. **Botrytis Bunch Rot or Gray Mold of Grape: *Botrytis cinerea***
3. **Blue mould rot: *Penicillium digitatum***
4. **Stalk end rot: *Aspergillus niger***
5. **Rhizopus rot : *Rhizopus nigricans***

1. Anthracnose/ Bird eye spot: *Elsinoe ampelina*

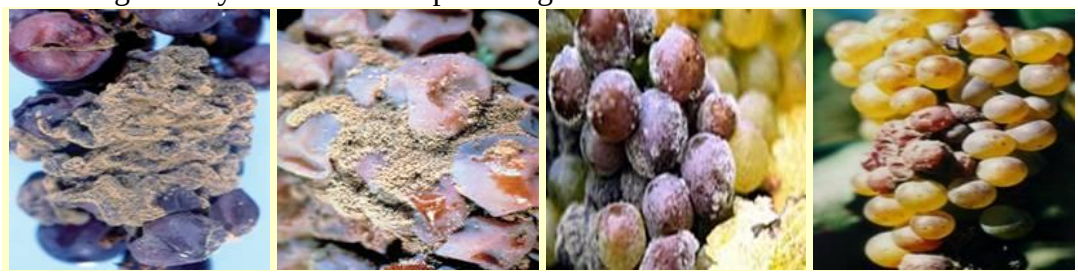
- On berries, small, reddish circular spots initially develop.
- The centers of the spots turn whitish grey and are surrounded by narrow reddish-brown to black margins.
- Acervuli (fungal fruiting structures) eventually develop in the lesions.
- A pinkish mass of fungal spores (conidia) exudes from these structures during prolonged wet weather condition.
- Wetness for 24 hours or more and the temperature is above 36°F.
- splashing rain are spread the disease


Management:

- The diseased leaves and twigs should be pruned and burnt.
- Spraying -Ferrous sulphate 2.5 kg + 0.5 pint sulphuric acid in 4.5 l of water.
- Spraying -BM 1.0 % or Copper oxychloride 0.25% or Carbendazim 0.1% or Mancozeb 0.2% or Difolatan 0.2% or Chlorothalonil 0.2% or Bitertenol 0.1%.
- Resistant varieties – Bangalore Blue, Beauty Seedless, Bharat Early, Golden queen, Large white.

2. Botrytis Bunch Rot or Gray Mold of Grape: *Botrytis cinerea*

- Infected berries first appear soft and watery.
- Infected berries of white cultivars become brown and shriveled,
- Purple cultivars develop a reddish color
- Healthy berries touching infected berries will become infected.
- Rotted berries generally shrivel and drop to the ground as hard mummies



Management

- Preharvest infection can be controlled by three application of captan 0.2 % at monthly intervals before rainfall.

3. Blue mould rot: *Penicillium digitatum*

- Scanty growth - white and turn bluish green are seen.
- Decay the berries
- Infected tissues become soft and watery
- Infected berries emits a moudly flavour

Management

- Avoiding injuries to the ripe berries helps to reduce soft rot.
- Clean planting stock; (ii) Disease wood removal and immediate burning; (iii) fungicide application at shoot extension and later if temperatures are cool. Sulphur is said to reduce new infections in the early Spring

4. Stalk end rot: *Aspergillus niger*

- Brown rot at stalk end is start point of attack the pathogen.
- Rotting begins as a small, circular to oval, water soaked spots are brown in colour.
- Infected berries are soft and emit bad odour

5. Rhizopus rot : *Rhizopus nigricans*

- Round irregular, light brown and water soaked lesion appear on fruits.
- Decaying fruits emits fermented, moudly smell.
- Conidia aseptate, small and globose

Management:

Diphenyl sprayed on cushions is effective at 1 g and 2 g per pack in protecting the fruits upto 15 days in storage as protectant and eradicate

APPLE

1) Apple Scab : *Venturia inaequalis*
2) Bitter Rot *: Glomerella cingulata*
3) Blue Mould Rod *: Penicillium expansum*
4) Grey Mould Rot *: Botrytis cinerea*
5) Alternaria Rot *: Alternaria alternata*
6) White Rot *: Botryosphacria obtiusa*
7) Brown Rot *: Monilinia fructiglna*

1. Apple Scab:

Symptoms: - On leaves : On the lower surface of leaves green colour velvety spots with wavy Appears slowly it will starts showing symptoms on the upper surface i.e. slightly raiseol olive green spot.

On Fruits: Slightly reseal rough corky olive green spot appears later on cracking of fruits taken Place, later mummification may taken place.

Causal organism : *Venturia inaequalies*

Etiology: - Mycelia- It is pseudothecial fungi.

Asexual stage is spilocea.

Primary source of innaculum: Pseudothecium present on the affected taken leaf.

Secondary source of innaculum: Air born spilocea typed conidia.

Epidemiology: Moisture condition

2) Bitter Rot:

Symptoms: On fruits – Small lesion or cipien infection, brown, firm, flat or slightly sunken spots.
Causal organism: *Glomerella Cingulata,* Fruiting body Acervulus
Etiology: Mycelia Septate.
Primary source of innaculum: Dormant mycelia.
Secondary source of innaculum: Air born conidia.
Epidemiology: Weather is warm and humid during fruit development stages.

3) Blue mould rot:

Symptoms: on fruits: light colored soft rot and as soon it spreads on the surface and deep into the flesh.
Causal Organism: *Penicilliun expansum*
Epidemiology: High temperature.

4) Grey Mould Rot.

- Symptom: On fruit; - Pale brown to brown area on fruit. And may have ash-grey powdery spore masses later it starts to decaying
- Causal Organism: *Botrytis cinerea*

5) Alternaria Rot:

Symptoms: Round brown to black, dry firm, shallow lesions around skin breaks at the calyx stem depression. Advanced rots become spongy and the affected flesh is streaked with black.
Causal Organism: *Alternaria alternata.*

Pear

1) Blue Mould : *Penicillium expansum.*
2) Grey Mould : *Botrytis cinerea*
3) Alternaria Rot : *Alternarea alternata*
4) Mucor Rot : *Mucor piriformis*

Stone fruits: ALMOND, APRFCOTS. CHERIES PEACHSE AND RLUMS.
1) Brown Rot : *Monillnia laxa.*
2) Rhizopus Rot : *Rhizopus stolonifer*
3) Blue mould Rot : *Penicilliun expansum*
4) Cladosprium Rot : *Cladosporium harborum*
5) Grey mould Rot : *Botrytis cinerea*

Management of Post-Harvest Diseases

1. Harvest the produce at proper maturity.
2. Harvest carefully with out causing any wound.
3. Harvest during cooler hour and immediately shift to cold storage..
4. After harvest grading is must remove affected, misshaped, wounded fruits before cold storage
5. Use sterilized packing material
6. Keep clean around the vicinity of grading area.
7. Chemical treatment

Benomyl-1g/lit dip the fruit 5-6 min, dry under shade, pack it and transmit.

8. Oil dipping. olive oil or Neem oil¬- dip the fruit in this oil 5-6 min and dry under shade
9. Wax coating 0.1% in apple.
10. Trichoderma dipping-10% trichodermal solution dip 5-6 min, and dry it .

Cultural :

* **Pruning:** early identification of canker affected limbes and prune and wounded area should be pasted with C.O.C to avoid other saprophytic parasites.
* On fallen leaves and flowers spray urea solution of 5% which enhances degradation there by inoculums reduces.
*Maintain optimum population density.
*Go for drip irrigation.
*Remove affected fruit, branches carefully and burn.
*Resistance variety.
*Summer stressed plant is more susceptible.
*Summer Irrigation.
*Proper spacing should be maintained.

*Regulatory Measure – Avoid importing susceptible root sucks from diseased area.
*Pruning should be done properly their by better aeration.
*Uproot and burn.
*Avoid movement of water from infected to healthy plant.

Chemical Management:

1. Benomyl – 1g/lit
2. Thiophanate methyl 0.2%

COCOA

1. Black pod rot

Casual organism: *Phytophthora palmivora*

Symptoms:

• First sign of the disease is appearance of brown spot on the pod.
• The brown discolorations rapidly spread in all directions.
• The discolorations spread over the whole pod.
• Internal tissues of diseased pods become brown.
• Infected beans are discoloured.
• It causes further rotting leading to the spoilage of the quality of the produce.

Mode of spread & survival:

• Infected pods serves as source for the spread to the healthy pods in the storage and also during transit.

Management:

• Regular removal & destruction of infected pods at weekly intervals.
• Carefully identify the infected pods and remove them from the lot to the storage.
• Pre-harvest spraying with Benomyl 0.1% to avoid field infections.

2. Charcoal pod rot

Causal organism: *Botryodiplodia theobromae*

.Symptoms:-• The infection appears as dark brown to black spot on any place on the pod surface & spreads rapidly.

Management:

• Regular removal & destruction of infected pods at weekly intervals.
• Carefully identify the infected pods and remove them from the lot to the storage.
• Pre-harvest spraying with Benomyl 0.1% to avoid field infections.

3) Cherella rot:

Causal organism: *Colletotrichum gloeosporioides.*

Symptom:-

• Infected stalk becomes shrunken.
• The internal tissues of the pod become discoloured.
• Abundant pinkish slimy mass of conidial is produced on the lesions under high humid conditions.
• Ultimately the diseased pod turns brown to black & remains on the tree as mummified fruit.

Management:

• Regular removal & destruction of infected pods at weekly intervals.
• Carefully identify the infected pods and remove them from the lot to the storage.
• Pre-harvest spraying with Benomyl 0.1% to avoid field infections.

Lecture 33 Post Harvest Disease of Mango

1. **Anthracnos – *Colletotrichum gloeosporioides***
2. **Stem end rot - *Lasiodiplodia theobromae***
3. **Diplodia stem end rot - *Diplodia natalensis***
4. **Black mould rot - *Aspergillus niger***
5. **Brown spot - *Pestalotia mangiferae***
6. **Black spot rot - *Phomopsis mangiferae***
7. **Bacterial rot - *Pseudomonas mangiferae-indicae***

1. **Anthracnose –** ***Colletotrichum gloeosporioides***

Symptoms:

- Infection occurs – leaves, stems, young flowers and fruit
- Sunken black spots appear on the surface of the fruit during ripening.
- Infection – fruit is usually latent and manifests itself only as the mango begins to ripen
- The disease is most severe – wet weather.



Mode of spread and survival:

- Inoculum remains on dried leaves, defoliated branches, mummified flowers and flower brackets.
- Spread through air-borne conidia
- The fungus can enter the pores of green fruits.
- The latent infection of mature fruits may take place through lenticles.
- The fungus apparently infects the fruits - green and develops in flesh during ripening.
- The latent infection is carried from the field to storage.

Epidemiology:

The optimum temperature - 250°C and relative humidity from 95 to 97 per cent.

Management

Pre-harvest control

Spray with mancozeb (800 g/kg at 2 g/L) weekly during flowering and then monthly until harvest. Stop spraying 14 days before harvest. During dry weather, flower sprays may be reduced to fortnightly intervals.

Should rain occur during flowering, apply prochloraz (462 g/kg) (Octave, registered trade mark), using 1 g product/L in a tank mix with mancozeb. Prochloraz only needs to be applied every 3-4 weeks.

Copper oxychloride sprays (4 g/L) used for bacterial black spot control also control anthracnose, however copper oxychloride should not be used during flowering. Where bacterial black spot is serious, copper oxychloride can be substituted for mancozeb sprays after flowering.

Postharvest control

Hot carbendazim

Hot carbendazim (registered trade mark Spin Flo, manufactured by Aventis) is registered for postharvest treatment of mango in Queensland, Northern Territory, Western Australia and New South Wales. Spin Flo is a liquid formulation containing the active ingredient carbendazim. Dip fruit within 24 hours of harvest by totally submerging them for 5 minutes in **hot water (52°C)** to which has been added 100 mL product /100 L water. Lowering the temperature of the dip below 52°C will reduce the effectiveness of the treatment.

Temperature must be carefully controlled to within 0.5° to prevent fruit damage. Use an accurate thermometer to monitor temperatures in various parts of the dip during use, especially near the heat source. Many growers use specially designed tanks heated by gas or electricity with manual or thermostatic temperature control. With an approximate ratio of 3 litres of dip to 1 kg of fruit, no appreciable temperature drop occurs when fruit is added to the tank. This dip also partially controls stem end rot.

Notes on dipping

- Vigorous agitation before and during dipping by means of a powerful recirculating pump is recommended to keep the fungicide suspended. This is preferable to stirring or paddling. Agitation also helps distribute heat from the heating element.
- Bleed sap from fruit before dipping. Mango sap affects the stability of the fungicide suspension.
- Replace the dip once it becomes contaminated by sap and dirt or after 3 days continuous use or after 4000 trays have been treated. Prewashing fruit helps to prolong dip life.
- Dipping temperatures should not exceed 52° as this may result in skin damage. Allow fruit to cool before brushing. During wet weather, reduce the dipping temperature to 50° as susceptibility to skin damage increases. Disease control will be reduced at these lower temperatures.

Unheated prochloraz

- Unheated prochloraz (Sportak, registered trade mark) spray to control anthracnose can be used as an alternative to dipping in hot carbendazim (Spin Flo).

- Prochloraz is not effective against stem end rot.
- Apply prochloraz 45% at 55 mL/100 L of water at ambient temperature. Prochloraz has been approved for use only as a non-recirculated spray over fruit. Complete coverage of the fruit is essential for effective control.
- Fenthion may be mixed with prochloraz for fruit fly treatment for Victoria, provided fruit remain wet for one minute.
- Postharvest treatments will not provide complete disease control.

2. Stem End Rot: *Lasiodiplodia theobromae*

Symptoms

- In fruits, the pericarp darkens near the base of the pedicel.
- The affected area enlarges to form a circular, black patch which under humid atmosphere extends rapidly and turns the whole fruit completely black within two or three days.
- The pulp becomes brown and softer.

Prevention and control

- Avoid harvesting immature fruit. Postharvest treatment with hot water and carbendazim (Spin Flo) is partially effective against stem end rot.
- For control of stem end rot during controlled atmosphere storage, a dual treatment of hot carbendazim (Spin Flo) followed by prochloraz is necessary.
- Fruit from orchards with a history of stem end rot losses should be rejected for long term storage. The severity of stem end rot can be assessed as follows.
- Harvest 100 mature fruit at random from throughout the orchard.
- Leave them untreated and store at 25° until they are fully ripe. Ideally, less than one-tenth and certainly no more than one-third of the fruit should develop symptoms of stem end rot by the time they are fully ripe.

3. Diplodia* stem –end rot: *Diplodia natalensis

Symptom:

- Epicarp darkens around the base - pedicel.
- Circular, black patch which under humid atmosphere.
- Soft rot –aid of pectinolytic & cellulolytic enzymes.
- More portions of fruit turns black and soften.
- Lose ascorbic acid & non- reducing sugars rapidly
- **Mode of spread and survival:**
- The fungus persists in infected plant parts which serve as source of inoculum

Epidemiology:

- RH – 80%, max.& min.temp. of 31.5 and 25.90C.

4. Black mould rot: *Aspergillus niger*

Symptom:

- Yellowing of base – development of irregular, hazy, greyish spots.
- Mesocarp of the rotted area becomes depressed – soft.
- The fruit surface – covered – blackish fungal growth.
- Decrease in ascorbic acid.

5. Brown spot: *Pestalotia mangiferae*

Symptoms:

- The affected area of fruits becomes olivaceous-black and shrinks.
- Black dots appear at the centre of the spots represent the acervuli.
- On matured green fruits, small brown spots appear with greyish white centre which later turn to bigger lesions with large number of acervuli seen as black dots.

Epidemiology:

- Temp. between 20 and 250 C.
- Mycelial growth with sporulation takes place at pH 5.5 to 6.0.
- Wounding leads to more disease incidence.

6. Black soft rot: *Phomopsis mangiferae*

Symptom:

- Discrete and discoloured areas all over.
- Turn dark brown – black at maturity.
- Black fruit in bodies appear on the spots.

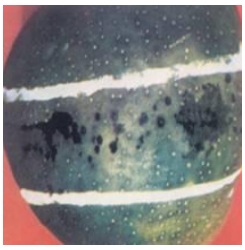
Spread

- Soil-borne conidia transmitted by wind & rain water.

8. Bacterial rot :*Pseudomonas mangiferae-indicae*

Symptom:

- Water-soaked lesions develop – turn dark brown to black.
- The spots become black as the disease advances, which are usually haloes.
- In severe cases these spots form in groups and become necrotic.
- Cracks in the skin – badly affected ones drop prematurely.



Mode of spread & survival:

- Bacterium enters the leaf through stomata and lenticels in fruit.
- When fruits are found in bunches disease spreads when they contact each other.

Management of other post-harvest diseases

A few other fungi (*Aspergillus niger*, *Mucor* spp. etc) occasionally cause losses in fruit during storage. They cause rots on the sides or at the stem end of fruit. Rough harvesting and handling can encourage these diseases. Hot carbendazim (Spin Flo) used for anthracnose control, careful handling and observance of hygiene measures will help control these problems.

Export requirements

Choose fruit from orchards with low disease levels. Fruit from orchards with a history of stem end rot or other diseases should not be exported.

Where carbendazim and prochloraz are not acceptable to the importing country, export is not recommended unless fruit are treated with a combination of hot water and vapour heat. Vapour heat treatment was developed for export markets which require quarantine security against fruit fly but do not accept chemical disinfestation treatments such as ethylene dibromide. Vapour heat treatment will control anthracnose during short term storage, but will not give adequate control of stem end rot. Dipping fruit in hot water at 48-52°C for 5 minutes, 24 hours prior to vapour heat treatment will improve stem end rot control.

Sanitation of packing equipment

Sanitizers should be used after equipment has been cleaned. Steam cleaners or high-pressure hot water applicators are very effective. Otherwise, use a hose and household detergent. If possible, use chlorinated town water.

Spray packing equipment with a sanitizing agent such as:

(a) Chlorine solution

Use a solution containing 200 ppm (0.02%) available chlorine.

Notes

1. Sodium hypochlorite (liquid)

- Most preparations contain from 5% to 12.5% available chlorine.
- For a 5% commercial solution, add 4 mL/L.
- For a 12.5% commercial solution adds 1.6 mL/L.

2. Calcium hypochlorite (powder)

- Contains approximately 30% active chlorine
- First make a stock solution by adding 330 g of powder/L, then store in a cool, dark place.
- Add 2 mL stock solution/L

3. Monitoring the chlorine level

- Add 5 mL of wash solution to one litre of water, which should give a solution of 1 ppm available chlorine.
- Use a swimming pool test kit to check the concentration.

Warning

Chlorine may corrode steel and some rubber compounds if used continuously, but 2 or 3 sprays a week should not cause problems. Avoid inhalation.

- **(b) Quaternary ammonium compounds (e.g. applied 3.300*)**
  - Use 2 mL/L water. This product has a residual effect. Apply only to clean surfaces. Avoid inhalation.
- **(c) Formalin**

Use 20 to 50 ml of formalin/L water. This is a potent product which is unpleasant to use and should not be inhaled. In confined spaces, a full face mask with the correct canister is recommended. Wear protective clothing

POST-HARVEST DISEASE OF PAPAYA

S.No.	**Post Harvest Diseases of Papaya**	Pathogen
1	Macrophomina fruit Rot	*Macrophomina phaseoli* (Maubl).
2	Rhizophus fruit Rot or Soft Rot	*Rhizophus stolonifer* (Ehr.)
3	Phomopsis fruit Rot	*Phomopsis caricae* (Pterrak and Cif)
4	Anthracnose of fruit	*Colletotrichum gloeosporioides*

POST HARVEST DISEASES OF PAPAYA:

Fruit Rot of Papaya:

(1). Macrophomina rot: Caused by *Macrophomina phaseoli*

SYMPTOMS: *Macrophomina* rot appears as small water soaked spots on fruit surface. Gradually, such spots become deeper and sunken causing rotting of inner tissues. Subsequently, small sclerotia develop on these spots. The inner tissues of such fruits develop brownish black color having dark mycelial growth.

Causal Organism: Caused by *Macrophomina phaseoli* .The conidiomata is pycnidial, pycnia is brown colored and thick walled. Conidia are septate. Sclerotia are black colored and hard.

epidimiology: It prefers warm weather and usually invades immature unthrifty damaged or senescent tissues. Maximum decay occurs at 300 c and 100% RH.

(2)Rhizophus rot or soft rot: Caused by *Rhizophus stolonifer*

SYMPTOMS: Rhizophus fruit rot or watery fruit rot develops on injured fruits, which develops irregular water soaked lesions. These lesions are in due course, covered with whitish fungal growth which later on turns dark brown. The fruit becomes watery and emit foul smell. Infection spread quickly to the adjoining fruits.

Causal Organism: Caused by *Rhizophus stolonifer* .The sporangiophores are produced on arching stolons, usually born opposite tuft of rhizoids and and typically unbranched sporangiophores not in umbels

Epidimiology: Factors such as nature and type of wounds, rainfall, pre and post harvest treatments and shipment conditions influence the development of rot.

(3)**Phomopsis rot**: Caused by *Phomopsis caricae*

Symptoms: In this, initially water soaked spots appear which will become sunken and dark brown to black in advance stages. Some times such spots are surrounded by white raised tissues on the side. The whole area becomes soft and pulpy giving the typical appearance of soft rot.

Causal Organism: It is caused by *Phomopsis caricae*. The hyphae are hyaline initially which turn to sub hyaline later. The conidiophores are rod shaped tapering towards the apex. Conidia are mostly rod shaped. Pycnidia are flask shaped.

(4). Phytophthora rot: *Pytophthora palmivora*

Symptoms: *Phytophthora* rot appears as small water soaked lesions on fruit surface. Gradually, such lesions become deeper and sunken causing rotting of inner tissues. Subsequently, it produces white coating and covers all external surface of the ripened fruits. Whitish coat comprising of sprangio phore and sporangia.

Causal organism: *Pytophthora palmivora*. Mycelium is aseptate, asexual spores are zoospores borne in sporangia.

Epidemiology: It prefers cool weather and usually invades mature, damaged or senescent tissues. Maximum decay occurs at 180 c and relative humidity of 100%.

Management of post harvest diseases:

- Harvesting at proper maturity and cool hours is necessary to avoid post harvest disease
- Post harvest dipping of fruits for 5 min in TBZ (1000) ppm or benomyl (20) has been observed to reduce storage decay

- Dusting of fruits with benzoic acid (0.1%) coated in koaline also reduces the rotting.
- The disease free plantations should be selected for raising new plantations.
- The harvested fruits should be dried in sun for 2 hrs and the packing boxes should be sprayed with 3 % formaline.

POST-HARVEST DISEASE OF CITRUS

1	Anthracnose	*Colletotrichium gloeosporioides*
2	Septoria spot	*Septoria depressa*
3	Blue & Green Mould	*Penicillium digitatum* (green mould) and *P. italicum* (blue mould)
4	Sour Rot	*Galactomyctes citri-aurantii* (formally, *Geotrichum candidum*)

1. Anthracnose: *Colletotrichium gloeosporioides.*

Symptoms
- Superficial leathery appearance
- Silver/grey to dark lesions.
- Tear-staining pattern common.
- Pink tinge (spores) under humid conditions.

Occurrence
- Infection occurs by rain-splash during autumn.
- Ethylene degreening increases sensitivity to anthracnose

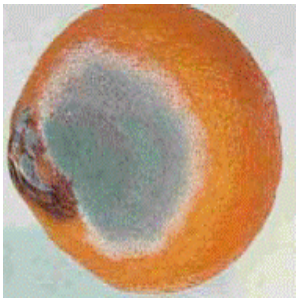
Management
- Dead wood should be pruned as the fungus harbours in dead branches.
- Field sprays of copper-based fungicides should be applied prior to autumn rains.
- Postharvest treatment with Benzimidazole fungicides may reduce fruit losses.

2. **Septoria spot:** *Septoria depressa.*

Symptoms
- Dark brown collapsed lesions, with a purple tinge.
- Black specks develop in decayed area.

Occurrence
- Mainly inland citrus regions.
- Infection occurs in autumn but remains dormant until cool conditions.
- Fruit more susceptible after frosts

Management
- Field application of copper-based fungicides.



3. Blue & Green Mould: *Penicillium digitatum* (green mould) and *P. italicum* (blue mould).

Symptoms
- Softening of damaged tissue.
- White fungal growth, which progressively turns blue or green as spores develop.
- Postharvest fungicides (Imazalil) can arrest spore development resulting in white only fungal growth.

Management
- Careful handling reduces damage to rind.
- Good hygiene and sorting reduces spore load and infection rates.
- Sanitation destroys spores in recirculating water and packingline equipment.
- Postharvest fungicides should be applied within 24h of harvest.

- Lower storage temperatures slow down fungal development.

4. Sour Rot: *Galactomyctes citri-aurantii* (formally, *Geotrichum candidum*).

Symptoms

- Very soft, watery decay.
- Distinct margin between decayed and healthy tissue.
- Sour odour detectable.

Occurrence

- Infection occurs in damaged fruit.
- Fungicide used to control blue & green moulds may not control Sour rot. (eg. USA accepted fungicides).
- Sour rot spores in soil can accumulate in recirculating water in dips and drenches.
- Spreads by contact after packing creating nests of infected fruit in boxes.

Management

- Careful handling reduces rind damage.
- Apply Guazatine fungicide within 24hrs of harvest.
- Strong emphasis of sanitisers when Guazatine fungicide not approved for use.