

Practical manual on
Diseases of Field and Medicinal Crops
APP- 515 3 (2+1)



For

M.Sc. (Ag.) Plant Pathology



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Practical manual

Diseases of Field and Medicinal Crops

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PRACTICAL NO.1

Study of paddy diseases

Objective: To study diseases of paddy (*Oryza sativa*)

- Blast
- Brown spot
- Bacterial blight
- Sheath blight
- False smut
- Khaira
- Tungro

Material required:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Blast affects at all stages of crop growth

Symptoms/ Macroscopic

Leaf blast:

- Symptoms appear on leaves, nodes, rachis, and glumes
- Common on leaves and the neck of the panicle
- On leaves, the lesions originate as small specks, which enlarges from few mm to several cms
- Characteristic symptom is spindle shaped spots with grey centre and brown margin

Nodal blast:

- Spots also appear on sheath, culm, culm nodes and glumes
- Spots coalesce and covering large areas of the leaves
- Black lesions appear on nodes girdling them
- Affected nodes may break up and all the plant parts above the infected nodes may die
- Severely infected nursery and field appear as burnt

Neck blast:

- Affects at flower emergence
- Attacks the peduncle and the lesion turns to brownish-black
- Referred to as rotten neck / neck rot / panicle blast

Pathogen- *Pyriculariaoryzae* (Syn: *P. grisea*) (Sexual stage: *Magnaportheoryzae*, *M. grisea*)

- Hyaline to olivaceous and septate mycelium
- Conidia are pyriform to ellipsoid, attached at the broader base by a hilum and are hyaline to pale olive green, usually 3 celled
- Conidia are produced sympodially in clusters on long, septate and olivaceous conidiophores
- Perfect state of the fungus is *M. oryzae* producing perithecia
- The ascospores are hyaline, fusiform, 4 celled and slightly curved

Brown spot**Symptoms**

- Affects the crop from seedling to milky stage in main field
- Minute spots on the coleoptile, leaf blade, leaf sheath, and glume
- Spots on the leaf blade and glumes are more prominent and commonly observed symptom
- Spots are of brown colour and round to oval in shape
- Grains can also get infected where black or dark brown spots on glumes are covered by olivaceous velvety growth
- Neck region can get infected and symptoms appear similar to neck blast except that colouration is brown or grayish brown while in blast it is blacken

Pathogen - *Helminthosporiumoryzae* (Syn: *Drechsleraoryzae*; *Bipolarisoryzae*)**(Sexual stage: *Cochliobolusmiyabeanus*)**

- Mycelium is brown and septate

- Conidia are curved with a bulged center, tapered ends brown coloured and are 8 to 10 celled
- Conidiophores arise singly or in small groups through epidermis/stomata and possess numerous bends and scars at regular intervals
- The perfect stage of the fungus is *C. miyabeanus*
- It produces perithecia with asci containing 6-15 septate, filamentous or long cylindrical, hyaline to pale olive green ascospores.

Bacterial leaf blight

Symptoms

- Dull greenish water-soaked or yellowish spots towards the tip or margins of the leaves
- Seedlings in the nursery show circular, yellow spots in the margin
- Spots coalesce leading to drying of foliage
- “**Kresek**” symptom is seen in seedlings, 3-4 weeks after transplantation
- Bacteria enter through the cut/wounds in the leaf tips, become systemic and cause death of entire seedling
- Milky or opaque dew drops containing bacterial masses are formed on young lesions in the early morning
- Bacterial masses dry up on the surface leaving a white encrustation
- Affected grains have discoloured spots
- If the cut end of leaf is dipped in water, it becomes turbid because of bacterial ooze (**Ooze test**)

Pathogen - *Xanthomonas oryzae* pv. *oryzae*

- The bacterium is aerobic, gram negative, non spore forming, rod
- Size ranging from 1-2 x 0.8-1.0µm
- Monotrichous polar flagellum
- Bacterial colonies are circular, convex with entire margins, whitish yellow to straw yellow colored and opaque

Sheath blight

Symptoms

- Crop is affected from tillering to heading stage
- Initial symptoms are noticed on leaf sheaths near water level
- On the leaf sheath oval or elliptical or irregular greenish grey spots are formed

- Spots enlarge, the centre becomes greyish white with an irregular blackish brown or purple brown border

Lesions on the upper parts of plants extend rapidly coalesce to cover entire tillers from the water line to the flag leaf

- The presence of several large lesions on a leaf sheath usually causes death of the whole leaf
- In severe cases all the leaves of a plant may be blighted
- The infection extends to the inner sheaths resulting in death of the entire plant
- Older plants are highly susceptible
- Plants heavily infected in the early heading and grain filling growth stages produce poorly filled grain

Pathogen – *Rhizoctoniasolani*(Sexual stage: *Thanetophorus cucumeris*)

- Fungus has septate and hyaline mycelium
- Hyaline when young, yellowish brown when old
- It produces large number of spherical brown sclerotia

False smut

Symptoms

The fungus transforms individual ovaries / grains into greenish spore balls of velvety appearance. Only a few spikelets in a panicle are affected.

Pathogen - *Ustilagoideavirens*(Syn: *Clavicepsoryzae - sativa*)

Chlamydospores are formed as spore balls which are spherical to elliptical, warty and olivaceous.

Khaira:

- It is a disease due to Zinc deficiency
- It was reported by Y.L. Nene
- Yellowing of the seedlings starting from nursery
- The plants recover with the application of Zn

Tungro/Rice Tungro Disease (RTD)

Symptoms

- Affects crop in the nursery and main field
- Plants are markedly stunted

- Leaves show yellow to orange discoloration and interveinal chlorosis
- Young leaves are sometimes mottled while rusty spots appear on older leaves
- Tillering is reduced with poor root system
- Panicles not formed in very early infection, if formed, remain small with few, deformed and chaffy grains

Pathogen -*Rice tungro bacilliform virus (RTBV)* and *Rice tungro spherical virus (RTSV)*

- Two morphologically unrelated viruses present in phloem cells
- Rice tungro bacilliform virus (RTBV) bacilliform capsid, circular ds DNA genome
- Rice tungro spherical virus (RTSV) isometric capsid ssRNA genome.

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.

2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.2

Study of wheat diseases

Objective: To study diseases of wheat

- **Rust**
- **Flag smut**
- **Loose smut**
- **Hill bunt or Stinking smut**
- **Karnal bunt**
- **Foot rot**
- **Powdery mildew**
- **Leaf blight**

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Black or stem rust

Symptoms

- Symptoms are produced on almost all aerial parts of the wheat plant but are most common on stem, leaf sheaths and upper and lower leaf surfaces.
- Uredial pustules (or sori) are oval to spindle shaped and dark reddish brown (rust) in color.
- They erupt through the epidermis of the host and are surrounded by tattered host tissue.

- The pustules are dusty in appearance due to the vast number of spores produced.
- Spores are readily released when touched.
- As the infection advances teliospores are produced in the same pustule.
- The color of the pustule changes from rust color to black as teliospore production progresses.
- If a large number of pustules are produced, stems become weakened and lodge.

Pathogen –*Puccinia graminis tritici*

Brown or leaf rust

Symptoms

- The most common site for symptoms is on leaf blades, however, sheaths, glumes and awns may occasionally become infected and exhibit symptoms.
- Uredia are seen as small, circular orange blisters or pustules on the upper surface of leaves.
- Orange spores are easily dislodged and may cover clothing, hands or implements.
- When the infection is severe leaves dry out and die.
- Since inoculum is blown into a given area, symptoms are often seen on upper leaves first.
- As plants mature, the orange urediospores are replaced by black teliospores.
- Pustules containing these spores are black and shiny since the epidermis does not rupture.
- Yield loss often occurs as a result of infection by *Pucciniarecondita* sp. *tritici*.
- Heavy infection which extends to the flag leaf results in a shorter period of grain fill and small kernels.

Pathogen - - *Puccinia triticina* (*P. recondita*)

Yellow or stripe rust

Symptoms

- Mainly occur on leaves than the leaf sheaths and stem.
- Bright yellow pustules (Uredia) appear on leaves at early stage of crop and pustules are arranged in linear rows as stripes.
- The stripes are yellow to orange yellow.
- The teliospores are also arranged in long stripes and are dull black in colour.

Pathogen- *Puccinia striiformis*

- The uredospores of rust pathogen are almost round or oval in shape and bright orange in colour.

- The teliospores are bright orange to dark brown, two celled and flattened at the top.
- Sterile paraphyses are also present at the end of sorus.

Loose smut

Symptoms

- It is very difficult to detect infected plants in the field until heading.
- At this time, infected heads emerge earlier than normal heads.
- The entire inflorescence is commonly affected and appears as a mass of olive-black spores, initially covered by a thin gray membrane.
- Once the membrane ruptures, the head appears powdery.
- Spores are dislodged, leaving only the rachis intact.
- In some cases, remnants of glumes and awns may be present on the exposed rachis.
- Smutted heads are shorter than healthy heads due to a reduction in the length of the rachis and peduncle.
- All or a portion of the heads on an infected plant may exhibit these symptoms.
- While infected heads are shorter, the rest of the plant is slightly taller than healthy plants.
- Prior to heading affected plants have dark green erect leaves.
- Chlorotic streaks may also be visible on the leaves.

Pathogen - - *Ustilago nuda tritici* (*Ustilago tritici*)

Flag smut

Symptoms

- The symptoms can be seen on stem, culm and leaves from late seedling stage to maturity.
- The seedling infection leads to twisting and drooping of leaves followed by withering.
- Grey to grayish black sori occurs on leaf blade and sheath.
- The sorus contains black powdery mass of spores.

Pathogen- *Urocystis tritici*

- Aggregated spore balls, consisting 1-6 bright globose, brown smooth walled spores surrounded by a layer of flat sterile cells.

Hill bunt or Stinking smut

Symptoms

- The fungus attacks seedling of 8-10 days old and become systemic and grows along the tip of shoot.
- At the time of flowering hyphae concentrate in the inflorescence and spikelets and transforming the ovary into smut sorus of dark green color with masses of chlamydospores.
- The diseased plants mature earlier and all the spikelets are affected.

Pathogen- *Tilletia caries* / *T.foetida*

- Reticulate, globose and rough walled. No resting period.
- Germinate to produce primary sporidia which unite to form 'H' shaped structure.

Karnal bunt

Symptoms

- Symptoms of Karnal bunt are often difficult to distinguish in the field due to the fact that incidence of infected kernels on a given head is low.
- There may be some spreading of the glumes due to sorus production but it is not as extensive as that observed with common bunt.
- Symptoms are most readily detected on seed after harvest.
- The black sorus, containing dusty spores is evident on part of the seed, commonly occurring along the groove.
- Heavily infected seed is fragile and the pericarp ruptures easily.
- The foul, fishy odor associated with common bunt is also found with karnal bunt.
- The odor is caused by the production of trimethylamine by the fungus.
- Seed that is not extensively infected may germinate and produce healthy plants.

Pathogen – *Neovossia indica*

Foot rot

Symptoms

- The disease mainly occurs in seedlings and roots and rootlets become brown in colour.
- Seedlings become pale green and have stunted growth.
- Fungus produces sporangia and zoospores and oospores.

Pathogen – *Pythium graminicolum* and *P. arrhenomanes*

Powdery mildew

Symptoms

- Greyish white powdery growth appears on the leaf, sheath, stem and floral parts.
- Powdery growth later become black lesion and cause drying of leaves and other parts.

Pathogen- *Erysiphe graminis var. tritici*

- Fungus produces septate, superficial, hyaline mycelium on leaf surface with short conidiophores. The conidia are elliptical, hyaline, single celled, thin walled and produced in chains.
- Dark globose cleistothecia containing 9-30 asci develop with oblong, hyaline and thinwalled ascospores.

Leaf blight

Symptoms

- Reddish brown oval spots appear on young seedlings with bright yellow margin.
- In severe cases, several spots coalesce to cause drying of leaves.

Pathogen - *Alternaria triticina*, *A. alternata* and *Bipolaris sorokiniana*

Observations:

Microscopic:

Macroscopic:

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.3

Study of maize diseases

Objective: To study diseases of maize (*Zea mays*)

- Stalk rots
- Downy mildew
- Leaf spots

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Stalk rot

Symptoms

Can be caused by several fungi and bacteria

- Affects the plants near maturity
- Stalk rot and ear rot are the two important phases of the disease
- In stalk rot, symptoms appear after a few weeks of pollination as premature dying of lower leaves which turn into dull grey appearance
- The internodes become soft and appear tan to brown from outside and pink or reddish inside
- The pith is completely rotten and the stalk may lodge
- Plants may die if harvesting is delayed
- In ear rot, ears may rot completely and a pinkish mold can be seen between ear and husks
- Losses from stalk rot vary region to region and are estimated 10 – 20 % and are caused either by poor filling of the cobs or due to lodging of affected plants

Pathogens:

Gibberella zeae*; *Diplodia zeae*; *Fusarium* species and *Colletotrichum graminicola are the major pathogens involved in the rot complex but *G. zeae* dominates in the complex

The fungus produces ascospores in perithecia, mycelium, or chlamydospores in infected plant debris. *G. zeae* also produces mycotoxins which are toxic to human and animals

The following pathogens are associated with stalk rot of maize.

Bacterial Pathogens:

- *Pseudomonas avenae* sub-sp. *avenae* Manns.
- *Enterobacter dissolvens* (Rosen) Brenner et al. = *Erwinia dissolvens* (Rosen) Burkholder
- *Erwinia carotovora* sub-sp. *carotovora* (Jones) Bergey et al. = *E. chrysanthemi* pv. *Zae* (Sabet) Victoria et al.

Fungal Pathogens :

- *Colletotrichum graminicola*., Teleomorph: *Glomerella graminicola*, *G. tucumenensis*
- *Physoderma maydis*
- *Diplodia maydis*
- *Fusarium moniliforme* var. *subglutinans*
- *Gibberella zeae* (Anamorph: *Fusarium graminearum*)
- *Setophacteria turcica* (Anamorph : *Exserohilum turcicum*= *Helminthosporium turcicum*)
- *Pythium aphanidermatum*
- *Rhizoctonia solani*= *R. zeae* = *R. solani* sub sp. *sasakii*
- *Cochliobolus heterostrophus* Anamorph: *Bipolaris maydis* = *Helminthosporium maydis*
- *Fusarium* spp., *Mucor* sp., *Spicaria* spp. & *Rhopoglyphus zeae*

Downy mildew – *Peronosclerospora sorghi*

Symptoms

- Most characteristic symptom is chlorotic streaks on the leaves
- Stunted and bushy appearance of plants due to shortening of the internodes
- White downy growth is seen on the lower surface of leaf
- Downy growth also occurs on bracts of green unopened male flowers in the tassel
- Small to large leaves are noticed in the tassel
- Proliferation of axillary buds on the stalk of tassel and the cobs is common

Pathogen

- White downy growth on both surface of the leaves
- Downy growth consist of sporangiophores and sporangia
- Sporangiophores are quite short and stout,
- Sporangiophores branch profusely into series of pointed sterigmata
- Sporangia are hyaline, oblong or ovoid
- Sporangia germinate directly and infect the plants
- In advanced stages, oospores are formed which are spherical, thick walled and deep brown

Several mildews are known as mentioned below:

S.No.	Disease	Pathogen
1.	Brown stripe mildew	<ul style="list-style-type: none"> • <i>Sclephthora rayssiae</i> var. <i>zeae</i>
2.	Crazy top downy mildew	<ul style="list-style-type: none"> • <i>Sclephthora macrospora</i> (Sacc.) Thirumalachar et al. • <i>Sclerospora macrospora</i> Sacc.
3.	Green ear downy mildew	<ul style="list-style-type: none"> • <i>Sclerospora graminicola</i>(Sacc) J. Schrot.
4.	Philippine downy mildew	<ul style="list-style-type: none"> • <i>Peronosclerospora philippinensis</i>(W.Weston) C.G.Shaw
5.	Spontaneum downy mildew	<ul style="list-style-type: none"> • <i>Peronosclerospora spontanea</i>(W.Weston) C.G. Shaw. = <i>Sclerospora spontanea</i>W. Weston.
6.	Sorghum downy mildew	<ul style="list-style-type: none"> • <i>Peronospora sorghi</i>(Weston &Uppal) C.G.Shaw = <i>Sclerospora sorghi</i>Weston and Uppal.
7.	Sugarcane downy mildew	<ul style="list-style-type: none"> • <i>Peronosclerospora sacchari</i>(Miyake0 Shirai& Hara = <i>Sclerospora sacchari</i>Miyake). • <i>Sclerophthora rayssiae</i>, • <i>Peronosclerospora maydis</i> • <i>P. philippinensis</i>

P. sorghi and *P.sacchari* are commonly distributed downy mildew pathogens

These pathogens belong to the group *Oomycetes* and family *Peronosporaceae*.

- The first two pathogen attacks maize but the rest two are the pathogens of sorghum and sugarcane respectively but also infect maize
- The *S. rayssiae* produces sporangia at the tips of sporangiophores at their branches, sporangia are white in colour in the beginning but turn to greyish light brown later
- The sporangia germinate by protruding a germ tube and finally produce zoospores at higher temperature.

- d. The *P. philippinensis* fungus produces numerous hyaline, thin walled, ellipsoidal conidia on dichotomously branched conidiophores

Leaf blight and spot

Symptoms

- Affects the crop at young stage
- Small yellowish round to oval spots are seen on the leaves
- Spots gradually increase into bigger elliptical spots and are straw to grayish brown in the centre with dark brown margins
- The spots coalesce giving blighted appearance
- The surface is covered with olive green velvety masses of conidia and conidiophores

Pathogen – *Helminthosporium maydis* (Syn: *H. turcicum*)

- Conidia - distinctly curved, fusiform, pale to mid dark golden brown with 5-11 septa
- Conidiophores – occur in group, geniculate, mid dark brown, pale near the apex and smooth

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.4

Study of sorghum diseases

Objective: To study diseases of Sorghum (*Sorghum bicolor*)

- Smuts
- Grain mold
- Anthracnose

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Grain smut/Kernel smut / Covered smut / Short smut

Symptoms

- The individual grains are replaced by smut sori
- The sori are oval or cylindrical and are covered with a tough creamy skin (peridium) which often persists unbroken up to thrashing
- Ratoon crops exhibit higher incidence of disease

Pathogen - *Sphacelotheca sorghi*

Loose smut/ kernel smut

Symptoms

- The affected plants can be detected before the ears come out
- They are shorter than the healthy plants with thinner stalks and marked tillering
- The ears come out much earlier than the healthy
- The glumes are hypertrophied and the earhead gives a loose appearance than healthy

- The sorus is covered by a thin membrane which ruptures very early, exposing the spores even as the head emerges from the sheath

Pathogen- *Sphacelotheca cruenta*

Long smut

Symptoms

- This disease is normally restricted to a relatively a small proportion of the florets which are scattered on a head
- The sori are long, more or less cylindrical, elongated, slightly curved with a relatively thick creamy-brown covering membrane (peridium)
- The peridium splits at the apex to release black mass of spores (spore in groups of balls) among which are found several dark brown filaments which represent the vascular bundles of the infected ovary

Pathogen- *Tolyposporium ehrenbergii*

Head smut

Symptoms

- The entire head is replaced by large sori
- The sorus is covered by a whitish grey membrane of fungal tissue, which ruptures, before the head emerges from the boot leaf to expose a mass of brown smut spores
- Spores are embedded in long, thin, dark colored filaments which are the vascular bundles of the infected head

Pathogen - *Sphacelotheca reiliana*

Head mould/Grain mould/Head blight

More than thirty two genera of fungi were found to occur on the grains of sorghum

Symptoms

- Rains during the flowering and grain filling stages, cause severe grain molding

- Frequently occurring genera are *Fusarium*, *Curvularia*, *Alternaria*, *Aspergillus* and *Phoma*. *Fusarium semitectum* and *F. moniliforme*
- Develop a fluffy white or pinkish coloration, *C. lunata* colours the grain black
- Symptom varies depending upon the organism involved and the degree of infection

Anthracnose and red rot

Symptoms

The fungus causes both leaf spot (anthracnose) and stalk rot (red rot)

- The disease appears as small red coloured spots on both surfaces of the leaf
- The centre of the spot is white in colour encircled by red, purple or brown margin
- Numerous small black dots like acervuli are seen on the white surface of the lesions
- Red rot can be characterized externally by the development of circular cankers, particularly in the inflorescence
- Infected stem when split open shows discoloration, which may be continuous over a large area or more generally discontinuous giving the stem a marbled appearance

Pathogen - *Colletotrichum graminicolum*

- Fungus mycelium is localised in the spot
- Acervuli with setae arise through epidermis
- Conidia are hyaline, single celled, vacuolate and falcate in shape

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and its causal organism

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.5

Study of pearl millet diseases

Objective: To study diseases of pearl millet (*Pennisetum glaucum*)

- Downy mildew
- Ergot

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Downy mildew

Symptoms

- Infection is mainly systemic and symptoms appear on leaves and inflorescence
- The initial symptoms appear in seedlings at three to four leaf stages
- The affected leaves show patches of light green to light yellow colour on the upper surface and the corresponding lower surface bears white downy growth of the fungus consisting of sporangiophores and sporangia
- The yellow discolouration often turns to streaks along veins
- As a result of infection young plants dry and die ultimately
- Symptoms may appear first on the upper leaves of the main shoot or the main shoot may be symptom free and symptoms appear on tillers or on the lateral shoots
- The inflorescence of infected plants gets completely or partially malformed with florets converted into leafy structures, giving the typical symptom of green ear

- Infected leaves and inflorescences produce sporangia over a considerable period of time under humid conditions and necrosis begins
- The dry necrotic tissues contain masses of oospores

Pathogen – *Sclerospora graminicola*

The mycelium is systemic, non septate and intercellular

- Short, stout, hyaline sporangiophores arise through stomata and branch irregularly, with stalks bearing sporangia
- Sporangia are hyaline, thin walled, elliptical and bear prominent papilla
- Oospores are round in shape, surrounded by a smooth, thick and yellowish brown wall

Ergot or Sugary disease

Symptoms

1. The symptom is seen by exudation of small droplets of light pinkish or brownish honey dew from the infected spikelets
2. Under severe infection many such spikelets exude plenty of honey dew which trickles along the earhead
3. This attracts several insects
4. In the later stages, the infected ovary turns into small dark brown sclerotium which projects out of the spikelet

Pathogen– *Claviceps fusiformis*

- The pathogen produces septate mycelium which produces conidiophores and is closely arranged
- Conidia are hyaline and one celled
- The sclerotia are small (3-8mm x 0.3-15mm) and dark grey but white inside

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.6

Study of chickpea diseases

Objective: To study diseases of chickpea

- Ascochyta blight
- Rust
- Wilt
- Collar rot

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Ascochyta blight

Symptoms

- All above ground parts of the plant are infected
- On leaf, the lesions are round or elongated, bearing irregularly depressed brown spot and surrounded by a brownish red margin
- Similar spots may appear on the stem and pods
- The spots on the stem and pods have pycnidia arranged in concentric circles as minute black dots. When the lesions girdle the stem, the portion above the point of attack rapidly dies.
- If the main stem is girdled at the collar region, the whole plant dies.

Pathogen- *Ascochyta rabiei*

- The fungus produces hyaline to brown and septate mycelium.
- Pycnidia are spherical to sub-globose with a prominent ostiole.
- Pycnidiospores are hyaline, oval to oblong, straight or slightly curved and single celled, occasionally bicelled.

Rust

Symptoms

- The infection appears as small oval, brown, powdery lesions on both the surface, especially more on lower surface or leaf.
- The lesions, which are uredosori, cover the entire leaf surface.
- Late in the season dark teliosori appear on the leaves.
- The rust pustules may appear on petioles, stems and pods.
- The pycnial and aecial stages are unknown.

Pathogen- *Uromyces ciceris-arietini*

- The uredospores are spherical, brownish yellow in colour, loosely echinulated with 4-8 germ pores.
- Teliospores are round to oval, brown, single celled with unthickened apex and the walls are rough, brown and warty.

Wilt

Symptoms

- The disease occurs at two stages of crop growth, seedling stage and flowering stage stage.
- The main symptoms on seedlings are yellowing and drying of leaves, drooping of petioles and rachis, withering of plants.
- In the case of adult plants drooping of leaves is observed initially in upper part of plant, and soon observed in entire plant.
- Vascular browning is conspicuously seen on the stem and root portion

Pathogen- *Fusarium oxysporum f.sp. ciceris*

- The fungus produces hyaline to light brown, septate and profusely branched hyphae.
- Microconidia are oval to cylindrical, hyaline, single celled, normally arise on short conidiophores.

- Macroconidia which borne on branched conidiophores, are thin walled, 3 to 5septate, fusoid and pointed at both ends.
- Chlamyospores are roughwalled or smooth, terminal or intercalary, may be formed singly or in chains.

Collar rot

Symptoms

- It comes in the early stages i.e up to six weeks from sowing.
- Drying plants whose foliage turns slightly yellow before death, scattered in the field is an indication of the disease.
- Seedlings become chlorotic.
- The joint of stem and root turns soft slightly contracts and begins to decay.
- Infected parts turn brown white.
- Black dots, like mustard in shape known as sclerotia are seen appearing on the white infected plant parts.

Pathogen- *Sclerotiumrolfsii*

- Mycelium of *S. rolfsii*. is floccose, not ropy, producing numerous sclerotia which are globose, pinkish dull or light to dark brown in color and 0.8–2.5 mm in diameter.

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.7

Study of black gram diseases

Objective: To study diseases of Black gram (*Vigna mungo*) & Green gram (*Vigna radiata*)

- Cercospora leaf spot
- Anthracnose
- Yellow mosaic

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Cercospora leaf spot

Symptoms

- Small, circular spots develop on the leaves with grey centre and brown margin
- Several spots coalesce to form brown irregular lesions
- In severe cases defoliation occurs and brown lesions may be seen on petioles and stem
- Powdery growth of the fungus may be seen on the centre of the spots

Pathogen–*Cercospora canescens*

- Conidia - linear, hyaline, thin walled and 5-6 septate
- Conidiophores – clusters, dark brown and septate

Anthracnose

Symptoms

- Observed in all aerial parts of the plants and at any stage of crop growth
- Dark brown to black sunken lesions appear on the hypocotyl area and cause death of the seedlings
- Small angular brown lesions appear on leaves, mostly adjacent to veins, which later become greyish white centre with dark brown or reddish margin
Lesions may be seen on the petioles and stem
- The prominent symptom is seen on the pods
- Minute water soaked lesion appears on the pods initially and becomes brown and enlarges to form circular, depressed spot with dark centre with bright red or yellow margin
- Several spots join to cause necrotic areas with acervuli
- The infected pods have discoloured seeds

Pathogen – *Colletotrichum lindemuthianum* (Sexual stage: *Glomerella lindemuthianum*)

- The mycelium of pathogen is septate, hyaline, and branched.
- Conidia are produced in acervuli, arise from the stroma beneath the epidermis which later rupture to become erumpent.
- A few dark colored, septate setae are seen in the acervulus.
- The conidiophores are hyaline and short and bear oblong or cylindrical, hyaline, thin walled, single celled conidia with oil globules.
- The sexual stage of the fungus produces perithecia with limited number of asci, which contain typically 8 ascospores either one or two celled with a central oil globule.

Yellow mosaic

Symptoms

- Initially small yellow patches or spots appear on green lamina of young leaves
- Develops into a characteristics bright yellow mosaic or golden yellow mosaic symptom
- Yellow discoloration slowly increases and leaves turn completely yellow
- Infected plants mature later, bear few flowers and pods
- The pods are small and distorted
- Early infection causes death of the plant before seed set

Pathogen– Mungbean yellow mosaic virus (MYMV)

- It is caused by *Mungbean yellow mosaic India virus* (MYMIV) in Northern and Central region and *Mungbean yellow mosaic virus* (MYMV) in western and southern regions.

- It is a *Begomovirus* belonging to the family *Geminiviridae*.
- Germinate virus particles, ssDNA, bipartite genome with two genomic components DNA-A and DNA-B.

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.8

Study of Pigeonpea diseases

Objective: To study diseases of Pigeonpea (*Cajanus cajan*)

- Phytophthora blight
- Wilt
- Sterility mosaic

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Phytophthora blight

Symptoms

- Affected plants show as water soaked brown to dark lesions on the leaves
- These lesions become necrotic afterward
- The lesions on stem and petiole are somewhat brown and sunken
- The lesions enlarge in size and girdle the stem resulting drying of branches and foliage
- The seedlings die suddenly due to infection
- No symptoms are found on root system
- Branches and petioles lead to desiccation
- In severe cases, the whole foliage becomes blighted
- Infected stem can easily break by the wind
- In advanced stages, the stem is commonly swollen into cankerous structures near the lesions
- The seedlings are highly prone to this infection and dry plants are common during rainy season

- The disease is serious when continuous rains occur or there is water logging in the field

Pathogen – *Phytophthora drechsleri* f. sp. *cajani*

- Fungus produces hyaline, coenocytic mycelium.
- The sporangiophores are hyaline bearing ovate or pyriform, non-papillate sporangia.
- Each sporangium produces 8-20 zoospores.
- Oospores are globose, light brown, smooth and thick walled.

Wilt

Symptoms

- The main symptoms are wilting of seedlings and adult plants
- The wilting starts gradually showing yellowing and dying of leaves following by wilting of whole infected plant
- Sometimes wilting is sudden
- The affected plants can be seen in patches in the field and can be easily recognized
- The tissues of root and stem at the base show black streaks, which can be easily observed by removing the bark
- The branches arising from discoloured parts show the wilting symptoms first
- The partial wilting may occur as the branches on one side will show wilting while on the other side they remain healthy

Pathogen-*Fusarium udum* Butler. (perfect stage *Gibberella indica*)

- The pathogen is restricted to vascular tissues
- The mycelium is septate, hyaline, and both inter and intracellular

The fungus produces three types of spores within the host tissues:-

- a. Microconidia - minute, elliptical, curved, and unicellular with one or two septa and measure 5-15 X 2-4 μ .
- b. Macroconidia - long, curved, pointed at the tips with 3-4 septa and measure 15-50 X 3-5 μ .
- c. Chlamydospores - oval, single or in chains, terminal or intercalary and remain in the soil for long time

Sterility mosaic

Symptoms

- The plants infected remain stunted
- The leaves show mosaic symptoms
- The symptoms may develop on all the leaves of infected plants
- The flowering is partially or completely stopped and a few flowers which develop are sterile

Pathogen- Pigeonpea sterility mosaic (PPSMV)

- Shows properties similar to viruses in the genus *Tenuivirus*
- All tenuiviruses are phloem limited, transmitted by planthoppers and infects plants only in family Poaceae, thus ruling out PPSMV as a *Tenuivirus*
- Ultrastructural studies of PPSMV infected tissues showed 100 – 150 nm quasispherical-membrane bound bodies (MBBs) and fibrous inclusions
- The filamentous virus-like particles (VLPs) of PPSMV resemble the nucleoprotein particles of tomato spotted wilt virus (TSWV), but PPSMV VLPs are slightly larger than those of TSWV and is not serologically related to *Maize stripe tenuivirus* and peanut bud necrosis *Tospovirus*
- The sterility mosaic causal agent is transmitted by the arthropod mite vector – *Aceria cajani* eriophyid mite

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.9

Study of soybean diseases

Objective: To study diseases of Soybean (*Glycine max*)

- Rhizoctonia blight
- Mosaic

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Rhizoctonia aerial blight

Symptoms

- Initially the disease appears on lower leaves as water soaked lesions which are later turned as greyish brown to reddish brown and finally turn dark brown
- Subsequently, the affected leaves get blighted and in severe cases the whole crop looks blighted
- During flowering time, the root of affected plants show brown to dark brown discoloration of cortical region
- The root tissues may also be lignified
- A reddish brown canker may encircle the stem at the base and drooping of leaves is also common
- Under high humidity the fungal mycelium can be observed on leaves and in between closely spaced plants
- Oval to elongated spots appear on stem, petiole and pods
- Dark brown sclerotia are formed on leaves and petioles
- The disease also affects the seedlings causing stunting and also pre emergence mortality
- Seeds on infected plants may show irregularly shaped tan or light brown sunken lesions

Pathogen

- The disease is caused by *Rhizoctiniasolani*Kuhn
- The perfect stage of the pathogen is *Thanatephorus cucumeris*
- The mycelium of the causal fungus produces branches at right angle of the main hypha, slightly constricted at the main junction and have a cross wall near the junction
- The pathogen produces sclerotia – like tufts of short, broad cells that function as chlamydospores, or the tufts develop into sclerotia
- The basidia of the perfect stage develop on a membranous layer of mycelium and have four strigmata, each bearing one basidiospore

Mosaic

Symptoms

- Affected soybean plants show rugosity
- Dark vein banding and light green interveinal areas
- Stunting and leaf curling
- Seed coat mottling
- Male sterility and flower deformation
- Less pubescent
- Sometimes necrotic lesions and systemic necrosis
- Bud blight

Pathogen - Soybean mosaic virus (SMV)

- SMV is filamentous, flexuous rod shaped
- Clear modal length of 650-700 nm or 760 nm, 15-18 nm wide
- The pathogen belongs to *Potyvirus* group in family *Potyviridae*
- Virions contain 5.3% nucleic acid and 94.7% protein
- The genome consists of single stranded RNA of the size of 10.4 kb
- The genome is Monopartite
- The SMV is mechanically transmissible by sap inoculation to hosts, like *Chenopodium album*, *C.quinoa*, *Cyamopsistetragonoloba* where SMV produces local lesions and systemic symptoms on hosts like *Phaseolus vulgaris*, *Glycine max* etc.

- SMV can also be detected in ELISA and PCR systems of diagnosis

Sixteen species of aphids such as *Acyrtosiphonpisuii*, *Ahisfabae* and *Myzuspersicae* are the vectors which transmit the virus in a non-persistent manner

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and its causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.10

Study of mustard diseases

Objective: To study diseases of mustard

- *Alternaria* blight
- White Rust
- Downy Mildew
- *Sclerotinia* Stem Rot

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

***Alternaria* blight**

Symptoms

- The symptoms caused by *A. brassicicola* appear as dark coloured circular lesions on the leaf.
- Concentric rings may also form in the lesions.
- The spots may be linear on stem, petioles and pods.
- Similar spots are also caused by *A. brassicae* except that these spots are smaller and lighter in colour.
- When too many spots are formed on leaves, they die prematurely indirectly affecting the yield.

Pathogen- *Alternariabrassicicola*, *Alternariabrassicae*

- The conidiophores of *A. brassicicola* are septate, olive green and branched measuring 5 – 7.5 X 35 – 45 μ .
- Conidia are linear; develop in chains of 8 – 10 and measure 11 – 17 X 50 – 75 μ on maturity.
- In *A. brassicae*, the conidiophores arise in fascicles.
- The conidia borne singly or in short chains and are dark, obclavate, muriform and measure 125 – 225 X 16 – 18 μ .

White Rust

Symptoms

- The pathogen causes both local and systemic infection and symptoms may appear to all plant parts except roots.
- In case of local infection, white pustules are irregularly formed on leaves and stems.
- These pustules may merge together to form larger pustules.
- The host epidermis is ruptured showing white powder of spores.
- When fungus becomes systemic it causes deformities to stem and floral parts.
- Due to hyperplasia and hypertrophy of tissues, the axis of the inflorescence and flower stalk become thickened, floral parts become swollen and green to violet in colour.
- The petals look like sepals and stamens become leafy.
- The carpels may be open and ovules and pollen grains atrophied causing sterility to ovary.
- The swollen parts carry the oospores of the fungus.
- In case of early infection whole plant may remain dwarfed and only small leaves will develop. Swelling on stem may be restricted to some portion or may spread to whole stem.
- The stem and floral axis may twist showing a zigzag appearance and lateral shoots may appear on the stem.

Pathogen - *Albugo candida* also known as *Cystopus candidus*

- The pathogen belongs to family Albuginaceae, order Peronosporales and subdivision Mastigomycotina of Eumycota.
- The pathogen is an obligate parasite.
- The mycelium develops intercellularly with knob shaped haustoria.

- The sporangiophores develop from the mycelium and produce sporangia in basipetal succession in chains.
- A gelatinous pad is formed between the sporangia which swell during the presence of moisture thus helps in disintegration and freeing the sporangia.
- The sporangia germinate and produce zoospores in water.
- The zoospores swim in water with the help of flagella and later become round and encysted and go for hibernation.
- Under favourable conditions (optimum temperature 10° C and maximum 25° C) the encysted zoospores germinate by producing germ tube and infect the host through stomata and form new mycelium.

Downy Mildew

Symptoms

- Pulpish brown spots are formed underside the leaf.
- The upper surface above the lesions show tan to yellow colouration.
- The cottony growth of the fungus appears on the undersurface of the lesions.
- In systemically infected plants symptoms appear similar to white rust except that the deformities are more on stem but flower parts donot show deformities except enlargement and twisting of ovary.
- The stalks are abruptly bent and flower buds are atrophied.

Pathogen-*Peronospora parasitica*

- Belongs to family Peronosporaceae, order Peronosporales and sub-division Mastigomycotina.
- The pathogen is an obligate parasite and the mycelium is intercellular with branched haustoria.
- The numerous branched conidiophores emerge through the stomata on the lower surface of leaves.
- The conidiophores are dichotomously branched 6-8 times at the tip.
- A single conidium is formed on each tip of the branch and is oval, ellipsoidal and hyaline, and measure 24-27 X 15-20µ.
- The conidia fall of and germinate through a lateral germ tube.

Sclerotinia Stem Rot

Symptoms

- First symptoms of stem rot appear in the field 65-70 days after sowing.

- Diseased plants can be identified by sudden drooping of leaves and finally drying of plants.
- Lodged stems come in contact of soil and develop watery lesions with snowy white mycelium and black, irregularly shaped sclerotia.

Pathogen-*Sclerotinia sclerotiorum*

Belongs to the family Aganomycetaceae, order aganomycetales and sub-division Deuteromycotina. The pathogen infects about 400 other plant species.

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.

3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.11

Objective: To study diseases of groundnut (*Arachis hypogaea*)

- Early leaf spot
- Late leaf spots
- Wilt

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Tikka disease/ Early leaf spot and Late leaf spot

Symptoms (Early leaf spot)

- Appears within a month after sowing
- Lesions are brown when seen on the under surface of the leave
- Spots encircled by a bright yellow halo
- Sporulation on the upper surface of the spot
- Spots are circular to irregular 1-10mm in dia., larger than late leaf spot
- The pathogen does not produce haustoria

Pathogen - *Cercosporaarachidicola* (Sexual Stage: *Mycosphaerellaarachidis*)

Conidiophore

- Consists of continuous, unbranched, yellowish-brown, geniculated and septate (1-2 septa present) conidiophore.
- It is 22-44 μ long and 3-5 μ wide.

Conidia

- Consists of long, cylindrical, hyaline (Pale yellow in colour) conidia. It is 38-108 μ and 6-8 μ wide.
- The shape of conidia truncates at the base and sub truncates at the apex.
- Conidia of *Cercosporaarachidicola* are septate, and around 1-12 septa are present

Symptoms (Late leaf spot)

- Appears towards the maturity of the crop
- Spots are smaller 1-6 mm in dia and more circular than early leaf spot
- Carbon black
- Yellow halo is absent
- Abundant sporulation occurs on the under surface of the spot
- Produces haustoria

Pathogen - *Cercospora personata* (Sexual stage : *Mycosphaerella berkeleyii*)

Conidiophore

- Consists of continuous, unbranched, light brown in colour, geniculated and aseptate conidiophore.
- It is 25-54 μ long and 5-8 μ wide.

Conidia

- Consists of short, cylindrical conidia.
- It is 18-60 μ and 6-11 μ wide.
- The shape of conidia is rounded at one end and tapered on the other end.
- Conidia of *Cercosporapersonata* is septate, and around 3-4 septa are present.

Wilt

Symptoms

- Germinating seeds are attacked by the pathogens shortly before emergence
- There is general tissue disintegration and the surface of the seedling is covered with sporulating mycelium
- Damping off symptoms characterized by brown to dark brown water soaked sunken lesions on the hypocotyl which later encircle the stem and extend above the soil level
- Roots are also attacked, especially the apical portions
- The affected seedlings become yellow and wilted

- The leaves turn greyish green and the plants dry up and die
- The roots and stems show internal vascular browning and discolouration
- These fungi are also commonly associated with pod rot

Pathogen – *Fusarium oxysporum* and *Fusarium solani*

- Two types of spores: Macro-conidia and Micro-conidia
- Macro-conidia is sickled shape and micro-conidia is globular
- They produced sporodochia as fruiting body
- They produced another spore Chlamydospores as the resting structure in the soil.

Observation:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.

3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.12

Study of sesame diseases

Objective: To study diseases of Sesame

- Root rot or stem rot or charcoal rot
- Leaf blight
- Leaf spot
- Wilt
- Stem blight
- Powdery mildew
- Bacterial leaf spot
- Bacterial leaf spot
- Phyllody

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Root rot or stem rot or charcoal rot

Symptoms

- The disease symptom starts as yellowing of lower leaves, followed by drooping and defoliation.
- The stem portion near the ground level shows dark brown lesions and bark at the collar region shows shredding.
- The sudden death of plants is seen in patches.
- In the grown-up plants, the stem portion near the soil level shows large number of black pycnidia.
- The stem portion can be easily pulled out leaving the rotten root portion in the soil.
- The infection when spreads to pods, they open prematurely and immature seeds shriveled and become black in colour.
- Minute pycnidia are also seen on the infected capsules and seeds.

- The rotten root as well as stem tissues contains a large number of minute black sclerotia.
- The sclerotia may also be present on the infected pods and seeds.

Pathogen- *Macrophomina phaseolina*(Sclerotial stage: *Rhizoctonia bataticola*)

- The pathogen produces dark brown, septate mycelium showing constrictions at the hyphal junctions.
- The sclerotia are minute, dark black and 110-130mm in diameter.
- The pycnidia are dark brown with a prominent ostiole.
- The conidia are hyaline, elliptical and single celled.

Leaf blight

Symptoms

- Initially small, circular, reddish brown spots (1-8mm) appear on leaves which enlarge later and cover large area with concentric rings.
- The lower surface of the spots are greyish brown in colour.
- In severe blighting defoliation occurs.
- Dark brown lesions can also be seen on petioles, stem and capsules.
- Infection of capsules results in premature splitting with shriveled seeds.

Pathogen- *Alternaria sesami*

- The mycelium of the fungus is dull brown and septate
- Produce large number of pale grey-yellow conidiophores which are straight or curved.
- The conidia are light olive coloured with transverse and longitudinal septa.
- These are around 3-5 septate and conidia are borne in chain over short conidiophore

Leaf spot

Symptoms

- The disease first appears on the leaves as minute water-soaked lesions, which enlarge to form round to irregular spots of 5-15 mm diameter on both the leaf surface.
- The spots coalesce to form irregular patches of varying size leading to premature defoliation.
- The infection is also seen on stem and petiole forming spots of varying lengths.
- Dark linear spots also occur on pods causing drying shedding.

Pathogen- *Cercospora sesame*

- The hypha of the fungus is irregularly septate, light brown and thick walled.
- Conidiophores are produced in cluster and are 1-3 septate, hyaline at the tip and light brown coloured at base.
- Conidia are elongated, 7-10 septate, hyaline to light yellow, broad at the base and tapering towards the apex.

Wilt

Symptoms

- The disease appears as yellowing, drooping and withering of leaves.
- The plants gradually wither, show wilting symptoms leading to drying.
- The infected portions of root and stem show long, dark black streaks of vascular necrosis

Pathogen- *Fusarium oxysporum f.sp. sesame*

- The fungus produces macroconidia, microconidia and chlamydospores.
- Macroconidia are falcate shape, hyaline and 5-9 celled.
- Microconidia are hyaline, thin walled, unicellular and ovoid.
- The dark walled chlamydospores are also produced.

Stem blight

Symptoms

- Black coloured lesions appear on the stem near the soil level.
- The disease spreads further and affects branches and may girdle the stem, resulting in the death of the plant.
- Leaves may also show water-soaked patches and spread till the leaves wither.
- Infection may be seen on flowers and capsules.
- Infected capsules are poorly developed with shriveled seeds.

Pathogen- *Phytophthora parasitica var. sesame*

- The fungus produces non-septate, hyaline mycelium.
- The sporangiophores are hyaline and branched sympodially and bear sporangia.
- The sporangia are hyaline and spherical with a prominent apical papilla.
- The oospores are smooth, spherical and thick walled.

Powdery mildew

Symptoms

- Initially greyish-white powdery growth appears on the upper surface of leaves.
- When several spots coalesce, the entire leaf surface may be covered with powdery coating.
- In severe cases, the infection may be seen on the flowers and young capsules, leading to premature shedding.
- The severely affected leaves may be twisted and malformed.
- In the advanced stages of infection, the mycelial growth changes to dark or black because of development of cleistothecia.

Pathogen- *Erysiphe cichoracearum* (Syn: *Oidium acanthospermi*)

- The Pathogen produces hyaline, septate mycelium which is ectophytic and sends haustoria into the host epidermis.
- Conidiophores arise from the primary mycelium and are short and non septate bearing conidia in long chains.
- The conidia are ellipsoid or barrel-shaped, single celled and hyaline.
- The cleistothecia are dark, globose with the hyaline or pale brown myceloid appendages.
- The asci are ovate and each ascus produces 2-3 ascospores, which are thin walled, elliptical and pale brown in colour.

Bacterial leaf spot

Symptoms

- Initially water-soaked spots appear on the under surface of the leaf and then on the upper surface.
- They increase in size, become angular and restricted by veins and dark brown in color.
- Several spots coalesce together forming irregular brown patches and cause drying of leaves.
- The reddish brown lesions may also occur on petioles and stem.

Pathogen- *Xanthomonas campestris* pv. *sesami*

- The bacterium is a Gram negative rod with a monotrichous flagellum.

Bacterial leaf spot

Symptoms

- The disease appears as water-soaked yellow specks on the upper surface of the leaves.
- They enlarge and become angular as restricted by veins and veinlets.
- The colour of spot may be dark brown with shiny oozes of bacterial masses.

Pathogen- *Pseudomonas sesami*

- The bacterium is gram negative aerobic rod with one or more polar flagella.

Phyllody

Symptoms

- The symptoms start with vein clearing of leaves.
- The disease manifests itself mostly during flowering stage, when the floral parts are transformed into green leafy structures, which grow profusely.
- The flower is rendered sterile.
- The veins of phylloid structure are thick and prominent.
- The plant is stunted with reduced internodes and abnormal branching.

Pathogen- Phytoplasma

- It is caused by pleomorphic mycoplasma like bodies present in sieve tube of affected plants, now designated as a phytoplasmal disease.

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.

2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.13

Study of castor diseases

Objective: To study diseases of castor (*Ricinus communis*)

- Phytophthora blight

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Phytophthora blight/ Seedling blight of castor

Symptoms

- Appears circular, dull green patch on both the surface of the cotyledon leaves.
- It later spreads and causes rotting
- The infection moves to stem and causes withering and death of seedling
- In mature plants, the infection initially appears on the young leaves and spreads to petiole and stem causing black discoloration and severe defoliation

Pathogen- *Phytophthora parasitica*

- Mycelium - non-septate and hyaline
- Sporangiohores - emerge through the stomata on the lower surface, singly or in groups and unbranched
- Sporangia - single celled, hyaline, round or oval occur at the tip singly
- The sporangia germinate to produce abundant zoospores

The fungus also produces oospores and chlamydospores in adverse seasons

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.14

Study of cotton diseases

Objective: To study diseases of cotton (*Gossypium* spp.)

- Wilt
- Verticillium wilt
- Root rot
- Anthracnose
- Grey or Areolate mildew
- Boll rot
- Leaf blight
- Bacterial blight
- Stenosis or small leaf

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Wilt

Symptoms

- The disease affects the crop at all stages.
- The earliest symptoms appear on the seedlings in the cotyledons which turn yellow and then brown.
- The base of petiole shows brown ring, followed by wilting and drying of the seedlings.
- In young and grown up plants, the first symptom is yellowing of edges of leaves and area around the veins i.e. discolouration starts from the margin and spreads towards the midrib.
- The leaves lose their turgidity, gradually turn brown, droop and finally drop off.
- Symptoms start from the older leaves at the base, followed by younger ones towards the top, finally involving the branches and the whole plant.
- The defoliation or wilting may be complete leaving the stem alone standing in the field.

- Sometimes partial wilting occurs; where in only one portion of the plant is affected, the other remaining free.
- The taproot is usually stunted with less abundant laterals.
- Browning or blackening of vascular tissues is the other important symptom, black streaks or stripes may be seen extending upwards to the branches and downwards to lateral roots.
- In severe cases, discolouration may extend throughout the plant starting from roots extending to stem, leaves and even bolls.
- In transverse section, discoloured ring is seen in the woody tissues of stem.
- The plants affected later in the season are stunted with fewer bolls which are very small and open before they mature.

Pathogen-*Fusarium oxysporum f.sp. vasinfectum*

- The fungus produces three types of spores.
- Macroconidia are 1 to 5 septate, hyaline, thinwalled, falcate with tapering ends.
- The microconidia are hyaline, thinwalled, spherical or elliptical, single or two celled. Chlamydospores are dark coloured and thick walled.
- The fungus also produces a vivotoxin, Fusaric acid which is partially responsible for wilting of the plants.

Verticillium wilt

Symptoms

- The symptoms are seen when the crop is in squares and bolls.
- Plants infected at early stages are severely stunted.
- The first symptoms can be seen as bronzing of veins.
- It is followed by interveinal chlorosis and yellowing of leaves.
- Finally the leaves begin to dry, giving a scorched appearance.
- At this stage, the characteristic diagnostic feature is the drying of the leaf margins and areas between veins, which gives a “**Tiger stripe**” or “**Tiger claw**” appearance.
- The affected leaves fall off leaving the branches barren.
- Infected stem and roots, when split open, show a pinkish discolouration of the woody tissue which may taper off into longitudinal streaks in the upper parts and branches.

- The infected leaf also shows brown spots at the end of the petioles.
- The affected plants may bear a few smaller bolls with immature lint.

Pathogen- *Verticilliumdahliae*

- The fungus produces hyaline, septate mycelium and two types of spores.
- The conidia are single celled, hyaline, spherical to oval, borne singly on verticillateconidiophores.
- The micro sclerotia are globose to oblong, measuring 48-120 X 26-45um.

Root rot

Symptoms

- The fungus causes **three types of symptoms** viz., **seedling disease, sore-shin** and **root rot**.
- Germinating seedling and seedlings of one to two weeks old are attacked by the fungus at the hypocotyl and cause black lesions, girdling of stem and death of the seedling, causing large gaps in the field.
- In sore-shin stage (4 to 6 weeks old plants), dark reddish-brown cankers are formed on the stems near the soil surface, later turning dark black and plant breaks at the collar region leading to drying of the leaves and subsequently the entire plant.
- Typical root rot symptom appears normally at the time of maturity of the plants.
- The most prominent symptom is sudden and complete wilting of plants in patches.
- Initially, all the leaves droop suddenly and die within a day or two.
- The affected plants when pulled reveal the rotting of entire root system except tap root and few laterals.
- The bark of the affected plant shreds and even extends above ground level.
- In badly affected plants the woody portions may become black and brittle.
- A large number of dark brown sclerotia are seen on the wood or on the shredded bark.

Pathogen- *Rhizoctonia bataticola* (Pycnidialstage:*Macrophomina phaseolina*)

- The fungal hyphae are septate and fairly thick and produce black, irregular sclerotia which measure 100 um in diameter.

Anthracnose

Symptoms

- The fungus infects the seedlings and produces small reddish circular spots on the cotyledons and primary leaves.

- The lesions develop on the collar region, stem may be girdled, causing seedling to wilt and die.
- In mature plants, the fungus attacks the stem, leading to stem splitting and shredding of bark.
- The most common symptom is bolls spotting.
- Small water soaked, circular, reddish brown depressed spots appear on the bolls.
- The lint is stained to yellow or brown, becomes a solid brittle mass of fibre.
- The infected bolls cease to grow and burst and dry up prematurely.

Pathogen- *Colletotrichum capsici*

- The pathogen forms large number of acervul on the infected parts.
- The conidiophores are slightly curved, short, and club shaped.
- The conidia are hyaline and falcate, borne single on the conidiophores.
- Numerous black coloured and thick walled setae are also produced in acervulus.

Grey or Areolate mildew

Symptoms

- The disease usually appears on the under surface of the bottom leaves when the crop is nearing maturity.
- Irregular to angular pale translucent lesions which measure 1-10 mm (usually 3-4 mm) develop on the lower surface, usually bound by veinlets.
- On the upper surface, the lesions appear as light green or yellow green specks.
- A frosty or whitish grey powdery growth, consisting of conidiophores of the fungus, appears on the lower surface.
- When several spots coalesce, the entire leaf surface is covered by white to grey powdery growth.
- White or grey powdery growth may occur on the upper surface also.
- The infection spreads to upper leaves and entire plant may be affected.
- The affected leaves dry up from margin, cup inward, turn yellowish brown and fall of prematurely.

Pathogen - *Ramularia areola* (Sexual stage: *Mycosphaerella areola*)

- The fungus produces endophytic, septate mycelium.
- Conidiophores are short, hyaline and branched at the base.
- Conidia are borne singly or in chains at the tips of conidiophores.
- The conidia are hyaline, irregularly oblong with pointed ends, sometimes rounded to flattened ends, unicellular or 1-3 septate.

- The perfect stage of the fungus produces perithecia containing many asci.
- The ascospores are hyaline and usually two celled.

Boll rot

Symptoms

- Initially, the disease appears as small brown or black dots which later enlarge to cover the entire bolls.
- Infection spreads to inner tissues and rotting of seeds and lint occur.
- The bolls never burst open and fall off and prematurely.
- In somecases, the rotting may be external, causing rotting of the pericarp leaving the internal tissues free.
- On the affected bolls, a large number of fruiting bodies of fungi are observed depending upon the nature of the fungi involved.

Pathogen - It is a complex disease caused by several fungal pathogens viz., *Fusariummoniliforme*, *Colletotrichum capsici*, *Aspergillus flavus*, *A. niger*, *Rhizopus nigricans*, *Nematospora nagpuri* and *Botryodiplodia sp.*

Leaf blight

Symptoms

- The disease may occur in all stages but more severe when plants are 45-60 days old.
- Small, plate to brown, irregular or round spots, measuring 0.5 to 6mm diameter, may appear on the leaves.
- Each spot has a central lesion surrounded by concentric rings.
- Several spots coalesce together to form blighted areas.
- The affected leaves become brittle and fall off.
- Sometimes stem lesions are also seen.
- In severe cases, the spots may appear on bracts and bolls.

Pathogen – *Alternaria macrospora*

- The fungus produces dark brown, short, 1-8 septate, irregularly bend conidiophores with a single conidium at the apex.
- The conidia are obclavate, light to dark brown in colour with 3-9 transverse septa and four longitudinal septa, with a prominent beak.

Bacterial blight

Symptoms

The bacterium attacks all stages from seed to harvest. Usually five common phases of symptoms are noticed.

i) Seedling blight : Small, water-soaked, circular or irregular lesions develop on the cotyledons, Later, the infection spreads to stem through petiole and cause withering and death of seedlings.

ii) Angular leaf spot: Small, dark green, water-soaked areas develop on lower surface of leaves, enlarge gradually and become angular when restricted by veins and veinlets and spots are visible on both the surface of leaves. As the lesions become older, they turn to reddish brown colour and infection spreads to veins and veinlets.

iii) Vein blight or vein necrosis or black vein: The infection of veins cause blackening of the veins and veinlets, gives a typical 'blighting' appearance. On the lower surface of the leaf, bacterial oozes are formed as crusts or scales. The affected leaves become crinkled and twisted inward and show withering. The infection also spreads from veins to petiole and cause blighting leading to defoliation.

iv) Black arm : On the stem and fruiting branches, dark brown to black lesions are formed, which may girdle the stem and branches to cause premature drooping off of the leaves, cracking of stem and gummosis, resulting in breaking of the stem and hang typically, as dry black twig to give a characteristic "black arm" symptom.

v) Square rot / Boll rot: On the bolls, water soaked lesions appear and turn into dark black and sunken irregular spots. The infection slowly spreads to entire boll and shedding occurs. The infection on mature bolls lead to premature bursting. The bacterium spreads inside the boll and lint gets stained yellow because of bacterial ooze and loses its appearance and market value. The pathogen also infects the seed and causes reduction in size and viability of the seeds.

Pathogen – *Xanthomonas campestris* pv *malvacearum*

The bacterium is a short rod with a single polar flagellum. It is gram negative, nonspore forming and measures 1.0-1.2 X 0.7-0.9 um.

Stenosis or small leaf

Symptoms

- The disease appears when the plants are two to three months old and affected plants are stunted.
- They put forth numerous extremely small leaves in cluster and the dormant buds are stimulated resulting in profuse vegetative growth.
- The leaves are disfigured and variously lobed.
- Flowers remain small with abortive ovary.

- Large number of flower buds and young seeds.
- Root system is poorly developed and can be easily pulled out.
- Sometimes, the disease affects only the base of the plant, resulting in the formation of clump of short branches which bear small and deformed leaves.
- The mode of transmission of disease and the role of vector are unknown.

Pathogen - *Mycoplasma like Organism*

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.15

Study of berseem diseases

Objective: To study diseases of berseem

- **Damping off**
- **Stem rot**
- **Root rot**
- **Viral Mosaic**
- **Nematode disease**

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Damping off

Symptoms

- Pre-emergence damping off, seed may decay or seedlings may become blighted and be killed before emergence.
- Postemergence damping off, infection commonly occurs as the seedling emerges and it to wilt, collapse, dry up and die from a root at the soil line and below.
- It is soil-borne fungal disease that affects seeds and new seedlings, damping off usually refers to the rotting of stem and root tissues at and below the soil surface.
- In most cases, infected plants will germinate and come up fine, but within a few days they become water-soaked and mushy, fall over at the base and die.
- It appears more in wet soil and is further increased by poor soil drainage.

Pathogen - *Pythium spinosum*

Stem rot

Symptoms

- Fungus attacks the basal portion of the stem and causes it to rot.
- It produces white cottony mycelium which begins to grow on dead organic matter on the surface of the soil.
- The white mycelium can be very easily spotted in the field around the wilted patches of the berseem crop
- The sclerotia are distributed between fields on plant material by machinery, animals, flowing water and with seeds.
- Sclerotia that over season on the surface or in the soil or in crop debris or as admixture with the seeds.
- The crop is infected by the ascospores produced from germination of these sclerotia.
- Most suitable temperature for ascospore germination lies between 15-30°C.

Pathogen – *Sclerotinia sclerotiorum*

Root rot

Symptoms

- The first sign of the disease is evidenced by the dropping and morbidity of one or two tiller of the affected plants under favorable conditions, it appears in the form of definite patches.
- The fungi only can incite the disease but the presence of nematode (*Tylenchorhynchus vulgaris*) accelerates the infection rate causing serious damage to the crop.
- Once the disease established in the field it becomes a permanent source of infection as the pathogen perpetuates in the soil through their resting structures.
- Heavy incidence of the disease reduces the plant density and the green fodder yield.
- The occurrence of disease is common in the Gangetic and Central plains.
- Association of several fungi like *Rhizoctonia solani*, *Fusarium semitectum*, with nematode *Tylenchorhynchus vulgaris* have been reported with root rot complex.
- The fungus spores (Chlamydospores) and mycelium survive in the soil for longer period without host plant.

Pathogen - Berseem root rot is a complex disease incited by three most virulent pathogens, viz, *Rhizoctonia solani*, *Fusarium moniliforme* and *Sclerotinia bataticola*

Viral Mosaic

Symptoms

- Systemic light and dark green or yellow mottling is the most common symptoms.

- Vein yellowing leaf crinkling and distortion and some dwarfing.

Pathogen - Alfalfa Mosaic Virus (AMV)

- It is the type species of the genus Alfamovirus in the family Bromoviridae.
- Alfalfa mosaic virus has a genome consisting of three, single stranded, positive-sense RNAs. RNAs1 and 2 encode proteins (P1 and P2) involved in virus replication.
- A mosaic disease of Egyptian clover or berseem in India was sap-inoculable and transmitted by *Aphis gossypii* but not by *A. rumicis* or *A. craccivora*.
- The virus, serologically related to alfalfa mosaic virus, and probably a new strain of that virus, was transmitted by 60-70% of *T. alexandrinum* seeds.

Nematode disease

Symptoms

- Root-knot nematodes do not produce any specific aboveground symptoms.
- Affected plants show stunting, wilting or chlorosis (yellowing), severe galling or knotted root system, excessive root branching in plants.

Pathogen - *Meloidogyne incognita* and *Meloidogyne arenaria*

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and its causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.16

Study of lucern diseases

Objective: To Study disease of lucerne (*Medicago sativa*)

- **Seed rot, damping off and seedling blights**
- **Downy mildew**
- **Rust**
- **Stemphylium leaf spot**
- **Common leaf spot**
- **Phytophthora root rot**
- **Bacterial wilt**
- **Alfalfa or Lucerne mosaic**

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Seed rot, damping off and seedling blights

Symptoms

- Seed may decay or seedlings may become blighted and be killed before they emergence with pre-emergence damping off
- Post-emergence damping off, infection commonly occurs as the seedling emerges and the disease develops slowly afterward the seedlings emerge only to wilt, collapse, dry up and die from a rot at the soil line and below.
- Young roots and stems decay, causing varying degree of stunting but the infected plants survive at the early seedling stage.
- Later, some plants may turn yellow and wither.

Pathogen

- These diseases are caused by soil borne fungi, primarily in the genera Pythium, Rhizoctonia, Fusarium, Phytophthora, Phoma (Ascochyta), Mycoleptodiscus and Sclerotinia
- Pythium is probably most common cause of these diseases.
- Some organisms (species of Pythium, Fusarium, Rhizoctonia and Phytophthora) are soil inhabitants and persist in and on plant residues as oospores and sporangia (Pythium, Phytophthora, dark sclerotia (Rhizoctonia, Sclerotinia), chlamydospores and mycelium (Fusarium) for two or more years without any suitable host plant.
- Other fungi (Phoma and Mycoleptodiscus) invade the soil and survive in crop till it decayed.

Downy mildew

Symptoms

- Light green to yellow blotches appears on upper leaves.
- Shoot tips are often dwarfed and the leaves twisted or rolled.
- A grayish cottony growth, the mycelium and fruiting structure of fungus is often visible on the underside of the leaflets.
- At the later stages of the disease the leaves of plants are dried and shed off leaving bare stems and branches.

Pathogen – *Peronospora trifoliorum* (Syn. *Peronospora aestivalis*)

- The pathogen survives with the fallen leaves residing in the soil which serve as the source of primary infection.
- Fungus spores on the undersides of the leaves are dispersed by air movement.
- This fungus occurs on lucerne, white clover and red clover.

Rust

Symptoms

- The fungus produces characteristic rust pustules on the leaf blade, though often they may be found on the petiole and stems.
- The reddish-brown uredia and telia develop on the stem late in the season.
- In severe infection the leaf may wither resulting into considerable damage to the crops.

Pathogen - *Uromyces striatus* var. *medicaginis*

- Rust is an obligate parasitic and heteroecious in nature.

Stemphylium leaf spot

Symptoms

- Initial symptoms consisted of white to tan spots with a brown border, 2 to 3 mm in diameter, circular to oval, enlarging to 5 to 8 mm in diameter.
- Large lesions often coalesced.
- Small, oval dark brown spots appear on the leaves, petioles, stems, peduncles and seed pods.
- Lower killed leaves remained attached to the primary stem.
- The slightly sunken spots later enlarge and often become zoned.
- They are light and dark brown often surrounded by a pale yellow 'halo'.
- Infected leaves commonly turn yellow and fall prematurely

Pathogen - *Stemphylium botryosum* (Teleomorph: *Pleospora herbarum*)

- Stemphylium leaf spot is a common disease of Lucerne, clover, lupin, broad bean and tomato.

Common leaf spot

Symptoms

- Small, circular, dark brown to black spots about 1-3 mm in diameter develop first on the lower surface and inner leaves.
- In the thickened center of fully developed spots, a tiny, raised, light brown, disk-shaped fungus fruiting body (apothecium) form on the upper leaf surface.
- Infected leaves cup, turn yellow then brown before falling to the ground.
- Elongated spots occur on stem and petioles.

Pathogen – *Pseudopeziza medicaginis*

Phytophthora root rot

Symptoms

- Germinating seed and seedlings of lucerne are infected and killed rapidly, with the disease appearing as damping off.
- The plants appear stunted and discoloured yellow or reddish purple and they may be wilted above ground.
- Damaged plants may have taproot girdled at same depth as water table in soil.
- Internally, the root tissue is discoloured yellow.
- The roots are severely rotted, the plants are pulled up easily, leaving the root in the soil.

Pathogen- *Phytophthora megasperma* Drechs. f. sp. *medicaginis*

- *P. medicaginis* a wide distributed disease and prevalent in almost every lucerne growing regions of the world.

Bacterial wilt

Symptoms

- Infected plants appear slightly yellow and stunted.
- Shortened stems cause bunchy growth and small, chlorotic and cupped leaves.
- During warm dry weather, plants may wilt and die rapidly.
- Initially, only the tips of the stems droop, then wilting followed by dying occurs.
- Roots of infected plants have a pale yellow to brown discoloration in the stale.
- Stunting is most evident during re-growth following cutting, progressively less growth is produced after each cutting.
- The water conducting tissues are invaded and clogged by rapidly multiplying bacteria, resulted yellowing, stunting and eventually death of the plant.

Pathogen – *Clavibacter michiganensis* sub sp. *insidiosus*.

- It is gram positive coryneform bacterium

Alfalfa or Lucerne mosaic

Symptoms

- Alfalfa mosaic virus symptoms vary from light and almost unnoticeable, to severe, causing plants to die, due to the diversity of strains of the virus, the cultivars and environmental conditions.
- AMV causes an inter veinal light green or yellow mottle on the leaves and a stunting of the plant and leaf deformation.
- When the disease advances the symptoms appear such as chlorosis, rugose and rosette.

Pathogen- Alfalfa Mosaic Virus (AMV)

- It is the species of the genus Alfamovirus in the family Bromoviridae.
- Alfalfa mosaic virus has a genome causing of three, single stranded, positive-sense RNAs. RNAs1 and 2 encode proteins (P1 and P2) involved in virus replication.

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.17

Study of menthe diseases

Objective: To study diseases of mentha

- Rust
- Leaf Spot
- Leaf spot
- Anthracnose
- Powdery Mildew
- Aerial blight
- Stolon rot
- Collar rot
- Wilt
- Stem and rhizome rot
- Sclerotinia blight

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Rust

Symptoms

- The leaves of the affected plants show characteristic dark brown uredial pustules and consequent leaf fall is common.
- The rust pathogen produces symptoms on leaves, which appears as elliptical blisters or pustules on leaves, stem and runners.
- These blisters develop parallel with long axis of leaf, stem and runners.
- The epidermis covering the pustules is later ruptured irregularly and pushed back revealing a powder mass of brick red coloured uredospores.
- Later in the season, as the plant approaches maturity, the rusty colour of pustules turns black and fungus produces teliospores.
- The aecial stage has not been observed in India.
- In severe conditions, defoliation can be seen in the field.
- The disease can be avoided by using the disease-free planting material.

Pathogen – *Puccinia menthae*

Leaf Spot

Symptoms

- Infection appears in the form of round to oval or slightly irregular dark brown spots on the upper surface of the leaf.
- The leaf spots developed as a result of infection of *Alternaria* are generally dark brown to black, often numerous and enlarging and usually developing in concentric rings which gives the spots a target-like appearance.
- Lower, leaves are usually attacked first but the disease progresses upwards and makes affected leaves turn yellowish and senescent which either dry up and droop or fall off.
- These spots consist of concentric rings/zones, which are surrounded by pale yellow margin.
- Spots later coalesce forming large dark patches leading to defoliation, which is often heavy, with a marked decrease in essential oil content.
- The stem may also be infected and after severe infection the severely affected fields may show blighted appearance.
- The disease is particularly severe during monsoon, though it is also common during summer months.

Pathogen – *Alternaria alternata*

Leaf spot

- The first symptoms of the disease appear as minute dirty brownish spots scattered all over the leaves.
- Later, with the advance of the disease, the spots increase in size becoming spherical or irregular patches of larger sizes.
- Though the symptoms may appear at any stage of growth of the plant but larger spots usually occur on lower leaves only.
- The remaining portion of the infected leaves become chlorotic and finally wither away.

Pathogen- *Curvularia lunata*

Anthracnose

Symptoms

- This disease causes stunting, defoliation and loss in economic yield in peppermint and spearmint.

Pathogen- *Sphaceloma menthae*

Powdery Mildew

Symptoms

- The disease first appears on young leaves as slightly raised blister like areas
- These areas soon become covered with grayish, white and powdery growth of the pathogen on mature leaves, though the fungal growth appears but there is little distortion.
- The white patches of fungal growth similar to those observed on the leaves may also be seen on green stolons and stems, which may coalesce and cover the entire surface.

Pathogen- *Erysiphe cichoracearum*

Aerial blight

Symptoms

- The infected plants show typical blight symptoms.
- The disease is particularly damaging after the first harvest and when the crop is closely planted.
- The disease first appears on leaf surfaces as faded patches, which generally start from the margin and extend inwards under moist and humid weather.

- Later the blight extends towards twigs/stem causing necrosis of the above-ground parts.
- In the case of severe infection, fungal webs can be seen on aerial portion.
- Sometimes sclerotia of the pathogen are also seen on dark brown coloured bodies in fungal webs. Early planting of the crop to avoid rainy months during maturity reduces the resultant losses.

Pathogen – *Rhizoctonia solani*

Stolon rot

Symptoms

- The initial symptoms of the disease are yellowing followed by the death of the whole plant. Underground stolons exhibit pinkish brown lesions in the earlier stages, which gradually turn into dark brown or black patches.
- These patches increase in size and finally result in decay of a portion or entire stolon.

Pathogen – *Rhizoctonia solani* and *Rhizoctonia bataticola*

Stolon rot

Symptoms

- The incidence of *Thielavia* rot was found to be severe in soils with high moisture and low aeration.
- The stolons show typical wilting symptoms.

Pathogen- *Thielavia basicola*

Collar rot

Symptoms

- This disease is serious only in rich and heavy soils.
- White mycelial strands develop around the infected collar portion resulting in yellowing and wilting of the plant.
- In advanced stages, white mustard like sclerotial bodies develop around the collar portion and the plant topples down.

Pathogen – *Sclerotium rolfsii*

Wilt

- The main symptoms of the disease are dwarfing, unilateral development of branches, etiolation and wilting.
- The disease spreads through infected stolons when used as propagating material.
- Soil inversion during summer and use of healthy planting material reduces the incidence of disease.

Pathogen - *Verticillium alba-atrum* var. *menthae*

Stem and rhizome rot

Symptoms

- Reddening of leaves, wilting and stunting of plants.
- On above-ground stem, infection occurs near the soil surface forming sunken cankers, which later girdle the stem and plant collapses.

- On rhizome, black lesions can be observed which later coalesce causing general necrosis of rhizome.

Pathogen – *Phoma strasserii*

Sclerotinia blight

Symptoms

- The disease is characterized by the appearance of symptoms on the stem as white cottony growth of the mycelium of the pathogen in the collar zone.
- After some time, small water-soaked lesions appear on the stem.
- Later on, the fungal mycelium moved both upwards and downwards resulting in stolon decay and decay of aerial plant parts, respectively.
- Under moist conditions, the pathogen produces white fluffy mycelia on different plant part.
- With the advance of disease, the infected parts show chocolate brown discoloration and watery symptoms of soft also develop resulting in die back of the branches of infected plants.

Pathogen – *Sclerotinia sclerotiorum*

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.18

Diseases of aloe vera

Objective: To study diseases of aloe vera

- Anthracnose
- Black leaf spot disease
- Leaf spot disease
- Brown leaf spot disease
- Leaf rot disease
- Root rot disease
- Collar and root rot

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Aspirator
4. Wash bottles
5. Watch glass
6. Needle
7. Forceps
8. Scalpel
9. Stereo microscope

Anthracnose

Symptoms

- Circular to oval, water soaked dark green to dark brown areas on the tips and the abaxial surfaces of leaves
- In the advance stage of infection, spots appeared on both leaf surfaces, affected area lost the mucilaginous gel and leads the death of infected leaves.
- Formation of acervuli is commonly found

Pathogen – *Colletotrichum gloeosporioides*

Black leaf spot disease

Symptoms

- Circular to oval, water-soaked spots with concentric double ring; greyish-black centre with dark brown margins the tip and abaxial surface of leaves
- As the diseases progressed black sporulation appeared on the centre of the spots. On later stage, spots become necrotic and dry

Pathogen – *Alternaria alternata*

Leaf spot disease

Pathogen –*Cladosporium sphaerospermum*

Symptoms

- Circular, oval to irregular, brown to olive black to dark black, sunken spots on the abaxial surface of leaves
- later stage sporulation appeared and spots became olive black to dark black in colour.
- Sometimes spots often joined together and became irregular in shape.

Pathogen –*Curvularia ovoidea*

Symptoms

- Elongated, water-soaked spots, appeared on the leaf tip and spiny margins which later became sunken, reddish brown to dark maroon in colour
- In severe conditions due to necrosis of tissues spiny margin of leaf is twisted inside

Pathogen –*Curvularia lunata*

Symptoms

- Initially circular, water-soaked spots are appeared on the abaxial surface of leaves.
- As the disease progresses, spots become sunken, maroon colour
- On later stage spots become dry, necrotic and turned into dark brown in colour

Pathogen –*Fusarium fusaroides*

Symptoms

- Circular to oval water-soaked maroon to reddish brown spots
- At maturity, diseased tissues show tissue death, become necrotic, spots turn into black in colour
- Formation of sporodochia is commonly found

Pathogen –*Fusarium moniliforme*

Symptoms

- Irregular to sometimes circular lesion as sunken and light cream to enlarged, embedded, creamish brown with reddish brown margin on the abaxial or adaxial surface of leaf.
- Dark brown sporulation observed on the centre of the spots
- Leaf gel becomes mushy and in severe condition diseased portion break down
- Formation of sporodochia is commonly found

Pathogen –*Phoma eupyrena*

Symptoms

- Irregular to elongated, sunken scrape lesion of creamish brown colour having maroon margin on the abaxial or adaxial surface of leaf
- Later on, lesions dry, tissue become necrotic, brown colour
- Formation of Pycnidia is commonly found

Pathogen –*Phomopsis* sp

Symptoms

- Small and maroon brown to black coloured with maroon margin spots on abaxial surface and tip of leaves which gradually become enlarged, sunken, dark brown in colour
- Many small black spots are speckled on the centre of the spots
- Formation of Pycnidia is commonly found

Pathogen –*Polyrostrata indica*

Symptoms

- The symptoms appear primarily on the abaxial surface of leaf during the winter season.
- Initially circular to oval water-soaked light maroon spots appears which progressively become, sunken, enlarged and turned into light brown in colour
- At the maturity, spots turn into necrotic, dark brown in colour
- Formation of Pycnidia is commonly found

Pathogen –*Helminthosporium sp.*

Symptoms

- Water-soaked spots which gradually enlarge into ellipsoidal to circular in shape
- Symptoms of disease are generally noticed in the month of August

Brown leaf spot disease

Pathogen - *Phomabetae*

Symptoms

- Water-soaked sunken spots appear as oval to circular with dark brown in colour having concentric ring pattern on the tip and the abaxial surface of leaf.
- Later, spots get dry, necrotic and shrunken.
- Sometimes two or more spots coalesce, form a big spot
- In severe condition leaf become dry and broken
- Formation of Pycnidia is commonly found

Leaf rot disease

Pathogen – *Pythium aphanidermatum*

Symptoms

- Spongy, watery soft patches on leaves.
- As rotting progressed, patches enlarged rapidly and the epidermis of leaf bulged, caused tissue rot.
- As rotting progressed and when reached to the collar portion the whole plant die within three to four days.

Root rot disease

Pathogen – *Fusarium solani*

Symptoms

- Rotting appears in rainy season in the form of browning and decaying of root tips. After decaying, symptoms spread towards the distal portion of root resulted in total rotting of root system and collapsed
- The leaves show decline and yellowing colouration and later the margin of leaf turned inside due to the dryness of mucilaginous gel
- Formation of sporodochia is commonly found.

Collar and root rot

Pathogen – *Penicillium purpurogenum*

Symptoms

- Reddening of the tips, and shrivelling of plant with spongy red patches/spots on the collar region.
- Started from roots, rot symptoms progress towards the collar portion with appearance of red to dark maroon-coloured spots.
- On severity, green sporulation of fungus appears on the root hairs, which led to browning and decaying of root tips

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope

PRACTICAL NO.19

Study of ashwagandha diseases

Objective: To study diseases of ashwagandha

- Damping off
- Root rot and wilt
- Leaf blight
- Leaf spot
- Black leaf spot mold
- Root-knot disease
- Witches broom

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Damping off

Symptoms

- Initially water-soaked, necrotic lesions on the basal stem.
- Stems became soft and mushy.
- Young leaves wilt and become grey to brown colour and ultimately plant die.

Pathogen – *Rhizoctonia solani*

Root rot and wilt

Symptoms

- It is a destructive disease in nursery.

- The first signs of the disease are withering and drooping of the plants, followed by severe wilting, death, and rotting of subsurface portions.
- The afflicted plant's root was pulpy and brownish in colour.
- The fungus grew as a white cottony growth at the base of afflicted plants around ground level.
- At the seedling stage, the plants in the nurseries also displayed yellowing, drooping, and decay indications, resulting in 30- 40% mortality.

Pathogen – *Fusarium solani*.

Leaf blight

Symptoms

- It is the most prevalent disease in *W. somnifera*.
- Initially, 20–30% of leaf showed brown to black spots of 2–9 mm in diameter surrounded by a yellow halo.
- The brownish black spots were apparent on both the dorsal and ventral surfaces of the infected leaves, though more pronounced on the ventral surface.
- In the later stage of infection, the leaf spots enlarged and were severely infected may have concentric zonate spots with a diffuse margin, frequently surrounded by light yellow haloes, conspicuous brownish concentric rings occur.
- Such leaves often dehisced prematurely.
- Under moist conditions (70-80% RH), fungal growth was often observed on the leaves.
- On the ventral side of the leaves, irregular necrotic patches grew along the veins.

Pathogen- *Alternaria alternata*

Leaf spot

i) *Curvularia* leaf spot

Symptoms

- On the leaves, small, circular to oval dark brown necrotic sunken patches formed.
- The center of the lesion turned reddish brown to brown in hue as these patches became larger.
- Spots formed on both surfaces of the leaf in the advanced stages of infection; the afflicted area lost its mucilaginous gel, resulting in the death of diseased leaves.

Pathogen – *Curvularia lunatus*

ii) *Phycomyces* leaf spot

Symptoms

- Circular to irregular necrotic patches of light brown colour are dispersed across the abaxial surface of the leaf as the first sign.
- Large necrotic patches emerge as spots combine.
- A brilliant golden halo surrounds each individual spot.
- Spots were round, grey to blackish, and dispersed throughout the majority of the leaf lamina on the adaxial surface.
- Plants that were severely affected defoliated early.

Pathogen – *Pithomyces chartarum*

iii) *Myrothecium* leaf spot

Symptoms

Small, yellow to brown water-soaked patches on the leaves with a brown to violet edge and a chlorotic halo developed as the first symptom.

Although infection is rare, it can hinder plant development during the wet season.

Pathogen – *Myrothecium roridum*

Black leaf spot mold

Symptoms

- Light chlorotic patches on both sides of old leaves were present in the early stages of the illness, which eventually developed into dark black spots, leading in early defoliation.

Pathogen – *Pseudocercospora fuligena*.

Root-knot disease

Symptoms

- The pathogen mostly infects roots, which are the primary source of valuable medications, making it extremely important.
- Plants that were heavily afflicted had several galls, and most of the time the whole root system was transformed into large galls.
- The plant becomes stunted and reduced productivity.

- Underground root totally deformed.

Pathogen - *Meloidogyne incognita* (race-2)

Witches broom

Symptoms

- It is a phloem inhabiting, wall less prokaryote.
- It results in abnormal brush like a cluster of dwarfed weak shoot arising at or near the same point.
- It can be checked by chloramphenicol, chlortetracycline.
- It can be destroyed above 45-50° C.

Pathogen - Phytoplasma

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.

PRACTICAL NO.20

Objective: To Study diseases of sacred basil

- Damping-off
- Fusarium Wilt and Crown rot
- Basal rots
- Leaf spot
- Downy mildew
- Graymold

Requirements:

1. Specimen/diseased plant or its part
2. Hand lens
3. Slides and cover slips
4. Cotton blue and Lactophenol
5. Wash bottles
6. Watch glass
7. Needle
8. Forceps
9. Scalpel
10. Compound and stereo microscope

Damping-off

Symptoms

- It infects the host stem near the surface of soil and spreads, causing soft, colourless to dark brown rotting.
- The disease does not weaken young plants, but it flattens the stems, which collapse 5 to 10 cm above the soil level.
- The infection progresses more slowly in subsequent stages, and the plants eventually die.
- It is especially dangerous to seedlings, causing wet rotting of seedlings or conventional damping off. When basil is damaged by damping-off, patches of poor growth are very common.

Pathogen- *Pythium ultimum*

Fusarium Wilt and Crown rot

Symptoms

- Yellowed shoots, twisted young leaves, and a few rotten leaves are the first signs of fusarium wilt disease.
- Starting with the apical leaves, affected plants develop asymmetric growth, epinasty, curling, chlorosis, and wilt.
- Xylem discolouration, which is more prominent in the apical region of the plant, is linked to external symptoms.
- A black stem rot spreads upward as the disease continues, causing the plants to wilt, shoots to fall back, leaves to drop and the plant to die.
- Necrosis then develops, extending basipetally from the vegetative apex to the entire plant, whereas the roots and base of the stem remain symptom-free until the infection reaches its terminal stage.
- Young plants dry quickly, usually within 4-7 days of the onset of symptoms; older plants may live longer.
- Basil plants will quickly wilt if water intake is completely stopped.
- Infected plants have shown indications of crown and root rot.
- Pale pink orange layer of macroconidia of *F. oxysporum* f. sp. *basilici* can be found on the stems of sick plants.

Pathogen-*Fusarium oxysporum* f. sp. *basilici*

Basal rots

Symptoms

- Young plants are particularly vulnerable to the pathogen, which causes damping-off.
- *R. solani* colonises the stem's basal sections quickly, forming large dry, sunken, zonate, necrotic regions from the soil surface to just below it.
- The entire stem is frequently girdled by lesions.
- The brown mycelia growth of the fungus can be observed on the surface of the lesion when examined with a lens.
- In cultivated fields, disease usually begins as a small, circular area that grows to a diameter of 1 m or more.
- The pathogen spreads rapidly through the soil and colonises uninfested soil quickly.
- The majority of the plants in the patch have been dampened.

- A common saprophyte, *M. tabacinum*, can induce superficial necrosis (black leg) of the stem's basal section.
- The disease thrives in heated greenhouse areas, with optimal growth temperatures of 25 to 26 °C and high relative humidity.
- The plant tolerates pathogen infections that develop late in the crop production cycle.
- Early infections can cause the inner tissues to collapse without halting xylem flow completely.
- The plant's upper portion begins to wilt and become yellow.

Pathogen – *Rhizoctonia solani*, *Sclerotinia sclerotiorum*, *Sclerotinia minor* and *Microdochium tabacinum*

- *R. solani* is the most common pathogen, infecting plants at all phases of development.
- Basil stem rot is most commonly caused by *Sclerotinia sclerotiorum* and *Sclerotinia minor*.

Leaf spot

a. Black spot

Symptoms

- The symptoms appear on the stems and leaves.
- Lesions appear as irregular to circular necrotic spots on leaves, which typically grow and merge. Lesions that are older look to be dried, with shredded tissue in the centre.
- The lesions on the stem are comparable to the lesions caused by *R. solani* or *Sclerotinia* sp., and they can girdle the entire stem, causing plant death.

Pathogen – *Colletotrichum gloeosporioides*

b. Cercospora leaf spot

Symptoms

- Symptoms vary in size and shape, appearing as circular to irregular dark dots on leaves with light centres.
- It thrives well in wet, moist climate.
- Fungal spores can overwinter in previously infected plant debris in the vicinity and spores can also survive at the soil surface and be dispersed by the wind.

Pathogen – *Cercospora ocimicola*

c. Bacterial leaf spot/Basil shoot blight

Symptoms

- Basil derivatives such as Purple basil, African Blue Basil, and Holy Basil are commonly affected by bacterial leaf spot.
- Small water-soaked lesions appeared near the leaf margin or all over the leaf at first.
- They might be angular and have little veins in the leaves, or they can be uneven in shape.
- These water-soaked lesions change colour from brown to black and may be encircled by a yellow halo.
- Under bacteriumfriendly conditions, these lesions frequently combine and lead to severe leaf blight. When the patches on the infected leaf dry, they frequently appear brittle and fracture.

Pathogen - *Pseudomonas cichorii*

Downy mildew

Symptoms

- Once the pathogen has infected the plant, it will appear as if it is suffering from nutritional shortages, with yellowing leaves as the first sign.
- The yellowing start around the main vein on the upper surface of the leaf and expands outwards, eventually turning into dark brown colour areas.
- Fungus growth appears as a grey fuzzy or downy growth on the lower surface of the leaf.

Pathogen – *Peronospora belbahrii*.

Graymold

Symptoms

- Organs infected with mycelia produce a lot of off-white to grey mycelia with dark conidia.
- Conidia are easily dispersed by wind currents or rain splashing from one plant to the next. Saprophytic mycelia or sclerotia live on crop residue during unfavourable conditions.
- Infections on stem cuttings occur immediately after harvest, according to Observations: of grey mould development in commercial greenhouses.
- The disease then spreads throughout the plant, killing all of the leaves and secondary buds.
- The entire plant dies when the disease reaches the main stem at the bottom of the plant.
- Stem cuttings are most susceptible to infection right after harvest, and their susceptibility fades gradually after 48 hours of harvest.

- *B. cinerea* can also form on packed bunches during transportation to market, causing the entire bundle to rot.

Pathogen - *Botrytis cinerea*

Observations:

Macroscopic

Microscopic

Study:

Based on the Observations: made by you name the disease of given crop and it's causal organism

Disease(s)	Pathogen

Activities

1. Collect the disease sample for wet as well as dry preservation/herbarium.
2. Draw the diagram of the disease symptoms observed on the specimen/sample.
3. Prepare a slide from the sample collected, observe under the microscope and draw diagram of the feature and structures as seen under the microscope.