PRACTICAL MANUAL

Diseases of Field and Medicinal Crops

Course No. PPA 515 Credit Hrs. 3(2+1)

M.Sc. (Agri.) Plant Pathology

Dr. R. K. Mishra
Principal Scientist, Plant Protection, IIPR, Kanpur
and
Dr. Manoj Kumar Chitara
Dr. Shivani Choudhary
Dr. Rajshree Verma

2024

Department of Plant Pathology
College of Agriculture
Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208001

Syllabus: Diseases of Field and Medicinal Crops (PPA 515)

Practical: Detailed study of symptoms and host parasite relationship of important diseases of Cereal crops- Rice, Wheat, Barley, Pearl millet, Sorghum and Maize; Pulse crops- Gram, Urdbean, Mungbean, Lentil, Pigeon pea, Soybean and Cowpea; Oilseed crops- Rapeseed and Mustard, Sesame, Linseed, Sunflower, Groundnut, Castor; Cash crops- Cotton, Sugarcane; Fodder legume crops- Berseem, Oats, Guar, Lucerne; and Medicinal crops- Plantago, Liquorice, Mulathi, Rosagrass, Sacred basil, Mentha, Ashwagandha, Aloe vera. Collection and dry preservation of diseased specimens of important crops.

Name of Student: .....

Roll No.: .....

Batch: .....

Session: .....

Semester: .....

Course Name : .....

Course No. : .....

Credit:.....

Published: 2024

No. of copies: ……..

Price: Rs.

CERTIFICATE

This is to certify that Shri./Km. .....ID.No..... has completed the practical of course.....course No. ..... as per the syllabus of M.Sc. (Agri.) Plant Pathology..... semester in the year.....in the respective lab/field of College.

Date:

Course Teacher

CONTENTS

Experiment No. 1

Objective: Collection and wet & dry preservation of plant diseased specimens for herbarium

Activity: Identification and collection of ten disease samples put in F.A.A. solution for wet and in a herbarium for dry preservation:

a. Host (name of the diseased plant): ……

b. Name of the pathogen (causal organism): ……

c. Place where collected: ……

d. Date of collection: ……

e. Name of the collector: ……

Materials Required: ……

……

Procedure for Dry Preservation: ……

……

……

……

……

……

……

……

……

……

……

……

Procedure for Wet Preservation: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

Experiment No. 2

Objective: Identification of paddy diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw a neat and clean diagram of characteristic symptoms and spores observed under the microscope.

Materials Required ……

……

……

……

Blast disease: Symptoms: ……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: ……

……

……

……

……

……

……

……

……

……

……

……

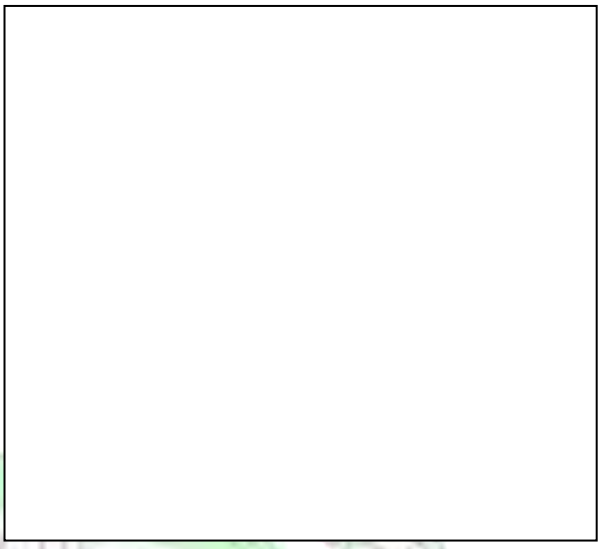
……

……

……

Identification:……

Brown spot disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

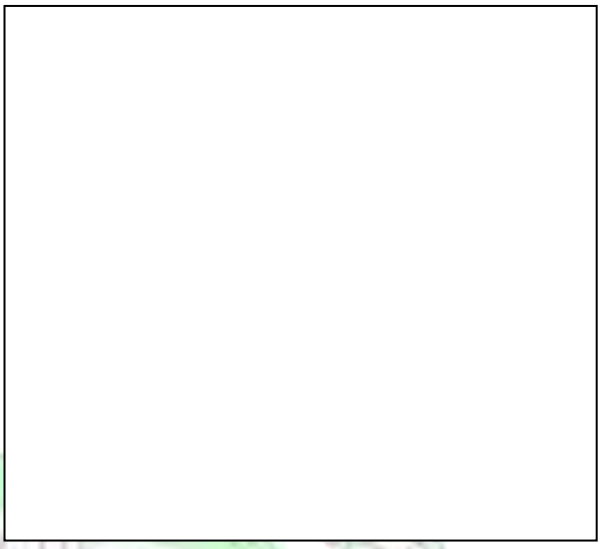
Identification:……

Bacterial Leaf blight disease: Symptoms: ....

Microscopic: ....

Identification: ....

Sheath blight disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

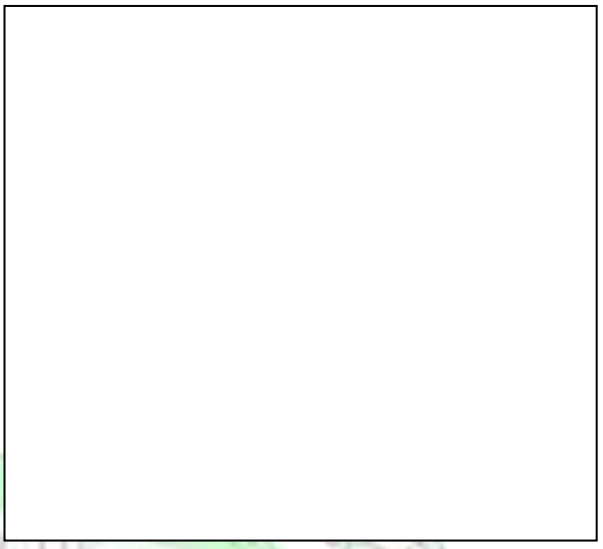
……

……

……

Identification:……

False Smut disease: Symptoms: .....



.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Microscopic: .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Identification:.....

Experiment No. 3

Objective: Identification of wheat diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw a neat and clean diagram of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Black or Stem rust disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

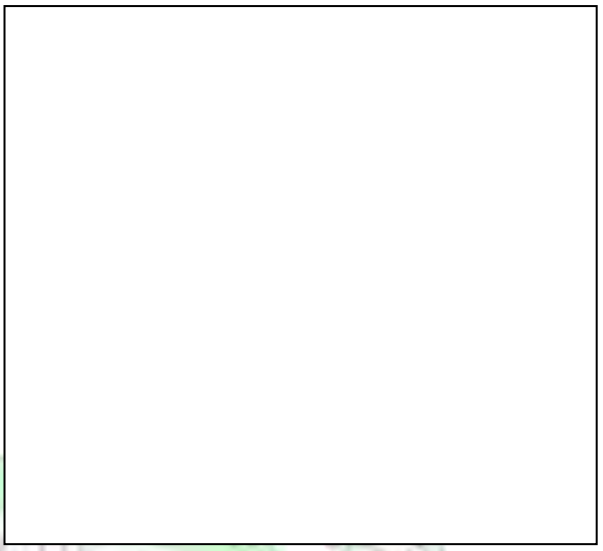
……

……

……

Identification:……

Brown or leaf rust disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

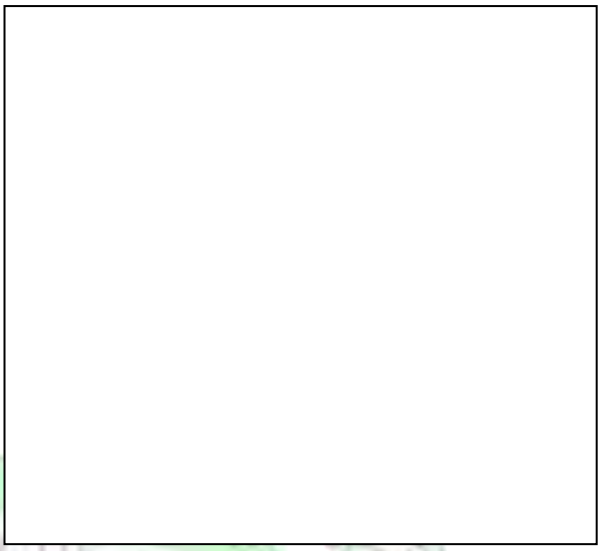
……

……

……

Identification:……

Yellow or Stripe rust disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

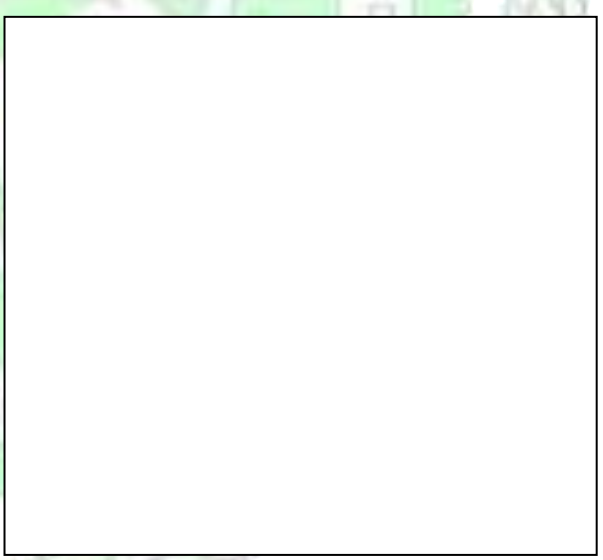
……

……

……

……

Microscopic: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

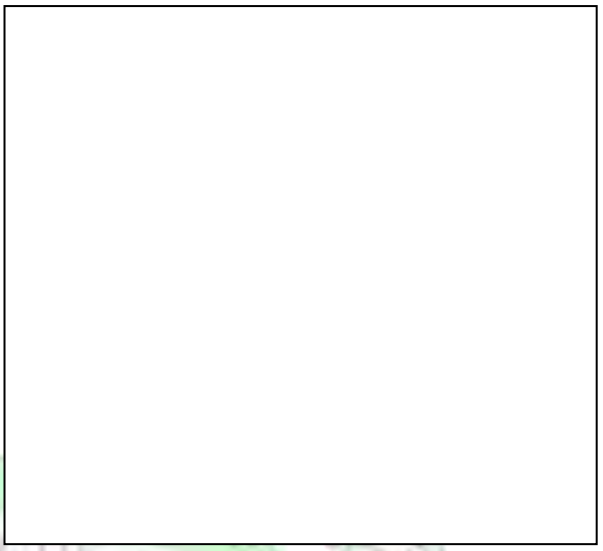
……

……

……

Identification:……

Loose Smut disease: Symptoms: .....



Microscopic: .....

Identification:……..……..……..……..

Karnal Bunt disease: Symptoms: ....

Microscopic: ....

Identification:...

Experiment No. 4

Objective: Identification of maize diseases

Activity: Identify the pathogen from the disease sample provided to you. Draw a neat and clean diagram of characteristic symptoms observed.

Materials Required: ……

……

Downy mildew disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

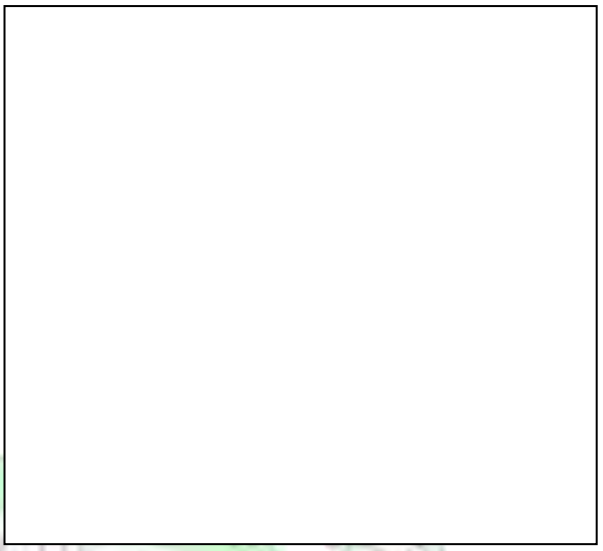
……

……

……

Identification:……

Leaf Spot disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification:……

Experiment No. 5

Objective: Identification of pearl millet diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw a neat and clean diagram of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Downy mildew disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification:……

Ergot disease: Symptoms: ……………………………………

Microscopic: ……………………………………

Identification:……………………………………

Experiment No. 6

Objective: Identification of barley diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw a neat and clean diagram of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Powdery mildew disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

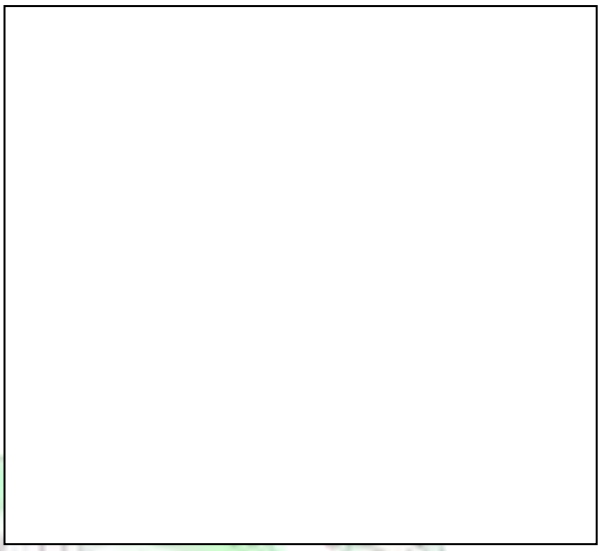
……

……

……

Identification:……

Smut disease: Symptoms: .....



Microscopic: .....

Identification:……..……..……..……..

Experiment No. 7

Objective: Identification of diseases of Legumes

Activity: Identify the pathogen from the **Chickpea** disease sample provided to you by preparing a slide. Draw a neat and clean diagram of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Aschcoyta blight disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

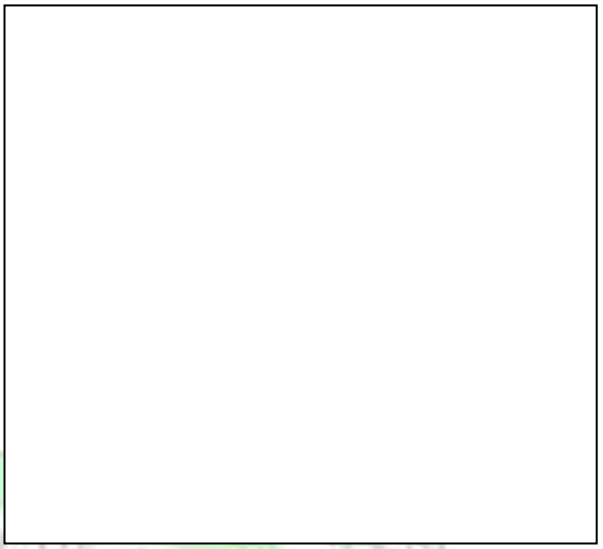
……

……

……

Identification:……

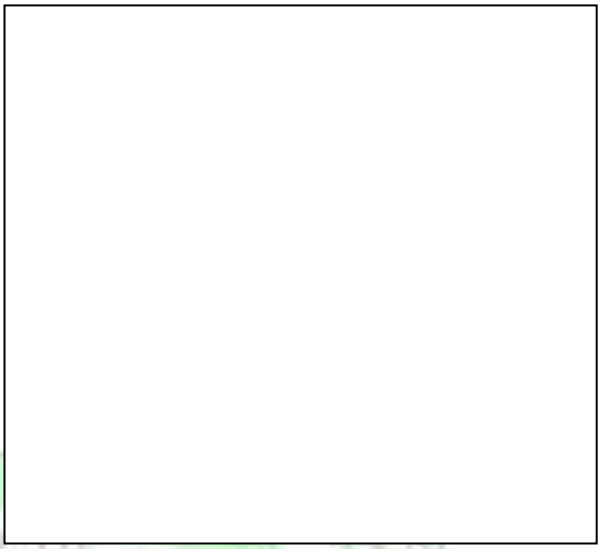
Rust disease: Symptoms: .....



Microscopic: .....

Identification:.....

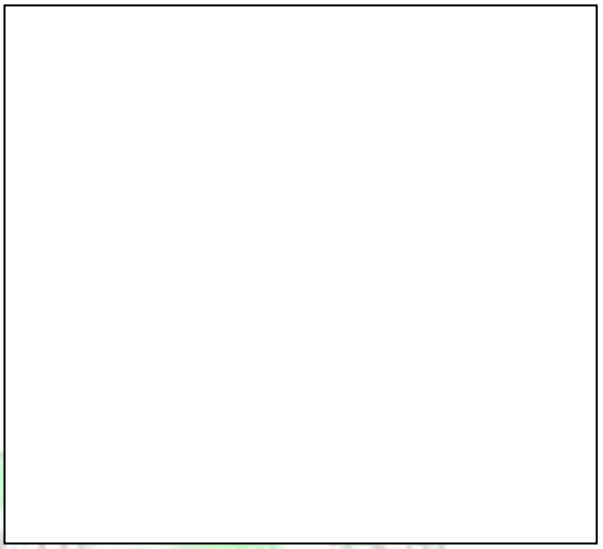
Wilt disease: Symptoms: .....



Microscopic: .....

Identification:.....

Collor rot disease: Symptoms: .....



Microscopic: .....

Identification:.....

Black gram diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Cercospora leaf spot disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

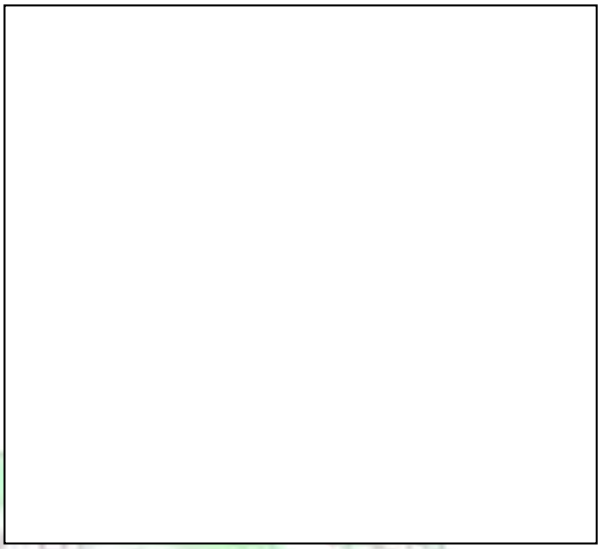
……

……

……

Identification:……

Rust disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

……

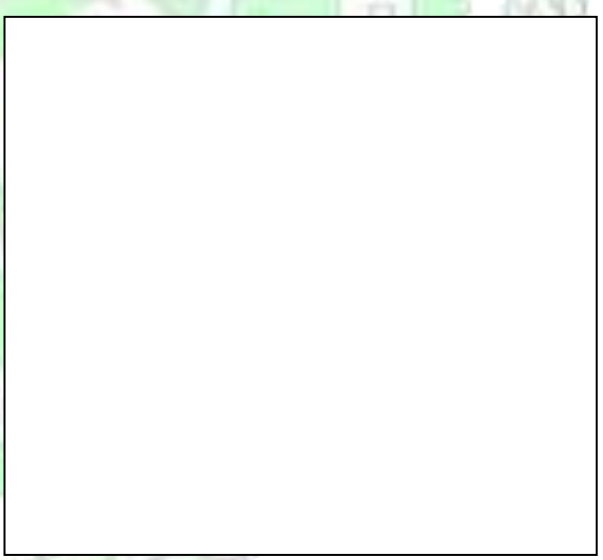
……

……

……

……

Microscopic: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

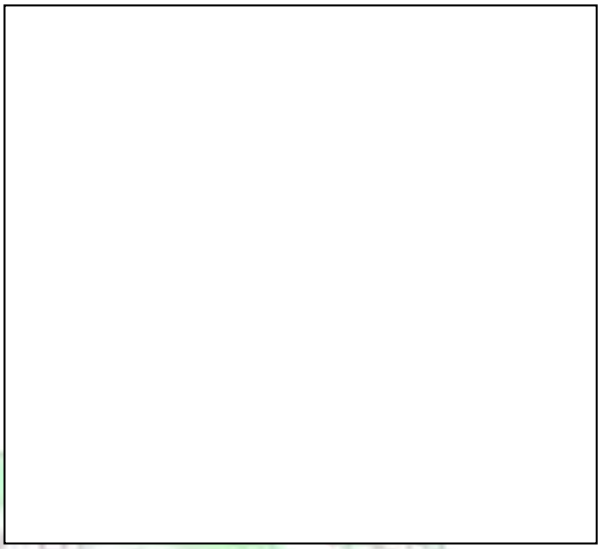
……

……

……

Identification:……

Yellow mosaic disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification:……

<u>Pigeon pea</u> diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Phytophthora blight disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification:……

Wilt disease: Symptoms: ……………………………………

Microscopic: ……………………………………

Identification:……………………………………

Mung bean diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Powdery mildew: Symptoms: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

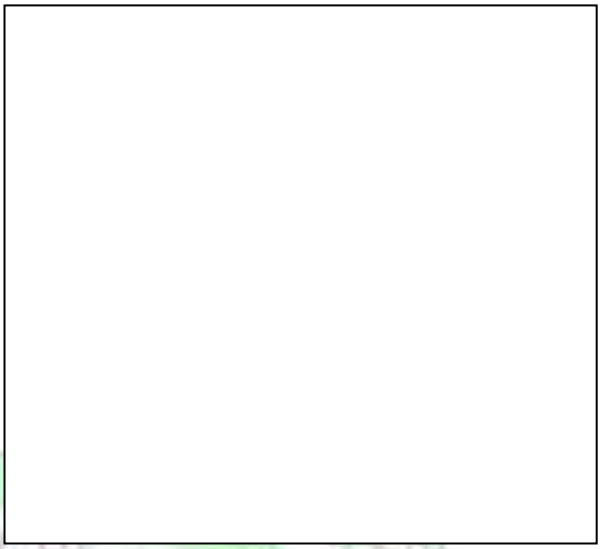
Identification:……

Anthracnose disease: Symptoms: ....

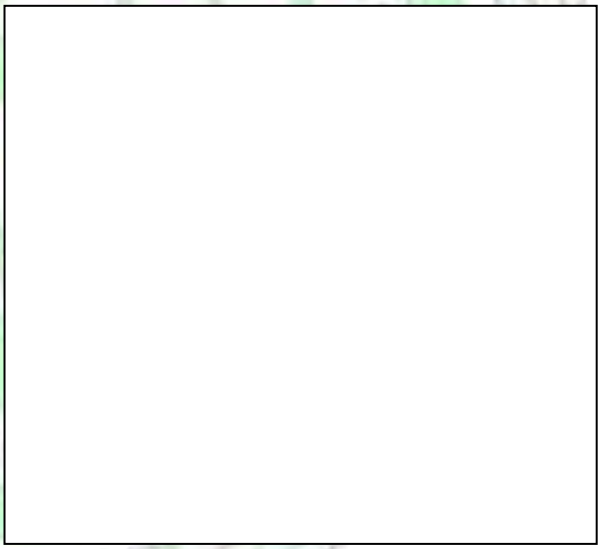
Microscopic: ....

Identification:............................

Yellow Vein Mosaic: Symptoms: .....



Microscopic: .....



Identification:……

Lentil diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Powdery mildew: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

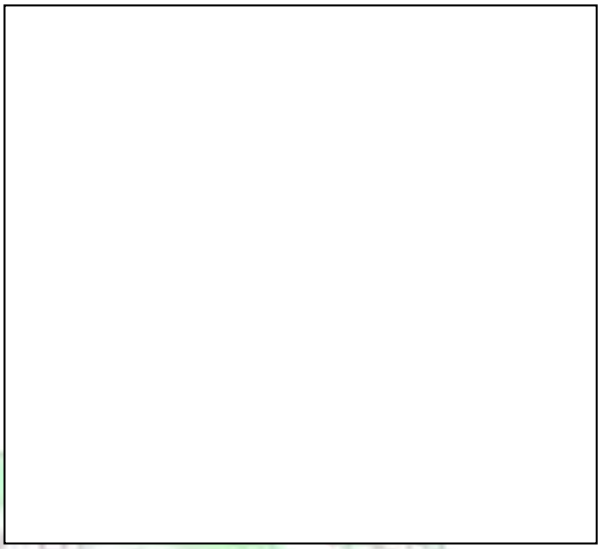
……

……

……

Identification:……

Anthracnose disease: Symptoms: .....



.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

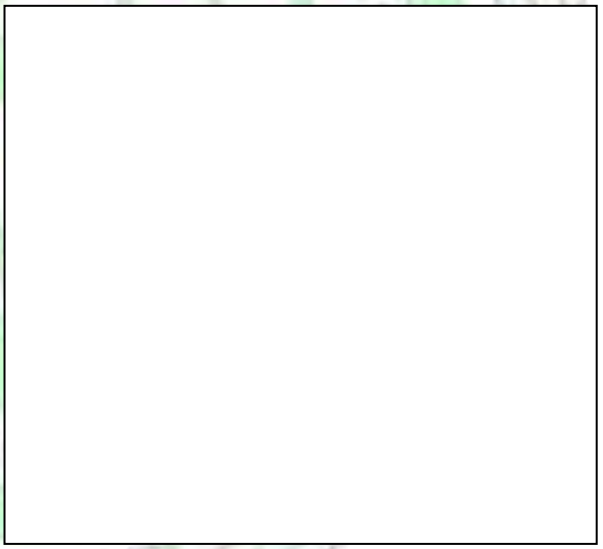
.....

.....

.....

.....

Microscopic: .....



.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

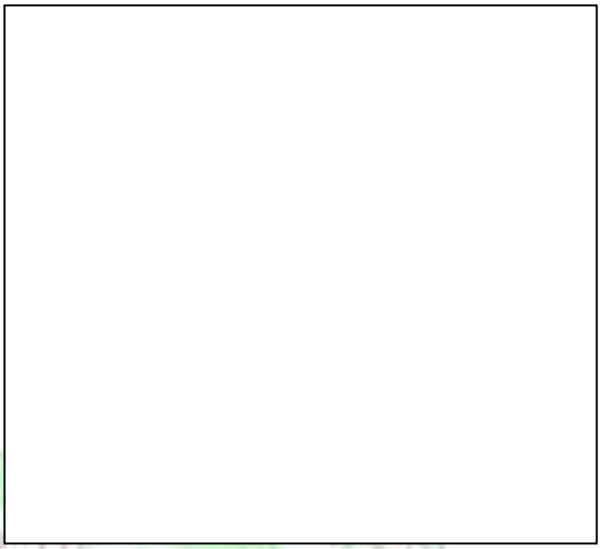
.....

.....

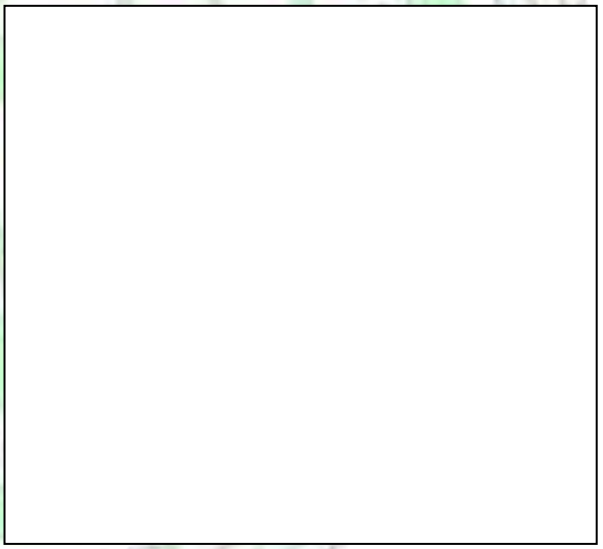
.....

Identification:.....

Yellow Vein Mosaic: Symptoms: .....



Microscopic: .....



Identification:……

Cowpea diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing a slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Root rot or damping off: Symptoms: .....

……

……

……

……

……

……

……

.....

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

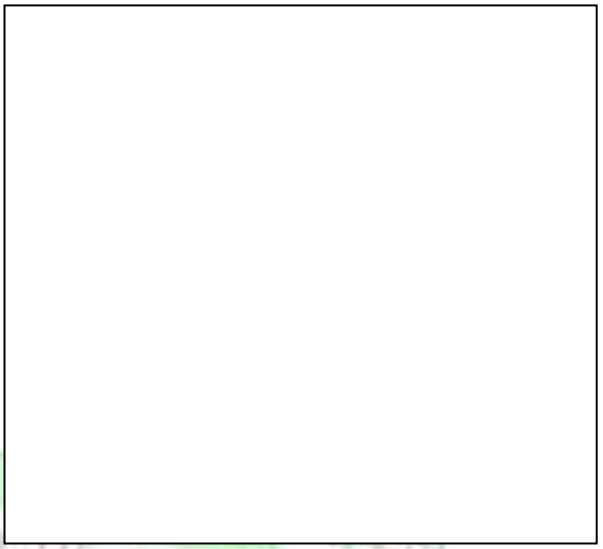
Identification:……

Wilt: Symptoms: ……………………………………………

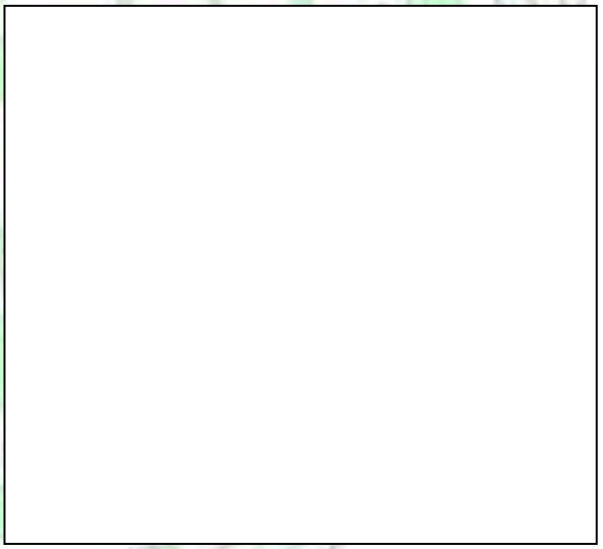
Microscopic: ……………………………………………

Identification:……………………………………………

Southern blight: Symptoms: .....



Microscopic: .....



Identification:……

Experiment No. 8

Objective: Identification of soybean diseases

Activity: Identify the pathogen from the disease sample and draw neat diagrams of characteristic symptoms observed.

Materials Required: ……

……

Mosaic disease: Symptoms: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification:……

Rhizoctonia blight disease: Symptoms: ....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

Microscopic: ....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

Identification:..

Experiment No. 9

Objective: Identification of mustard diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Alternaria blight disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

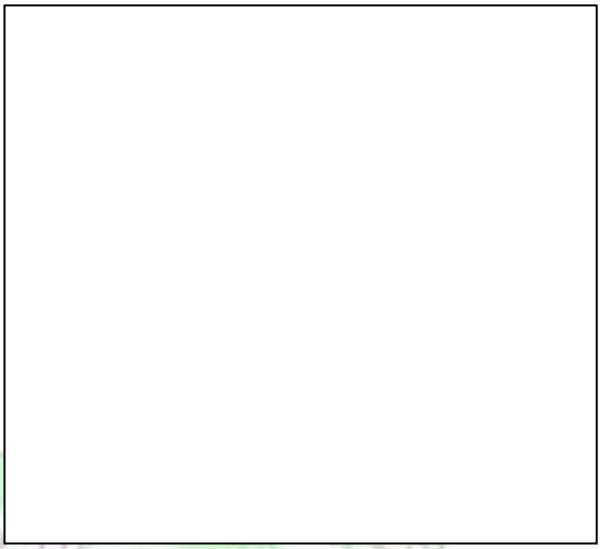
……

……

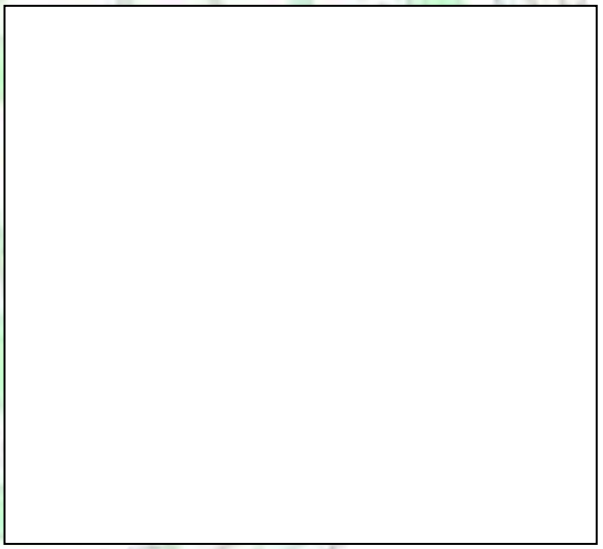
……

Identification:……

White rust disease: Symptoms: .....

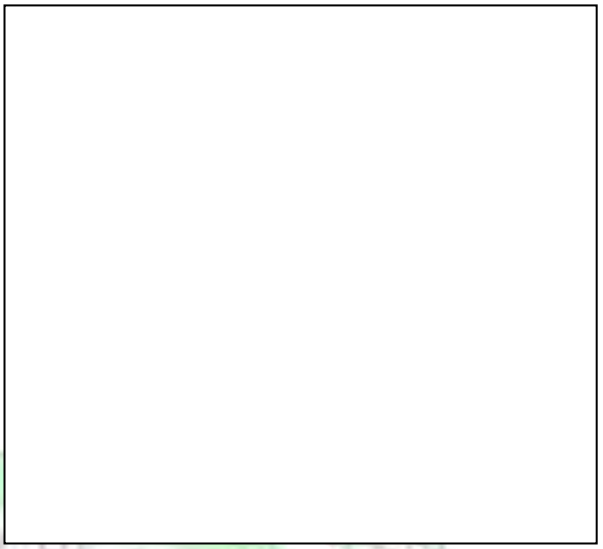


Microscopic: .....

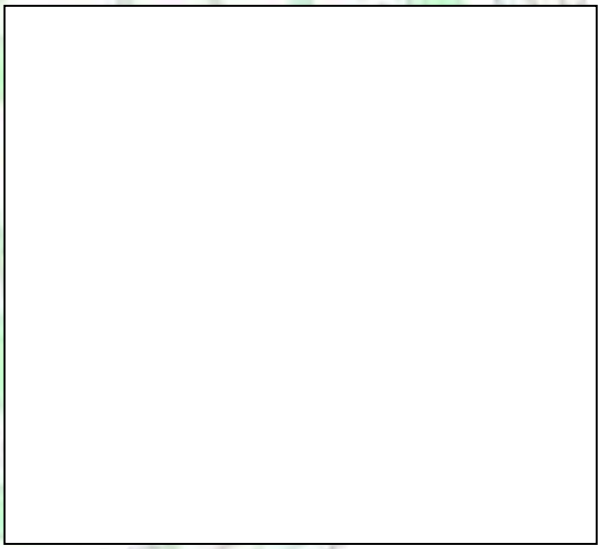


Identification:.....

Downy mildew disease: Symptoms: .....

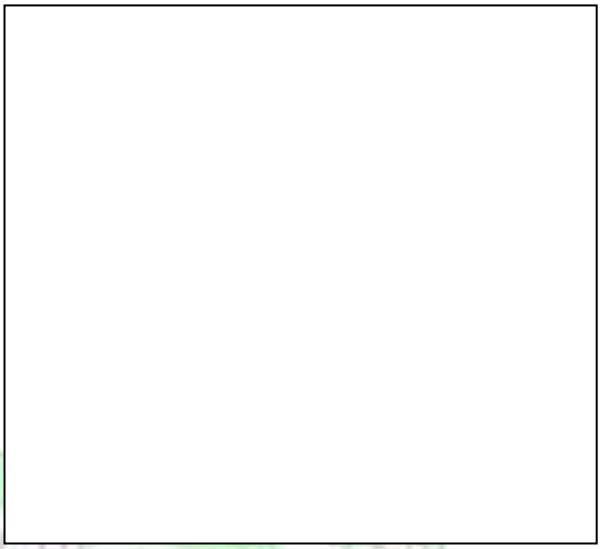


Microscopic: .....

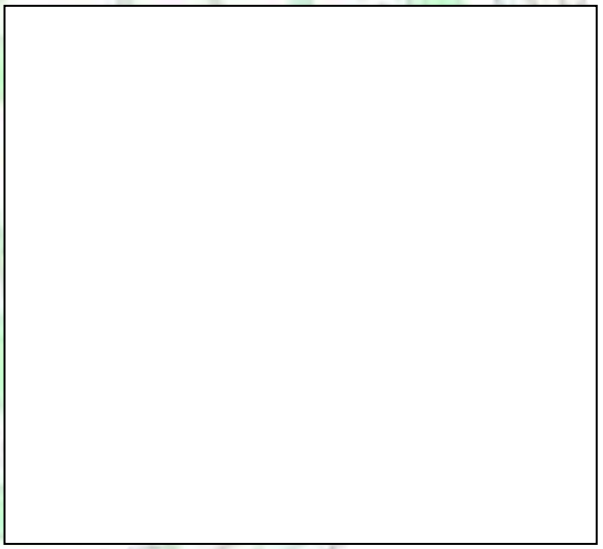


Identification:.....

Sclerotinia stem rot disease: Symptoms: .....



Microscopic: .....



Identification:.....

Experiment No. 10

Objective: Identification of groundnut diseases

Activity: Identify the pathogen from the disease sample and draw neat diagrams of characteristic symptoms observed.

Materials Required: ……

……

Early leaf spot disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

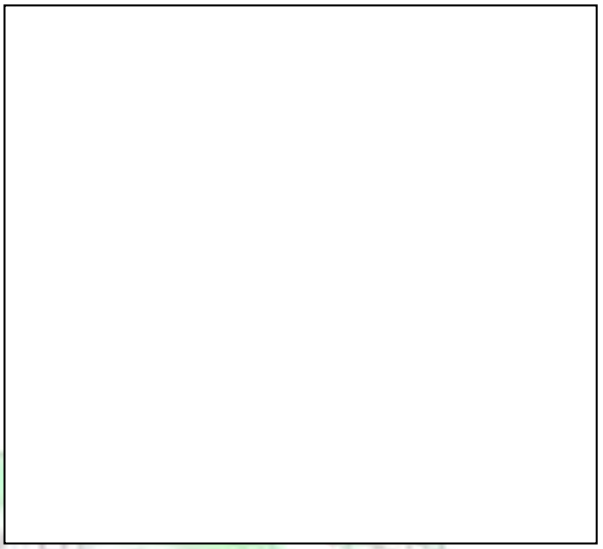
……

……

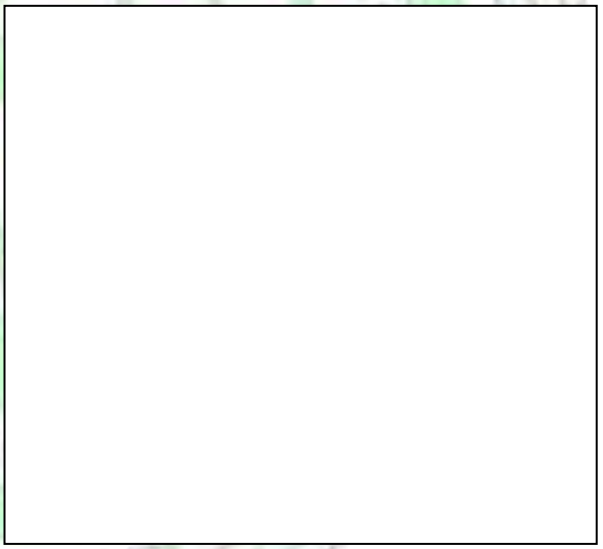
……

Identification:……

Late leaf spot disease: Symptoms: .....

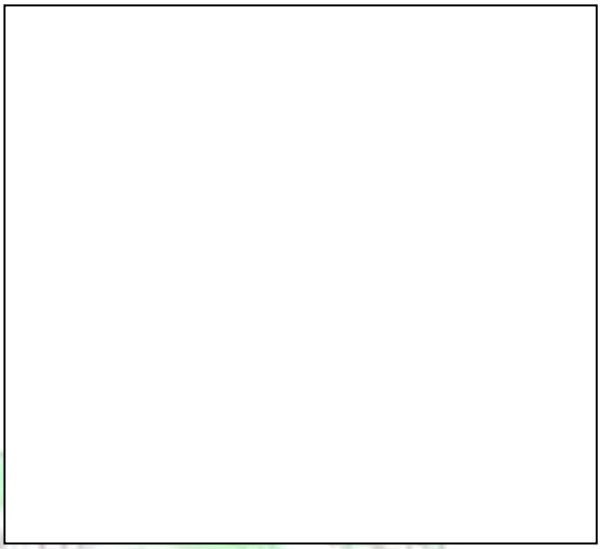


Microscopic: .....

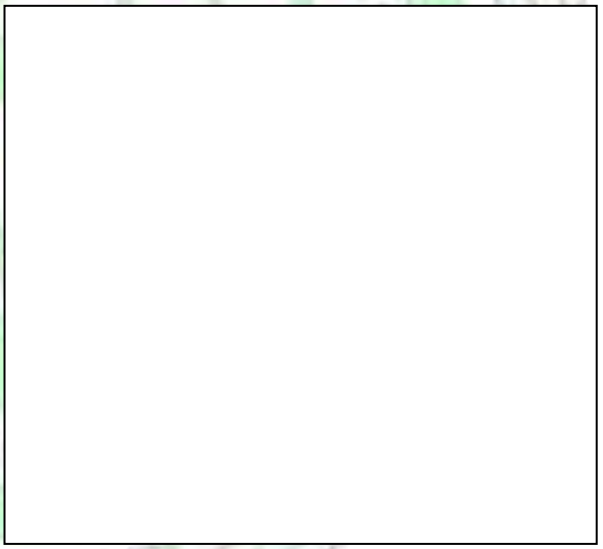


Identification:.....

Wilt disease: Symptoms: .....



Microscopic: .....



Identification:.....

Experiment No. 11

Objective: Identification of castor diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Phytophthora blight disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification**:**……

Experiment No. 12

Objective: Identification of cotton diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Bacterial blight disease: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: ……

……

……

……

……

……

……

……

……

……

……

……

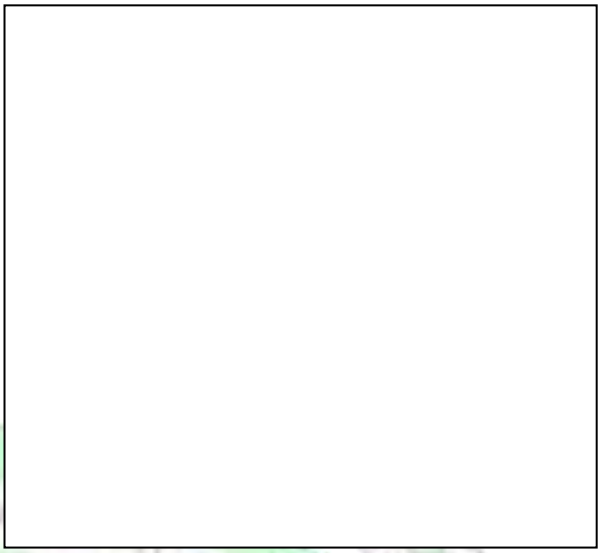
……

……

……

Identification:……

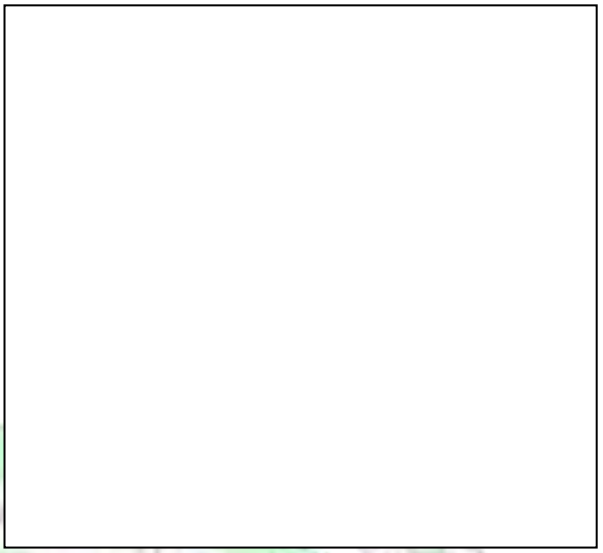
Anthracnose disease: Symptoms: .....



Microscopic: .....

Identification:..... .....

Wilt disease: Symptoms: .....



Microscopic: .....

Identification:…… ……

Experiment No. 13

Objective: Identification of berseem diseases

Activity: Identify the pathogen from the disease sample provided to you and draw neat diagrams of characteristic symptoms observed.

Materials Required: ……

……

Damping off disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification:…… ……

Stem rot disease: Symptoms:

Microscopic:

Identification:

Root rot disease: Symptoms: ……………………………

Microscopic: ……………………………

Identification: ……………………………

Experiment No. 14

Objective: Identification of mentha diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Rust disease: Symptoms: ……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

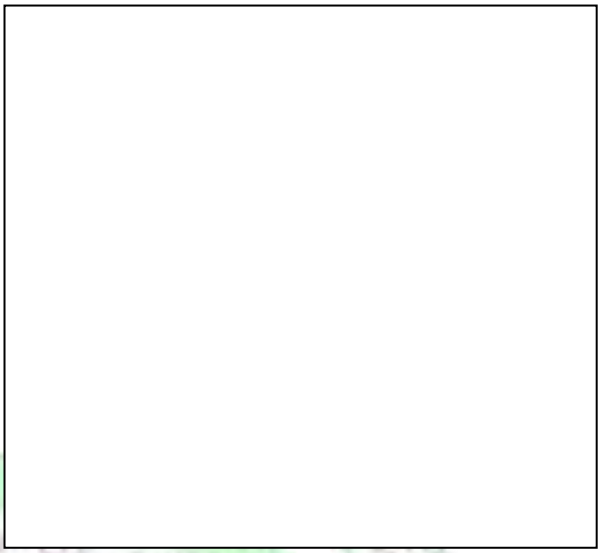
……

……

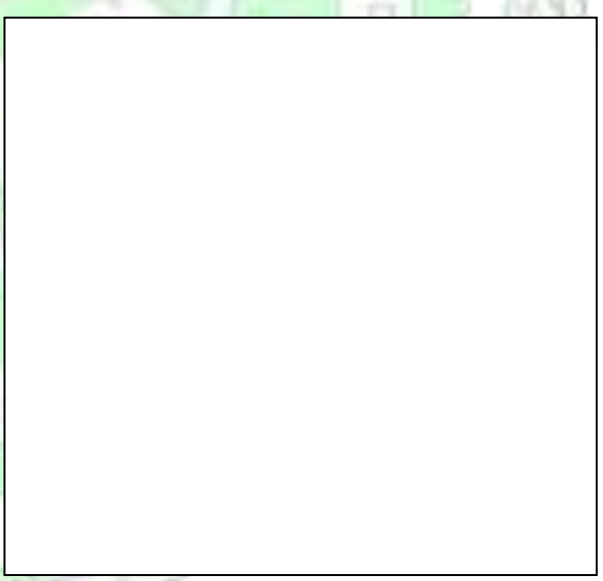
……

Identification:…… ……

Leaf spot disease: Symptoms: .....

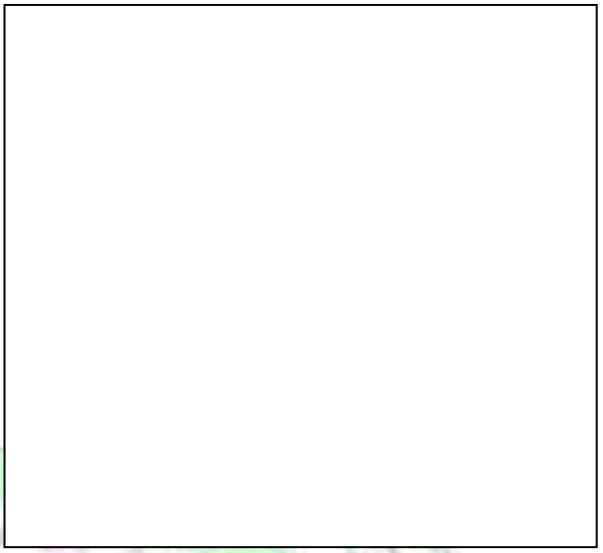


Microscopic: .....



Identification:…… ……

Sclerotinia blight disease: Symptoms: .....



……

……

……

……

……

……

……

……

……

……

……

……

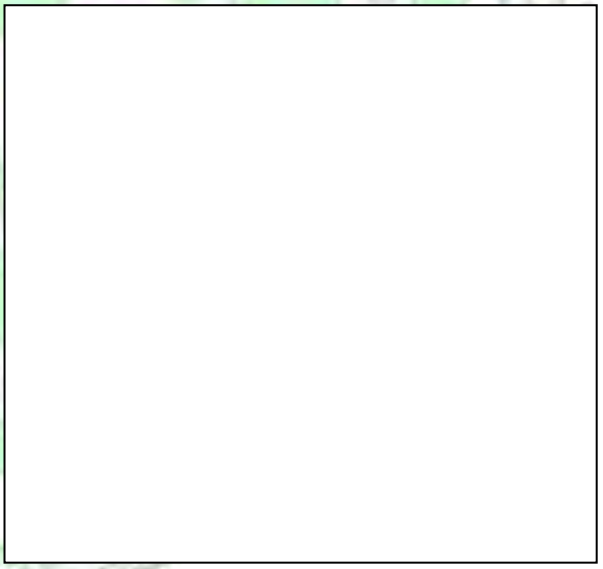
……

……

……

……

Microscopic: .....



……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Identification:…… ……

Experiment No. 15

Objective: Identification of aloe vera diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Anthracnose disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

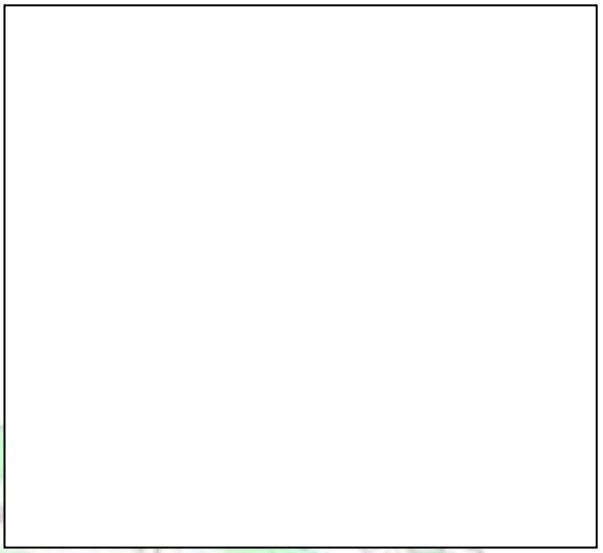
Identification:…… ……

Black leaf spot disease: Symptoms: ……………………

Microscopic: ……………………

Identification: ……………………

Root rot disease: Symptoms: .....



Microscopic: .....

Identification:…… ……

Experiment No. 16

Objective: Identification of ashwagandha diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Damping off disease: Symptoms: ……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: ……

……

……

……

……

……

……

……

……

……

……

……

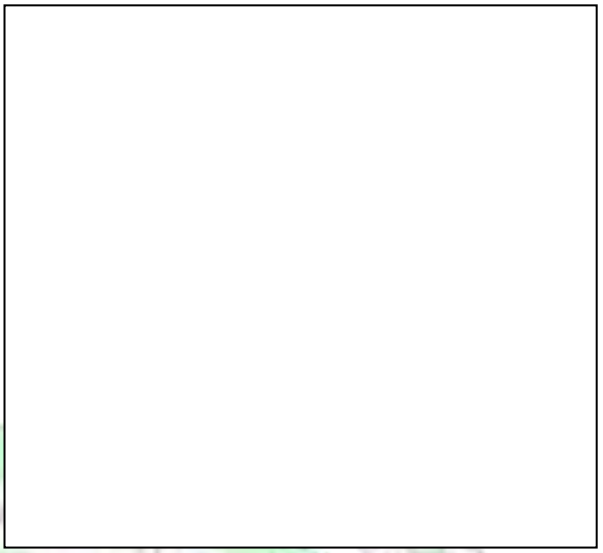
……

……

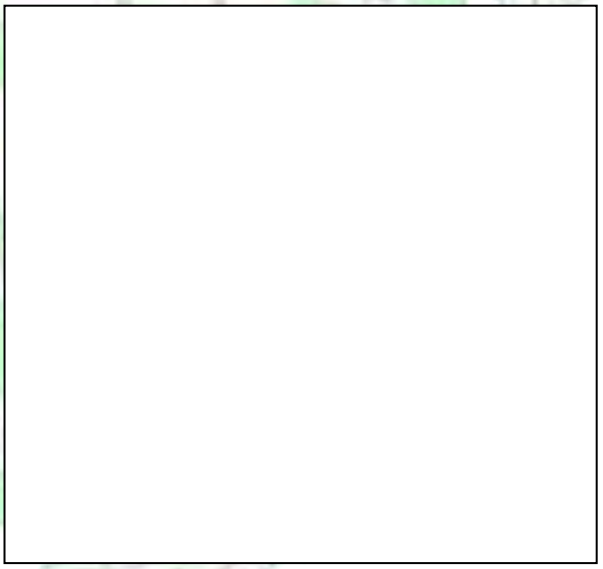
……

Identification:…… ……

Root rot and wilt disease: Symptoms: .....



Microscopic: .....



Identification:…… ……

Leaf blight disease: Symptoms: ....

Microscopic: ....

Identification: ....

Experiment No. 17

Objective: Identification of sacred basil diseases

Activity: Identify the pathogen from the disease sample provided to you by preparing slide. Draw neat diagrams of characteristic symptoms and spores observed under the microscope.

Materials Required: ……

……

Damping off disease: Symptoms: .....

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Microscopic: .....

……

……

……

……

……

……

……

……

……

……

……

……

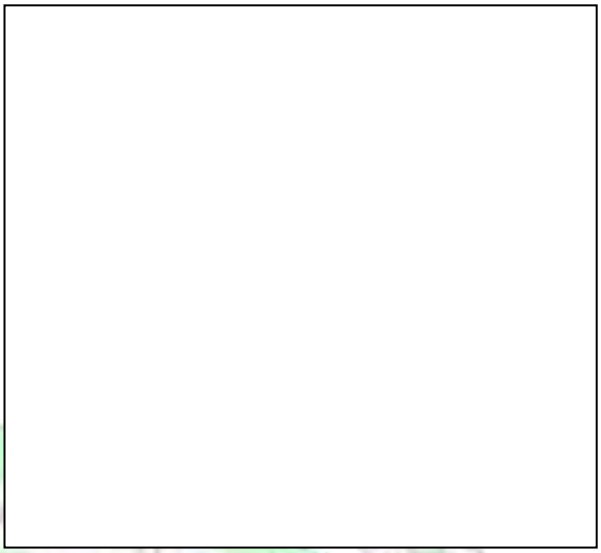
……

……

Identification:…… ……

Fusarium wilt and Crown rot disease symptoms: ...

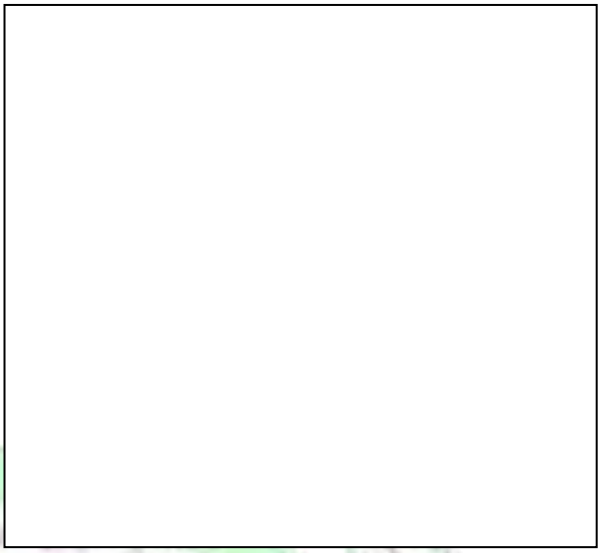
Symptoms: .....



Microscopic: .....

Identification:…… ……

Graymold disease: Symptoms: .....



Microscopic: .....

Identification:…… ……

APPENDICES

PRESERVATION

Materials Required: Polythene bags, Newsprint paper, Pruning shear, knife, Scissors, Hand lens, Pencil, Ink markers, Plant press, Paper bags, Envelopes, Blotting sheets and Methyl bromide

Specimen: A herbarium specimen may be a single sporocarp or a portion of it, dried culture, slide or the material on its host or substrate (e.g. leaf, stem, bark, rock, soil, paper, cloth). Two types of preservation methods-

DRY PRESERVATION

1. **Collection and drying:** The sample should have distinctively visible symptoms. Dry the specimen in layer of blotting sheets under sunlight or in hot air oven for few days.
2. **Labelling and packaging:** The material kept in good herbarium packets. This attached to a chart paper sheets. The two sides of packet folded first, and then bottom flap and finally top flap. Mention the name of pathogen, host, locality, date, name of scientist who identified the specimen, on the label.
3. **Disinfection and storage:** The specimen folders fumigated with methyl bromide vapours in fumigation chamber for 24-48h before storage.

Preparation of Specimen: A specimen should ideally be 25–40 cm long and up to 26 cm wide, allowing it to fit on a standard herbarium-mounting sheet, which measures 42 x 27 cm. This is also the approximate size of tabloid newspapers. Plant parts that are too large for a single sheet cut into sections pressed on a series of sheets, for example a palm or cycad frond. Long and narrow specimens such as grasses and sedges folded once, twice or even three times at the time of pressing. In this way, a plant of up to 1.6 metres high pressed onto a single sheet. For very small plants, a number of individuals placed on each sheet.

WET PRESERVATION

Preservative is a chemical which is used to fix (to maintain) the tissues of plants and animals for a long time so that decomposition does not take place. Chemicals used to kill, preserve and fix plant/animal tissues and specimens in such a way that they retain their original shape, form size and structure. These make the tissues hard and prevent them from decaying. A fixative must penetrate rapidly the tissue removed from the body.

Procedure:

1. Washed fresh diseased specimens are put in a boiling mixture of 1 part of glacial acetic acid saturated with normal copper acetate crystals and 4 parts of water till the green colour reappears and then kept preserved in 5 per cent formalin in the glass jars.
2. All mounted or preserved specimens must be labeled with as much of the following information as far as possible:
   a. Host (name of the diseased plant)
   b. Name of the disease Parasite (the name of the organism causing the disease)
   c. Place where collected (nearest town and state is usually sufficient)
   d. Date collected
   e. Name of the collector

Preparation of Formalin Acetic Acid Alcohol (F.A.A.): It is a very good fixative and tissues left in it for a long period without any harm.

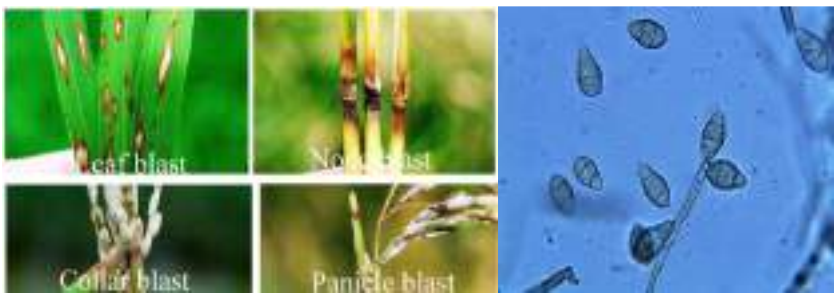
Composition: 50% Alcohol - 100 ml; 40% Formaldehyde - 6.5 ml; Glacial Acetic Acid - 2.5 ml

PADDY DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

BLAST: affects at all stages of crop growth

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- *Pyricularia oryzae* (Syn: *P. grisea*) (Sexual stage: *Magnaporthe oryzae*, *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 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 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– *Helminthosporium oryzae* (Syn: *Drechslera oryzae*; *Bipolaris oryzae*); (Sexual stage: *Cochliobolus miyabeanus*). Mycelium is brown and septate. Conidia 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 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 dewdrops containing bacterial masses 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 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 1-2x0.8-1.0µm. Monotrichous polar flagellum. Bacterial colonies are circular, convex with entire margins, whitish yellow to straw yellow colored and opaque

SHEATH BLIGHT

Symptoms: Crop affected from tillering to heading stage. Initial symptoms noticed on leaf sheaths near water level. On the leaf sheath oval, elliptical, or irregular greenish grey spots 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 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.

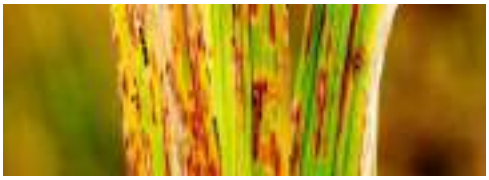
Pathogen – *Rhizoctonia solani* (Sexual stage: *Thanetophorus cucumeris*). Fungus has septate and hyaline mycelium. Hyaline when young, yellowish brown when old. It produces large number of spherical brown sclerotia.

FALSE SMUT

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

Pathogen – *Ustilaginoidea virens* (Syn: *Claviceps oryzae - sativa*). Chlamydospores formed as spore balls, which are spherical to elliptical, warty and olivaceous.

KHAIRA:



Symptoms: It is a disease due to Zinc deficiency. Dr. Y.L. Nene reported this disease. 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 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.

WHEAT DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

BLACK OR STEM RUST:

Symptoms: Symptoms produced on almost all aerial parts of the wheat plant but 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 surrounded by tattered host tissue. The pustules are dusty in appearance due to the vast number of spores produced. Spores readily released when touched. As the infection advances, teliospores 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 produced, stems 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 as small, circular orange blisters or pustules on the upper surface of leaves. Orange spores easily dislodged and may cover clothing, hands or implements. When the infection is severe leaves dry out

and die. Since inoculum blown into a given area, symptoms often seen on upper leaves first. As plants mature, the orange urediospores replaced by black teliospores. Pustules containing these spores are black and shiny since the epidermis does not rupture. Yield loss often occurs because of infection by *Puccinia recondite* f. 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 arranged in linear rows as stripes. The stripes are yellow to orange yellow. The teliospores arranged in long stripes and 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. Entire inflorescence 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 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*)

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 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 found with karnal bunt. The odor due to the production of trimethylamine by the fungus. Seed that is not extensively infected may germinate and produce healthy plants.

Pathogen – *Neovassia indica*

FLAG SMUT

Symptoms: The symptoms 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, 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.

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, and single celled, thin walled and produced in chains. Dark globose cleistothecia containing 9-30 asci develop with oblong, hyaline and thin walled 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*

MAIZE DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

DOWNY MILDEW

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 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 noticed in the tassel. Proliferation of auxiliary buds on the stalk of tassel and the cobs is common.

Pathogen- *Peronosclerospora sorghi*. 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

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 greyish 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

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.

BARLEY DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

POWDERY MILDEW

Symptoms: White to buff or grey powdery masses of spores scattered on or completely covering the leaf blade. All above-ground parts of the plant can be affected. Symptoms are associated with yellowing, browning and death of leaf tissue.

Pathogen: *Blumeria graminis* f.sp. *hordei*, Mycelium covers plant surface completely. The ascocarp is dark brown, globose with filamentous appendages, and asci oblong. Ascospores hyaline, ellipsoid, 20–30 x 10–13µm in size. Anamorph produces on hyaline conidiophores catenate conidia of oblong to cylindrical shape, not including fibrosin bodies, 32–44 x 12–15µm in size. Haustoria are palmate.

SMUT

Symptoms: Masses of olive-brown smut spores replace the entire head of the plants with little development of floral bracts and awns. Smutted heads often emerge earlier than healthy heads. Spores are dislodged and scattered by wind when the delicate membranes surrounding them break. The fungus infects open flowers and becomes established in the embryo of the developing seeds.

Pathogen: *Ustilago nuda*; teliospores give rise to basidiospores. Basidiospores germinate right where they are. The hyphae of two compatible basidiospores then fuse to establish a dikaryotic stage.

PEARL-MILLET DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, 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 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: The symptom is seen by exudation of small droplets of light pinkish or brownish honey dew from the infected spikelets. Under severe infection many such spikelets exude plenty of honey dew which trickles along the earhead. This attracts several insects. 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

CHICKPEA DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, 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 block dots. When the lesions girdle the stem, the portion above the point of attack rapidly dies. If the main stem is girdles 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 bi-celled.

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 telio sori 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. 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 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 oval to cylindrical, hyaline, single-celled, normally arise on short conidiophores. Macroconidia, which borne on branched conidiophores, are thin walled, 3 to 5 septate, fusoid and pointed at both ends. Chlamydospores are rough walled or smooth, terminal or intercalary, 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 seen appearing on the white infected plant parts.

Pathogen- *Sclerotium rolfsii.* 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.

BLACK GRAM DISEASES

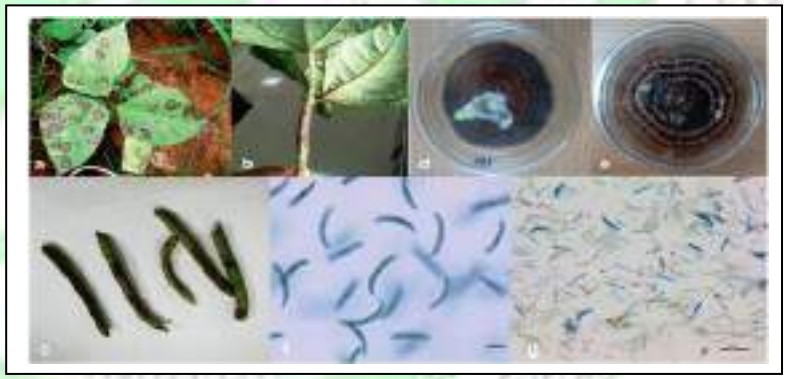
Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

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 seen on petioles and stem. Powdery growth of the fungus 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 appears 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 seen on the petioles and stem. The prominent symptom 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 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– Caused by Mungbean yellow mosaic virus (MYMV) 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.

PIGEON PEA DISEASES

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 found on root system. Branches and petioles lead to desiccation. In severe cases, the whole foliage blighted. Infected stem can easily break by the wind. In advanced stages, the stem 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 completely infected plant. Sometimes wilting is sudden. The affected plants seen in patches in the field and easily recognized. The tissues of root and stem at the base show black streaks, which 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. (Microconidia - minute, elliptical, curved, and unicellular with one or two septa and measure 5-15 X 2-4 µ.; Macroconidia - long, curved, pointed at the tips with 3-4 septa and measure 15-50 X 3-5 µ; 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 partially or completely stopped and a few flowers, which develop are sterile.

Pathogen- Pigeon-pea sterility mosaic (PPSMV). Shows properties similar to viruses in the genus Tenui virus. All tenui viruses are phloem limited, transmitted by planthoppers and infects plants only in family Poaceae, thus ruling out PPSMV as a Tenui virus. 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 tenui virus and peanut bud necrosis Tospo virus. The sterility mosaic causal agent is transmitted by the arthropod mite vector – *Aceria cajani* an eriophyid mite.

GREEN GRAM DISEASE

POWDERY MILDEW

Symptoms: Powdery mildew is one of the widespread diseases of several legumes in green gram. White powdery patches appear on leaves and other green parts, which later become dull coloured. These patches gradually increase in size and become circular covering the lower surface also. When the infection is severe, both the surfaces of the leaves are completely covered by

whitish powdery growth. Severely affected parts get shrivelled and distorted. In severe infections, foliage becomes yellow causing premature defoliation. The disease also creates forced maturity of the infected plants which results in heavy yield losses.

Pathogen- The fungus is ectophytic, spreading on the surface of the leaf, and sending haustoria into the epidermal cells. Conidiophores arise vertically from the leaf surface, bearing conidia in short chains. Conidia are hyaline, thin-walled, elliptical or barrel shaped or cylindrical and single celled. Later in the season, cleistothecia appear as minute, black, globose structures with myceloid appendages. Each cleistothecium contains 4-8 asci and each ascus contains 3-8 ascospores, which are elliptical, hyaline and single, celled.

ANTHRACNOSE

Symptoms: The disease appears on all aerial part parts and at any stage of plant growth. Circular, black, sunken spots with dark center and bright red orange margins on leaves and pods. In severe infections, the affected parts wither off. Seedlings blighted due to infection soon after seed germination.

Pathogen: The Disease appears on fungus mycelium is septate, hyaline and branched. Conidia are produced in acervuli, arise from the stroma beneath the epidermis and later rupture to become erumpent. A few dark coloured, septate setae 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 perfect stage of the fungus produces perithecia with limited number of asci, which contain typically 8 ascospores which are one or two celled with a central oil globule.

LEAF SPOT

Symptoms This is an important disease of green gram and is usually occurs in a severe form, causing heavy losses in yield. Spots produced are small, numerous in numbers with pale brown centre and reddish brown margin. Similar spots also occur on branches and pods. Under favourable environmental conditions, severe leaf spotting and defoliation occurs at the time of flowering and pod formation.

Pathogen: The fungus produces clusters of dark brown septate conidiophores. The conidia are linear, hyaline, thin walled and 5-6 septate.

YELLOW MOSAIC DISEASE

Mungbean yellow mosaic virus (MYMV) Symptoms Initially small yellow patches or spots appear on green lamina of young leaves. Soon it develops into a characteristic bright yellow mosaic or golden yellow mosaic symptom. Yellow discoloration slowly increases and leaves turn completely yellow. Infected plants mature later and bear few flowers and pods. The pods are small and distorted. The early infection causes death of the plant before seed set. Pathogen It is caused by Mungbean yellow mosaic India virus (MYMIV) in Northen 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 gemonic components DNA-A and DNA-B.

LENTIL DISEASE

WILT:

Symptoms: The disease appears in the field in patches at both seedling and adult stages. Seedling wilt characterized by sudden drooping, followed by drying of leaves and seedling death. The roots appear healthy, with reduced proliferation and nodulation and usually no internal discolouration of the vascular system. Adult wilt symptoms appear from flowering to late pod-filling stage and characterized by sudden drooping of top leaflets of the affected plant, leaflet closure without premature shedding, and dull green foliage followed by wilting of the whole plant or individual branches. Seeds from plants affected in mid-pod-fill to late pod-fill are often shriveled.

Pathogen: Among the diseases, Fusarium wilt caused by *Fusarium oxysporum* f. sp. *lentis* is the most important biological constraint to productivity of lentils worldwide. In India, lentil wilt first reported from undivided Bengal in 1934. The pathogen

causes serious disease and is widespread in India. It is a soil-borne, root pathogen colonizing the xylem vessels and blocking them completely to cause wilting.

BOTRYTIS GREY MOLD:

Symptoms: All above ground plant parts of lentils affected by botrytis grey mold. The disease first appears on the lower foliage as discrete lesions on leaves, which are initially dark green, but turn grayish-brown, then cream as they age, that enlarge and coalesce to infect whole leaflets. Severely infected leaves senesce and fall to the ground. Lesions girdle the stem and cover it with a furry layer of grey mold, eventually causing stem and whole plant death.

Pathogen: Botrytis grey mold (BGM) of lentils caused by the fungus *Botrytis cinerea,* which is a serious but sporadic disease. Botrytis ciñerea has also been isolated from lentil seed in India. The pathogen causes heavy losses, particularly in North Indian conditions and in several parts of Australia, Argentina, Nepal, Myanmar, Bangladesh and Pakistan, causing 70-80% yield losses under favourable conditions.

RUST:

Pathogen: Rust, caused by fungus *Uromyces viciae-fabae* regarded as the most important foliar disease of lentils. Complete crop failures can occur due to this disease. Rust disease is a potential threat to lentil cultivation and causes substantial yield losses ranging from 60-69 per cent. In 1978, severe outbreak of lentil rust recorded in the Narmada Valley of Madhya Pradesh during 2008-09 in Uttarakhand state resulting in yield losses of up to 100 per cent. In Tarai region of Uttarakhand state and its surrounding areas, rust has been a major constraint-affecting yield adversely. In the past, disease has appeared in almost epiphytotic form in this area.

Symptoms: Rust pustules seen on leaf blade, petiole & stem. Rust starts with the formation of yellowish-white pycnidia and aecial cups on the lower surface of leaflets and on pods, singly or in small groups in a circular form. Later, brown uredial pustules emerge on either surface of leaflets, stems and pods. Pustules are oval to circular and up to 1 mm in diameter. They may coalesce to form larger pustules. In severe infections, leaves shed and plants dry prematurely, the affected plant dries without forming any seeds in pods or with small-shriveled seeds.

COWPEA

ROOT ROT OR DAMPING-OFF DISEASES

Pathogen: *Pythium, Rhizoctonia, Macrophomina*
Symptoms are discolouration of taproots, longitudinal cracks of the stems, stunting, wilting and poor yields. Seeds may rot before emergence from the soil and young seedlings may die. The condition is most common on early plantings or when soil contains a large amount of undecomposed plant residue. Damping-off diseases favoured by cool, wet soil conditions.

WILT

Pathogen: *Fusarium oxysporum*
Symptoms: Fusarium wilt usually causes the lower leaves on one side of the plant to turn yellow. Infected plants usually are stunted and wilted as the organism develops in the food and water conducting tissues. Brick red tissue observed in the stem when it split lengthwise.

SOUTHERN BLIGHT

Pathogen: *Sclerotium rolfsii*
It attacks roots and stems of cowpeas. The first visible symptom of southern blight is a progressive, yellowing and wilting of the foliage beginning on the lower leaves. The plant dies within a few days after the rust symptoms appear. A brownish vascular discolouration inside the stem may extend several inches above the soil line. During warm, moist conditions, the course, white mycelium of the fungus makes characteristic fan-shaped patterns of growth on the stem at the soil line. In white-mat of the fungus, numerous smooth, round, light-tan to dark-brown mustard seed-like bodies called sclerotia formed.

SOYABEAN DISEASES

MOSAIC

Symptoms: Affected soybean plants show rugosity. Dark vein banding and light green inter-veinal 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 nd 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* where SMV produces local lesions and systemic symptoms on hosts like *Phaseolus vulgaris*, *Glycine max* etc. SMV also be detected in ELISA and PCR systems of diagnosis

RHIZOCTONIA BLIGHT

Symptoms: Initially the disease appears on lower leaves as water soaked lesions, which 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 lignified. A reddish brown canker may encircle the stem at the base and drooping of leaves common. Under high humidity, the fungal mycelium observed on leaves and in between closely spaced plants. Oval to elongated spots appear on stem, petiole and pods. Dark brown sclerotia formed on leaves and petioles. The disease also affects the seedlings causing stunting and pre emergence mortality. Seeds on infected plants may show irregularly shaped tan or light brown sunken lesions.

Pathogen- *Rhizoctinia solani* Kuhn (perfect stage: *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 sterigmata, each bearing one basidiospore.

MUSTARD DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

ALTERNARIA BLIGHT

Symptoms: The symptoms 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 also caused by *A. brassicae* except that these spots are smaller and lighter in colour. When too many spots formed on leaves, they die prematurely indirectly affecting the yield.

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

WHITE RUST

Symptoms: The pathogen causes local and systemic infection and symptoms may appear to all plant parts except roots. In local infection, white pustules irregularly formed on leaves and stems. These pustules may merge 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 thickened, and 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 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 formed between the sporangia, which swell during the presence of moisture thus helping 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, encysted and go into hibernation. Under favourable conditions (optimum temperature 10^0C and maximum 25^0C) the encysted zoospores germinate by producing germtube and infect the host through stomata and form new mycelium.

DOWNY MILDEW

Symptoms: Purplish 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 do not show deformities except enlargement and twisting of ovary. The stalks are abruptly bent and flower buds atrophied.

Pathogen- *Peronospora parasitica.* 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 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 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.

GROUNDNUT DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

TIKKA DISEASE/ EARLY 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 – *Cercospora arachidicola* (Sexual Stage: *Mycosphaerella arachidis*). 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 *Cercospora arachidicola* 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 25-54µ long and 5-8µ wide. Conidia- Consists of short, cylindrical conidia. It is 18-60 µ and 6-11 µ wide. The shape of conidia rounded at one end and tapered on the other end. Conidia of *Cercospora personata* is septate, and around 3-4 septa are present.

WILT

Symptoms: Germinating seeds attacked by the pathogens shortly before emergence. There is general tissue disintegration and the surface of the seedling 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 yellow and wilted. The leaves turn greyish green and the plants dry up and die. The roots and stems show internal vascular browning and dis-colouration. 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 a fruiting body. They produced another spore Chlamydospores as the resting structure in the soil.

CASTOR DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, 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, causing withering, and death of seedlings. 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. Sporangiophores - emerge through the stomata on the lower surface, singly or in groups and unbranched. Sporangia - single celled, hyaline, round or oval occurs at the tip singly. The sporangia germinate to produce abundant zoospores. The fungus also produces oospores and chlamydospores in adverse seasons

COTTON DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

BACTERIAL BLIGHT

Symptoms: The bacterium attacks all stages from seed to harvest. Usually, five common phases of symptoms noticed. **Seedling blight:** Small, water-soaked, circular or irregular lesions develop on the cotyledons, Later, the infection spreads to stem through petiole and causes withering and death of seedlings.

Angular leaf spot: Small, dark green, water-soaked areas develop on a 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.

Vein blight or vein necrosis or black vein: The infection of veins causes blackening of the veins and veinlets, giving a typical 'blighting' appearance. On the lower surface of the leaf, bacterial oozes 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.

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.

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* p.v. *malvacearum.* The bacterium is a short rod with a single polar flagellum. It is gram negative, non-spore forming and measures 1.0-1.2 X 0.7-0.9 um.

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 also seen. In severe cases, the spots may appear on bracts and bolls.

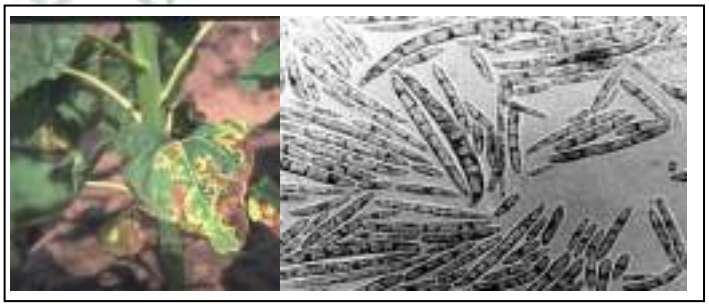
Pathogen – *Alternaria macrospora.* The fungus produces dark brown, short, 1-8 septate, irregularly bend conidiophores with a single conidium at the apex. The conidia are obclavate, light to dark brown in colour with 3-9 transverse septa and four longitudinal septa, with a prominent beak.

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, and stem girdled, causing seedlings 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 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 acervuil on the infected parts. The conidiophores are slightly curved, short, and club-shaped. The conidia are hyaline and falcate, borne singly on the conidiophores. Numerous black-coloured and thick walled setae also produced in acervulus.

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 a 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 only one portion of the plant is affected, and the other remaining free. The taproot usually stunted with less abundant laterals. Browning or blackening of vascular tissues is the other important symptom, black streaks or stripes 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 boils. In transverse section, discoloured ring seen in the woody tissues of stem. The plants affected later in the season 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. Macro-conidia are 1 to 5 septate, hyaline, thin walled, falcate with tapering ends. The micro-conidia are hyaline, thin-walled, spherical or elliptical, single or two celled. Chlamydospores are dark coloured and thick walled. The fungus also produces a vivo toxin, Fusaric acid, which is partially responsible for wilting of the plants.

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 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 taproot 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 seen on the wood or on the shredded bark.

Pathogen- *Rhizoctonia bataticola* (Pycnidial stage: *Macrophomina phaseolina*). The fungal hyphae are septate and thick and produce black, irregular sclerotia, which measure 100 um in diameter.

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 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 some cases, 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 observed depending upon the nature of the fungi involved.

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

BERSEEM DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and stereo microscope

DAMPING-OFF

Symptoms: Pre-emergence damping off, seed may decay or seedlings blighted and killed before emergence. Post emergence damping off, infection commonly occurs as the seedling emergences 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 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 beings to grow on dead organic matter on the surface of the soil. The white mycelium easily spotted in the field around the wilted patches of the berseem crop. The sclerotia 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 infected by the ascospores produced from germination of these sclerotia. Most suitable temperature for ascospore germination lies at 15-30^{0}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 condition, 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*

MENTHA DISEASES

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 not observed in India. In severe conditions, defoliation seen in the field. The disease 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 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 alternate*

SCLEROTINIA BLIGHT

Symptoms: The disease 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.
Pathogen – *Sclerotinia sclerotiorum*

ALOE VERA DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, Compound and 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 death of infected leaves. Formation of acervuli 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 alternate*

ROOT ROT DISEASE

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 found.
Pathogen – *Fusarium solani*

ASHWAGANDHA DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, 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. Afflicted plant's root is pulpy and brownish in colour. Fungus grew as a white cottony growth at the base of afflicted plants around ground level. At 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 alternate*

SACRED BASIL DISEASES

Material required: Specimen/diseased plant or its part, Hand lens, Slides and cover slips, Cotton blue and Lactophenol, Wash bottles, Watch glass, Needle, Forceps, Scalpel, 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 5-10 cm above the soil level. 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 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 discoloration, which is more prominent in the apical region of the plant, linked to external symptoms. 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 completely stopped. Infected plants show indications of crown and root rot. Pale pink orange layer of macroconidia of *F. oxysporum* f. sp. *basilici* found on the stems of sick plants.

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

GRAYMOLD

Symptoms: Organs infected with mycelia produce a lot of off-white to grey mycelia with dark conidia. Conidia 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*

BASIL 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. Entire stem frequently girdled by lesions. The brown mycelia growth of the fungus 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 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. 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 most commonly caused by *Sclerotinia sclerotiorum* and *Sclerotinia minor*.

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 starts 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.*