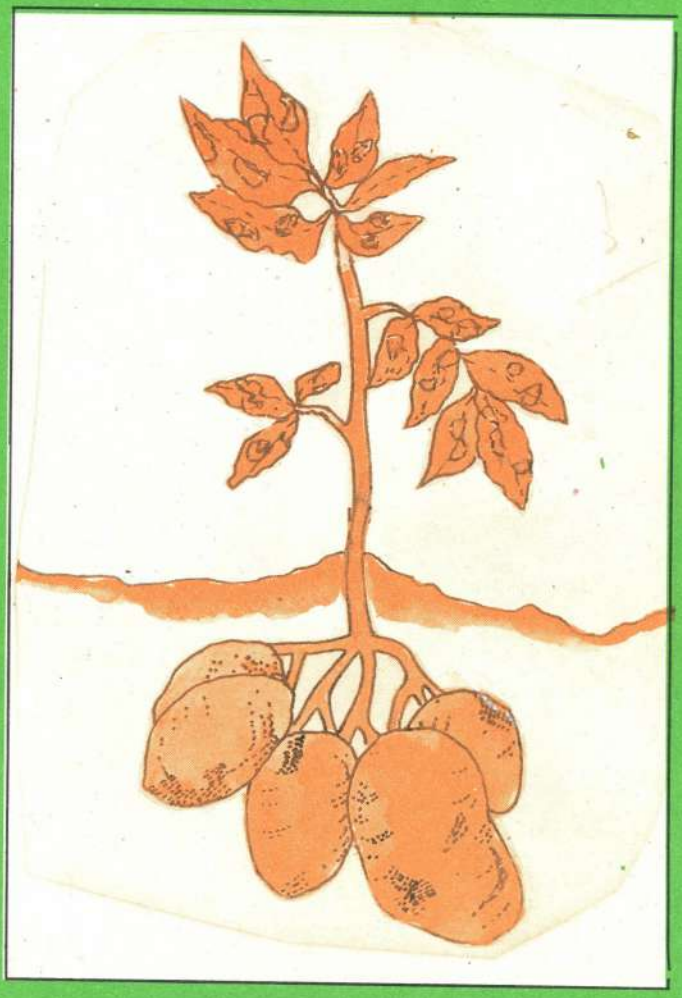
VOCATIONAL COURSE (AGRICULTURE)

PLANT PROTECTION



National Institute of Open Schooling

VOCATIONAL COURSE (AGRICULTURE)

PLANT PROTECTION

PART - I

National Institute of Open Schooling
B-31 B, Kailash Colony, New Delhi-110048

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Part IV A (Article 51 A)

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(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.

A brief Guide to NOS web site

The success of open learning and distance education very much depends upon the harnessing of the new and latest technology. The emerging Internet and Web technology help in effective dissemination of knowledge breaking all geographical boundaries. The web-site is a dynamic source of latest information and is also electronic information guide. The contents in the **NOS** web site are open to all.

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Clicking this site address will bring the user to NOS Home Page that will further guide them to visit different information pages of **NOS**. NOS is also developing a school network through Internet known as **Indian Open Schooling Network (IOSN)**. The network will provide a common communication platform for learners and educators. NOS is offering **Certificate in Computer Applications (CCA)** through selected AVI. This course is also offered through Internet on NOS Web-Site.

CURRICULUM

1. **Course Title :** Plant Protection (Plant Pathology)
2. **Duration :** 150 contact hours
3. **Entry qualification** : Matriculation or equivalent
4. **Introduction** :

Agricultural crops suffer heavily due to diseases and pests. It is essential to have basic knowledge about the plant pathogens, the different kinds of diseases caused by them on various crops and the methods of managing the diseases to avoid the enormous losses caused by the diseases. As plant protection is indispensable, job opportunities will be available to the persons having the basic knowledge about the diseases and pests of crops.

5. **Objectives** :

By doing this course, the learner will be able to

- study the characteristics of plant pathogens, and nature of diseases induced by pathogenic and physiogenic diseases,
- study the important diseases affecting agricultural and horticultural crops,
- acquire the knowledge of disease management methods

6. **Course contents** :

A. Theory

Module 1 Characteristics of plant pathogens

1.1 Fungi
- 1.1.1 Reproduction
- 1.1.2 Nutrition
- 1.1.3 Classification
- 1.1.4 Life cycle of plant pathogenic fungi:
- 1.1.5 Types of fungal diseases

1.2 Bacteria
- 1.2.1 Types of bacterial diseases :

1.3 Viruses
- 1.3.1 Nature of Plant viruses :
- 1.3.2 Modes of transmission
- 1.3.3 Virus-vector relationship
- 1.3.4 Types of diseases caused by viruses

1.4 Mycoplasma—like organisms

1.5 Physiogenic or non-infectious diseases
- 1.5.1 Nutritional disorders
- 1.5.2 Adverse environmental factors

Module 2 Diseases of crops

2.1. Diseases of cereals
- 2.1.1. Diseases of rice
- 2.1.2. Diseases of wheat

2.2. Diseases of millets
- 2.2.1. Diseases of maize
- 2.2.2. Diseases of sorghum
- 2.2.3. Diseases of ragi
- 2.2.4. Diseases of bajra

2.3. Diseases of pulses
- 2.3.1. Diseases of pigeonpea
- 2.3.2. Diseases of chickpea
- 2.3.3. Diseases of greengram and blackgram

2.4. Diseases of oilseeds
- 2.4.1. Diseases of groundnut
- 2.4.2. Diseases of sesamum
- 2.4.3. Diseases of sunflower

2.5. Diseases of cash crops
- 2.5.1. Cotton
- 2.5.2. Diseases of sugarcane
- 2.5.3. Diseases of tobacco

2.6. Diseases of Plantation Crops
- 2.6.1. Diseases of coconut
- 2.6.2. Diseases of arecanut
- 2.6.3. Diseases of coffee
- 2.6.4. Diseases of tea
- 2.6.5. Diseases of rubber
- 2.6.6. Diseases of cardamom
- 2.6.7. Diseases of pepper
- 2.6.8. Diseases of turmeric
- 2.6.9. Diseases of tapioca

2.7. Diseases of fruit crops
- 2.7.1. Diseases of banana
- 2.7.2. Diseases of mango
- 2.7.3. Diseases of grapes
- 2.7.4. Diseases of citrus
- 2.7.5. Diseases of apple
- 2.7.6. Diseases of papaya

2.8. Diseases of vegetable crops
- 2.8.1 Diseases of tomato
- 2.8.2. Diseases of brinjal
- 2.8.3. Diseases of bhendi
- 2.8.4. Diseases of potato
- 2.8.5. Diseases of cauliflower and cabbage
- 2.8.6. Diseases of beans
- 2.8.7. Diseases of beet root
- 2.8.8. Diseases of chillies

2.9. Diseases of other horticultural crops
- 2.9.1. Diseases of rose
- 2.9.2. Diseases of crossandra
- 2.9.3. Diseases of jasmine
- 2.9.4. Diseases of betelvine

Module 3 Management of Crop Diseases

3.1. Exclusion
- 3.1.1 Plant Quarantines

3.2. Eradication

3.3. Protection :

3.4. Immunization :

3.5. Biological control

3.6. Fungicides
- 3.6.1. Classification of fungicides
  - 3.6.1.1. Copper fungicides
  - 3.6.1.2. Sulphur fungicides
  - 3.6.1.3. Organomercuric compounds
  - 3.6.1.4. Non-mercurial organic compounds
  - 3.6.1.5. Miscellaneous chemicals
  - 3.6.1.6. Systemic fungicides
  - 3.6.1.6.1 Benomyl compounds
  - 3.6.1.6.2 Carboxin and Oxycarboxin compounds
- 3.6.2. Methods of application of fungicides
  - 3.6.2.1. Seed treatment
  - 3.6.2.2. Foliar application
  - 3.6.2.3. Soil application
- 3.6.3. Phytotoxicity
- 3.6.4. Compatibility

3.7 Biological control
- 3.7.1. Application of organic manures
- 3.7.2. Use of antagonists
- 3.7.3. Botanicals

3.8 Integrated disease management

B. Practical

Unit 1. Examination of asexual and sexual reproductive structures of fungal pathogens

Unit 2. General symptoms produced by fungal pathogens

Unit 3. General symptoms produced by bacterial, viral pathogens and non-pathogenic disorders

Unit 4. Differentiation of diseases by symptoms

Unit 5. Identification of diseases affecting rice and wheat

Unit 6. Identification of diseases affecting maize, sorghum and bajra

Unit 7. Identification of diseases affecting pigeonpea, chickpea, soybean, blackgram and green gram

Unit 8. Identification of diseases affecting groundnut sesamum, mustard and sunflower

Unit 9. Identification of diseases affecting cotton and sugarcane

Unit 10. Identification of diseases of coconut, arecanut, coffee and tea

Unit 11. Identification of diseases of tapioca, turmeric and banana

Unit 12. Identification of diseases of mango, grape, citrus and apple

Unit 13. Identification of diseases of tomato, brinjal, chillies and bhendi

Unit 14. Identification of diseases of potato, cauliflower, cabbage, beans and beet root

Unit 15. Identification of diseases of jasmine, rose, crossandra, and betelvine

Unit 16. Study of fungicides

7. **Scheme of**

   i. **Studies** : Theory: 40%; Practical: 60%

   ii. **Assessment**: Internal 40%; External: 60%

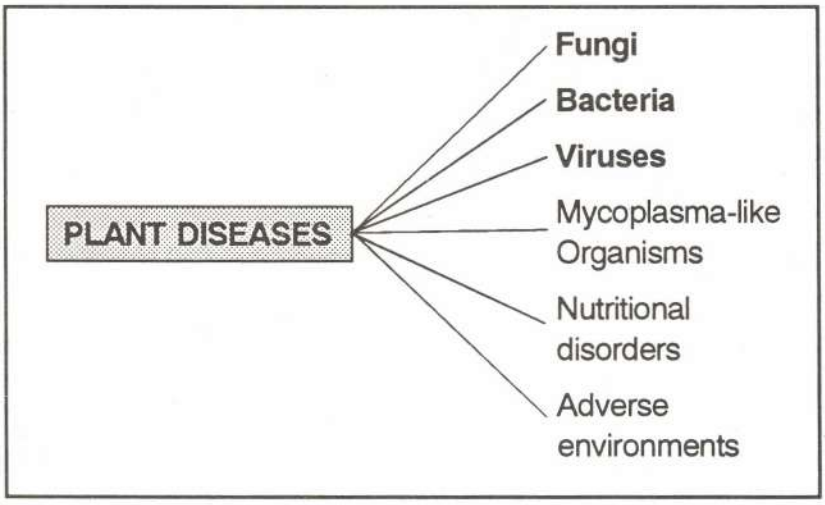
8. **Suggested Reading** :

G. Rangaswami 1985. *Diseases of crop plants in India*, Prentice-Hall, Bombay

Module 1

Characteristics of Plant Pathogens

Key concepts



INTRODUCTION

Crops cultivated by us are affected by many diseases. These diseases reduce the yield that we can get from the crops. The yield loss may be up to 80 per cent. You can guess the enormous loss that may be caused, if proper management practices are not adopted. You should know about the diseases and how they are caused. In this lesson you will know about the characters of the agents that are responsible for crop diseases.

OBJECTIVES

After reading this lesson, you will be able to do the following :

- differentiate fungi, bacteria and viruses
- distinguish the symptoms of diseases
- differentiate nutritional disorders
- identify the diseases based on symptoms

1. Characteristics of plant pathogens

You have to know how crop diseases are induced. What is the nature of plant pathogens? Crop diseases are due to fungi, bacteria, viruses and mycoplasma—like organisms. Some diseases are due to lack of nutrients and unfavourable soil conditions.

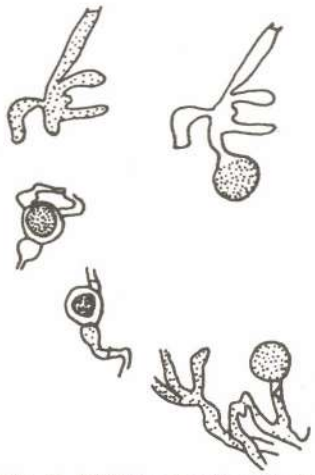


Fig. 1. *Pythium aphanidermatum*

a. Sporangium
b. Vesicle formation
c. Antheridium and Oogonium
d. Fertilization
e. Oospore

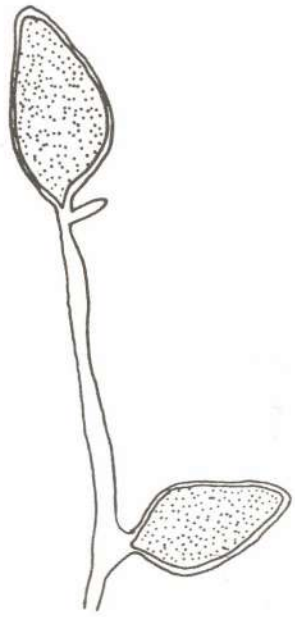


Fig. 2 *Phytophthora arecae*

1. Sporangiophore with Sporangium

1.1 Fungi

Fungi are small microorganisms. You can see them using a microscope. You will see tube like long structures called hyphae. The body of the fungus consists of thousands of hyphae. A group of hyphae is known as mycelium. The fungus produces some structures known as haustoria. Haustoria are used to take the nutrients from the plants. The fungi cannot produce food materials required for their growth. They depend on the plants for their materials. That is why you call them as parasites. These parasites cause the diseases and so they are called as pathogens.

1.1.1 Reproduction

The fungi produce vegetative reproductive (asexual) structures known as spores. The spores may have single cell or several cells. They may be colourless (hyaline) or differently coloured. You may see spores with different shapes like round, cylindrical, sickle shaped or pear-shaped. The vegetative spores may be called as sporangium or conidium. They will germinate and form a new individual colony.

Under favourable condition you may observe the formation of several reproductive structures. The male reproductive organ is known as antheridium. The female reproductive organs are called as oogonium or ascogonium (Fig. 1, 2 and 3) The sexual spores are formed when the organs of opposite sexes unite. In certain cases, spores of opposite sexual nature may unite forming spores.

1.1.2 Nutrition

You know that plants can synthesize their own food materials because of the presence of chlorophyll pigments in the leaves. The fungi do not have this pigment and hence they cannot synthesize food from carbon dioxide and water as the plants. Some of the disease causing fungi can live on dead organic matter in the absence of living plants. Some always live only on plants and they are called obligate parasites.

1.1.3 Classification

The fungi, are divided into four important groups (Classes) : 1. Oomycetes 2. Ascomycotina 3. Basidiomycotina and Deuteromycotina. Important properties of these classes are given below.

1. Oomycetes : The fungi have mycelium without any cross wall (septum) and produce spores in sac-like structures called as sporangium. The sexual spores are known as oospores.

2. Ascomycotina : The fungi , in this class, have mycelium with cross walls and produce conidia. The sexual spores are called as ascocarp.
3. Basidiomycotina : The fungi belonging to this class also have mycelium with cross walls. The sexual structure known as basidiocarp is formed by some fungi only.
4. Deuteromycotina : These fungi do not produce any sexual spores and they produce different types of asexual spores (conidia).

1.1.4 Life cycle of plant pathogenic fungi

You have to know about the life cycle of important plant pathogens. This knowledge will help you to identify them. You will also understand the vulnerable stage in the cycle at which the pathogen can be effectively controlled.

The fungal pathogens belonging to the class Oomycetes are responsible for serious diseases. Damping off disease destroys the vegetable seedlings in the nursery. Potato suffers severely when infected by late blight disease caused by Phytophthora infestans. Downy mildew disease caused by Sclerospora graminicola is an important disease of bajra.

These pathogens produce non-septate colourless (hyaline) mycelium. The sporangiophore forms sporangia during asexual reproduction. The sporangia when mature, can produce many zoospores which are released from them. The zoospores can infect healthy plants. During sexual reproduction, the pathogen forms the male reproductive organ known as antheridium and female reproductive organ called oogonium. The antheridium and oogonium unite to form oospores which are resistant to several adverse conditions and survive for several years in the absence of host plants.

Powdery mildew, leaf spots and ergots are the important diseases caused by the fungi belonging to the group Ascomycotina. Powdery mildew diseases infect many pulse crops, vegetable crops and fruit crops. Erysiphe polygoni is an important pathogen. Different kinds of fungi are responsible for various leaf spot diseases. The leaf spots may destroy the leaves which may fall off later. Banana, groundnut and several other crops suffer heavily. Ergot disease severely affects bajra. In the earheads, many grains are replaced by fungal sclerotia (hardened fungal mat). The fungus Claviceps microcephala is responsible for this disease. Ergot sclerotia are poisonous and may

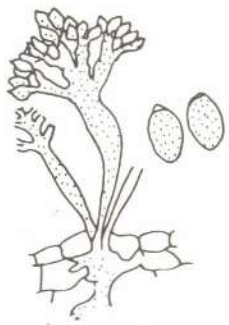


Fig. 3. *Sclerospora graminicola*

a. Sporangiophores with sporangia
b. Sporangia

cause disease in animals and human beings when consumed.

These pathogens produce septate (with cross walls) mycelium. During asexual reproduction the conidiophores are formed either directly from the hyphae or with special fruiting bodies. The conidiophores produce different kinds of conidia. The conidia may be colourless (hyaline) or coloured, single-celled or multicelled. They may be spherical, elongated or cylindrical in shape. They germinate and infect healthy plants, producing disease symptoms.

During sexual reproduction the male reproductive organ antheridium unites with ascogonium. The ascocarps are formed and the ascospores are released from them later. The ascospores infect the plants during next season.

The fungi belonging to Basidiomycotina cause smut and rust diseases. Smut diseases infect wheat, sorghum and sugarcane. Different species of Ustilago induce the smut diseases. Wheat is affected by three different rust diseases due to Puccinia spp. Beneficial fungi like mushrooms belong to this group.

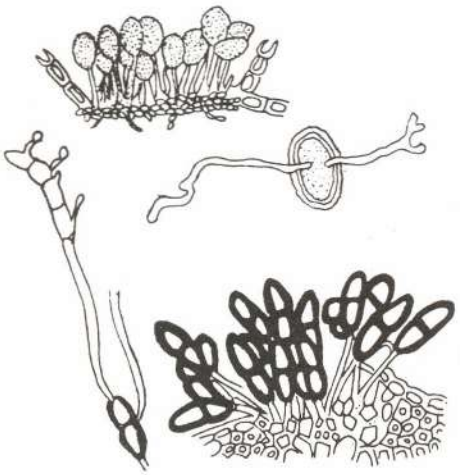


Fig. 4 *Puccinia graminis tritici*

The smut fungi produce dark mass of chlamydospores inside sac—like structures. The chlamydospores are released when the sac—wall is ruptured. The spores may spread though seeds or remain in soil to infect healthy plants when available.

Some rust fungi may require an additional host plant species to complete their life cycle. For example the wheat stem rust pathogen requires barberry for completion of its life cycle. The uredial stage in its life cycle is found on wheat. Wheat crop suffers heavily due to this disease. The pathogen can produce several crops of uredospores in one season. The second stage—telial stage is also seen as the wheat crop matures. The spores formed in this stage cannot infect wheat (Fig. 4). Further two stages—pycnial and aecial stages—are formed on the wild plant barberry.

Many crops suffer due to wilts, root rots, and anthracnose diseases. The fungi causing these diseases belong to the group Deuteromycotina. These fungi have been found only in the asexual reproductive stage. Wilt disease infect many important crops like banana and cotton. Different species of Fusarium are responsible for wilt diseases. Fusarium spp produces small spherical single celled microconidia and also sickle-shaped multi-celled macroconidia.

Root rot diseases affect a wide range of crops including cotton, groundnut, sunflower, gingelly, and pulse crops. The root rot pathogen Rhizoctonia spp. remains in soil and infects the roots and basal

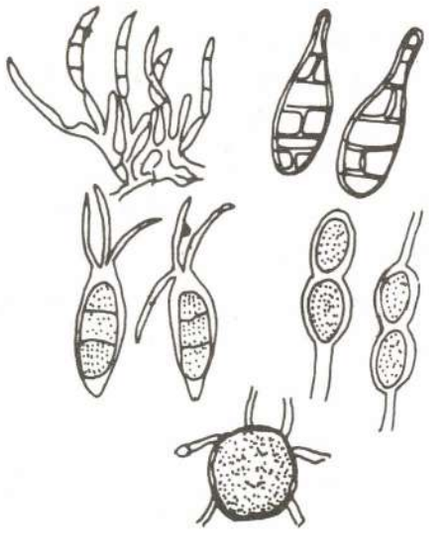
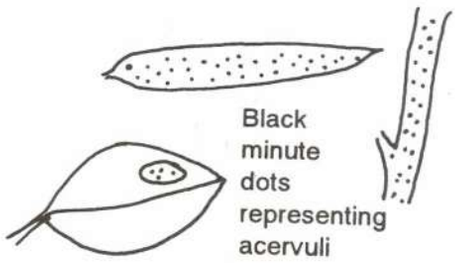


Fig. 5 *Asexual reproductive structures*

a. Sporodochium of Fusarium sp.
b. Alternaria
c. Pestalotia
d. Chlamydospores
e. Scelerotium

portions of plants. The fungus produces thick walled Chlamydospores. They are resistant to adverse conditions like drought and temperature (Fig. 5).

Anthracnose disease causes serious losses in banana, mango and grapes. The pathogen Colletotrichum spp. infects fruits reducing their quality and market value. The fungus forms single-celled, sickle-shaped, colourless conidia in special structures known as acervulus. (Fig. 6.1.4).



Anthracnose
Fig. 6.1.4

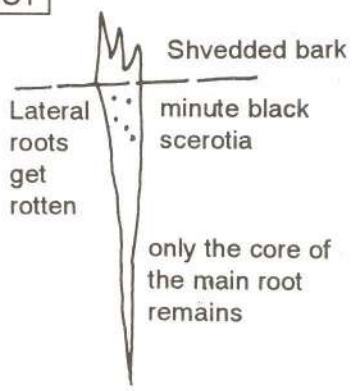
1.1.5 Types of fungal diseases

Diseases due to fungal pathogens can be grouped based on the plant part or tissue affected as follows

a) Root rot : You will see rotting of roots and basal portions of stem. The roots may become fibrous. Black sclerotia are seen in the affected tissues. (Fig. 6.2.1)

b) Wilt : Infection occurs through roots. The leaves turn yellow and plants begin to wilt. If you remove the bark on the root you can see black streaks. (Fig. 6.1.2)

ROOT



Root rot

Fig. 6.2.1

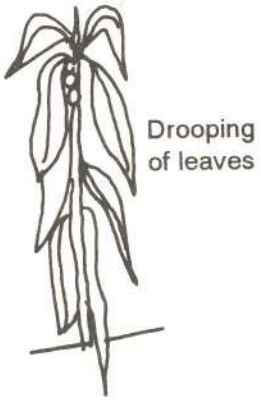
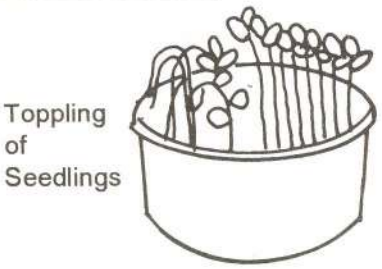


Fig. 6.1.2

WHOLE PLANTS



Damping-off

Fig. 6.1

c) Collar rot : The stem tissue near the ground level will show rotting. The affected plants soon collapse and die.

d) Damping off: You may see this disease in nurseries. The collar regions of seedlings turn brown and collapse. The fungi invade the roots and stem quickly and kill the seedlings. (Fig. 6.1.1)

e) Stem rot : The leaf sheath and culms are affected. The affected tissues turn brown and dry up. Large number of black sclerotia can be seen inside the culms. (Fig. 6.3.2) *

f) Leaf spots : On the leaves you may see spots ranging in size, shape and colour. Under favourable conditions the leaf spots join together covering almost the entire leaf surface. Seriously affected leaves may be shed off. (Fig. 6.4.1) *

g) Leaf blights : Dark brown irregular spots may be observed on leaves. In crops like sugarcane, maize and sorghum the spots may run the entire length of leaves causing extensive drying of leaves. (Fig. 6.4.2) *

h) Downy mildews : The disease starts as whitish downy fungal growth on the lower leaf surface and covers most of the leaf surface in due course. The leaves turn brown and dry later. The earheads and fruits are also affected. (Fig. 6.4.3) *

i) Powdery mildews : The fungal growth may be seen as powdery mass on the leaves. When the disease is severe, leaves dry up. Pods, flower buds and fruits are also affected. (Fig. 6.4.3) *

j) Rusts : Brownish or dark coloured erupted pustules (sori) are formed on leaves and leaf sheaths. The leaves dry up soon. (Fig. 6.4.4) *

k) Bud rot : Young growing bud and surrounding young leaves are infected. Sunken, brownish areas may be seen in the infected leaves. Soon the tender bud is affected, killing the trees like coconut.

l) Smuts : You can see individual grains or entire earhead being replaced by black fungal spores enclosed in sac-like structures. Yield reduction is heavy in severe cases. (Fig. 6.5.1) *

m) Ergot : This disease also affects earheads. Dark sclerotia are seen in place of grains. In the early stages sweet secretions may be observed in affected flowers. (Fig. 6.5.2) *

n) Fruit rots : Different fungi cause these diseases. Brownish or black spots appear on the fruits and enlarge rapidly as the fruits

* Fig. 6.3.2, 6.4.1, 6.4.2, 6.4.3, 6.4.4., 6.5.1 and 6.5.2 are shown on page 57

UNIT 5

IDENTIFICATION OF DISEASES AFFECTING RICE AND WHEAT

Objective : To study and observe the fungal characters and symptoms of the important diseases of rice and wheat.

In this class, you are going to observe diseases of rice and wheat.

The first disease is blast in rice. In the given specimen observe the symptoms. Spindle shaped spots with dark-brown margin and grey centre. Take scrapings from the infected portion and observe under microscope. You can see large number of hyaline, pear-shaped, 3 celled structures. These are all the conidia of the fungus *Pyricularia oryzae*, which causes blast disease.

Here is the next disease specimen. Observe the symptoms and take scrapings. You can see dark brown spots on the leaves. In the scrapings, club-shaped, brown coloured, 7-9 septate structures can be seen. These are all the conidia of *Helminthosporium oryzae* which causes the brown spot. You can also see the brown dots on the given paddy seeds. These also show infection of the fungus on the seed.

Next specimen is the symptom produced by a fungus called *Sarocladium oryzae*. You can see rotting areas in the boot leaf covering the panicles. The lesions are grey with dark brown margin and cause choking of the panicle. Tape scrapings and observe under microscope. You can now see a large number of single celled, oblong, hyaline conidia of the fungus.

Here is the another disease symptom in paddy. If you observe the lower portion of stem, large irregular lesions with grey centre and purplish margins can be seen on the leaf sheath. This the typical symptom produced by *Rhizoctonia solani*, called as 'sheath blight'. Take scrapings and see large number of minute, black, round sclerotia.

Here you can observe the typical symptom called leaf blight caused by the bacterium, *Xanthomonas campestris* pv. *oryzae*. Observe the symptoms. You can see yellowing and drying of leaves from tip and margins of leaves with wavy lines in the inner margins. Take of a bit of leaf and put it in a drop of water in a slide and observe under a microscope. A white slurry ooze of bacterial mass can be seen near the cut ends of the leaves.

Now you are observing the typical symptoms produced by Rice Tungro Virus.

Observe the symptoms. The leaves show yellow or orange discoloration of the leaves from tip downwards and along margins.

Next, we will see a few diseases of wheat. First important disease is rust caused by *Puccinia graminis tritici*. Now, in the given leaf specimen you can see a large number of brown to dark coloured raised blisters. Take the section and observe it under microscope. You can see a group of spores inside a saucer/shaped structure. These spores are called as uredospores. They are yellow in colour, round in shaped with a stalk. In addition, two celled brown spores are also seen. These are called as teliospores.

Here you can see the earhead of wheat showing smut symptoms. Because of infection, the spikelets become loose and each spikelet is counted into a single sorus covered by a very thin membrane. If you break open the membrane, a large number of very minute black spores are seen, which are black and round in shape.

Observations to be recorded : Draw the different symptoms produced by the pathogen. Draw the neat sketches of the fungal characters in association of the symptoms of the different diseases.

UNIT 6

IDENTIFICATION OF DISEASES AFFECTING MAIZE, SORGHUM AND BAJRA

Objective : To study and observe the fungal characters and symptoms of the important diseases of maize sorghum and bajra.

Now, you are supplied with sorghum leaves showing a leaf blight symptom caused by *H. turcicum*. Observe the symptoms you can see elongated lesions with dark brown margin and grey centre. You can see several spots on a single leaf, leading to drying and blighting. Take scrapings and observe the fungal characters. Large number of club shaped, multiseptate, brown coloured conidia are seen under microscope. You can now see, the similar type of symptoms on the maize leaves also.

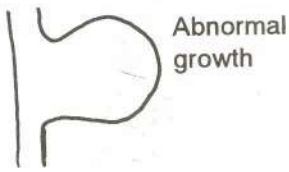
a) Leaf spots and blights : Brownish or purplish spots with different shapes are seen on leaves. The disease may spread to petioles and stems in certain crops leading to serious loss.

b) Soft rots : The bacterium may affect roots, fruits or tubers. Irregular water- soaked areas appear and the affected areas soon become mass of rotten tissues.

c) Wilts : The affected plants exhibit yellowing of leaves. They may collapse and wither in due course.

d) Canker: Corky brown erupted tissues can be seen on leaves, stem and fruits. In severe cases branches of affected plants may dry up. (Fig. 6.6.1)

e) Galls : Small or large outgrowths (tumours) of affected tissues are formed in roots and stems generally. Occasionally galls may be formed on leaves and petioles. (Fig. 6.3.5)



Stem gall

Fig. 6.3.5

1.2 INTEXT QUESTIONS

1. Mention whether the following statements are true (T) or False (F)
   a) Bacterial pathogens have single cells (T/F)
   b) Bacteria cannot move as the fungi (T/F)
   c) Gram stain is used for identification of bacteria (T/F)
   d) Cankers are caused by bacteria (T/F)
2. Bacteria may cause
   a) Soft rot
   b) Downy mildew
   c) Ergot
   d) Anthracnose
3. Plant pathogenic bacteria are
   a) spherical
   b) rod shaped
   c) ellipsoidal
   d) thread like

1.3 Viruses

You have learnt about two kinds of microorganisms namely fungi and bacteria capable of causing diseases in plants. The viruses are the smallest in size among the disease causing agents. Now you can know some facts about the plant viruses causing serious diseases in different crops.

1.3.1 Nature of Plant viruses

The viruses have certain distinct characteristics distinguishing them from fungi and bacteria. They are always inside the cells of the host plant. They do not produce any reproductive structures like spores. They multiply by inducing the host cells to produce materials required for multiplication. Viruses do not cause diseases by consuming cells or kill them with toxic substances. But they upset the normal functions of the host cells and this results in accumulation of abnormal substances or conditions injurious to the host plants.

Plant viruses differ strikingly from other plant pathogens in other properties. They are much smaller (more than million times) and may be either spherical or elongated rods in shape. They differ from other pathogens in chemical constitution, physical structure, mode of infection and transmission, multiplication in hosts, dissemination and the symptoms they produce on the plants.

The viruses do not have any resemblance to the cells of organisms. They have essentially only two components namely protein and nucleic acid which may be either RNA (ribonucleic acid) or DNA (deoxyribonucleic acid). The protein forms protective covering for the nucleic acid. When the virus is inside a plant cell the nucleic acid is released and the multiplication (replication) of virus particles begins. Within few hours thousands of new virus particles may be formed. The viruses do not divide or grow in size as other pathogens.

1.3.2 Modes of transmission

The viruses are transmitted from infected plants to healthy plants and from one generation to another, in different ways. The infected propagative materials like tubers, corms, bulbs, rhizomes, setts etc. carry the viruses internally. The diseases spread from one crop to another and from one location to different locations when infected seed materials are used for planting. The viruses infecting potatoes, banana, sugarcane, fruit and ornamental trees are sp read commonly in this manner. Viruses can spread through infected seeds also.

The virus diseases may be spread within the crop or carried to long distances by different kinds of vectors. Insects, mites, nematodes and fungi are the vectors spreading the viruses from infected to healthy plants. The insects are the predominant agents transmitting hundreds of plant viruses. They acquire the virus when they feed on infected plants and transmit the virus when they feed again on healthy plants.

Among the insect vectors, aphids, leafhoppers, white flies and thrips are the important groups of insects. Banana bunchy top (aphid), rice tungro (leafhopper), tomato leaf curl (whitefly) and groundnut bid necrosis (thrips) are some of the important diseases transmitted by insect vectors. A few viruses are transmitted through roots by nematodes or fungi.

1.3.3 Virus-Vector relationship

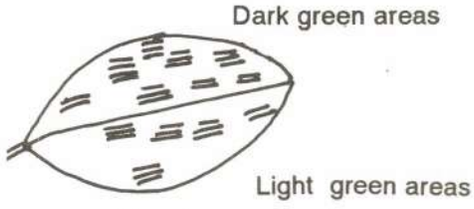
The plant viruses have a distinct biological relationship with the vector insects. Some viruses like sugarcane mosaic virus and cucumber mosaic virus are acquired by the aphids after feeding for a few minutes on infected plants. They can be transmitted to healthy plants immediately. Such viruses are known nonpersistent viruses.

Some of the viruses like banana bunchy top and tomato spotted wilt viruses can be acquired only after several hours of feeding on infected plants. The insects are able to transmit the virus only after certain period of time. This period is called as latent (incubation) period which may vary from few hours to several weeks. After completion of the latent period the insects will be able to transmit the virus to healthy plants. These viruses are known as persistent viruses. Usually these viruses are transmitted for the entire life period of the vector. But the non-persistent viruses are transmitted by their vectors only for short periods (one or two days only).

The nature of relationship between the virus and vector is determined by the virus and not by the vector. The extent of disease spread is largely depend on the nature of virus-vector relationship.

1.3.4 Types of diseases caused by viruses

a) Mosaic : The infected leaves show light and dark green or yellow and green areas intermingled together. The leaf size may be progressively reduced and the plants may be stunted is severe cases. Tobacco mosaic, sugarcane mosaic, tapioca mosaic, cardamom mosaic diseases show these symptoms. (Fig. 6.4.7)

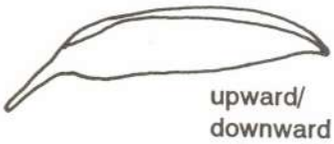


Mosaic

Fig. 6.4.7

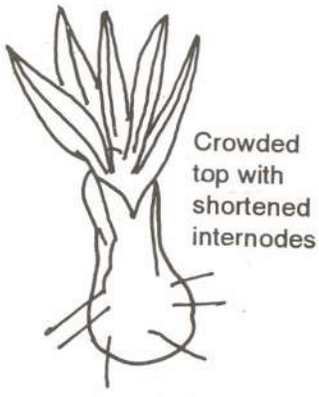
Leafcurl

Fig. 6.4.8



Leafroll

Fig. 6.4.13



Bunchy-top

Fig. 6.1.3

b) Leaf curl : Infected leaves become thick and small. Lamina curl severely and plants are stunted. Tomato leaf curl disease showing these symptoms is a serious disease. (Fig. 6.4.8)

c) Leaf roll : Infected plants are stunted. The leaves roll upwards characteristically and become tough. The potato leaf roll virus causes such symptoms in addition to formation of very small tubers. (Fig. 6.4.13)

d) Bunchy top : The infected plants are markedly stunted. The leaves are small, stiff and erect and crowded at the top. The plants are sterile. These symptoms may be seen in banana infected by bunchy top virus. (Fig. 6.1.3)

e) Necrosis : Viruses may cause death of tissues in different plant parts like leaf, stem, buds, The tissues turn brown and die. These symptoms are caused by tomato spotted wilt virus in tomato and groundnut.

f) Ring spots : On the leaves yellow concentric rings may be formed. After a few days, rings may turn brown when the tissues die. Tobacco ringspot virus causes these symptoms.

g) Tumours and galls : The virus may induce excessive cell division in the phloem or woody tissues. This leads to formation of tumours or galls on leaves, stems or roots. Clover wound tumour and rice ragged stunt viruses cause these symptoms.

h) Stunt: The infected plants are markedly stunted and have unusually large number of tillers. The leaves become pale, narrow, stiff and erect. Rice grassy stunt virus causes these symptoms.

1.4 Mycoplasma-like organisms

The mycoplasma-like organisms (MLO) are quite similar to bacteria, but they do not have a cell wall as the bacteria. The symptoms of some the diseases caused by MLO are similar to the virus diseases. These organisms are found in different shapes like spherical to filamentous structures. Most of them have not been cultured in artificial media.

They cause a group of diseases known as yellows diseases. The common symptoms induced by them include yellowing of leaves, stunting of plants and malformation of floral parts. Phyllody diseases affects many crop plants like sesamum, groundnut, cucurbits, jasmine etc.

1.3. INTEXT QUESTIONS

1. State whether the following are true (T) or False (F)
   a. Viruses produce toxic substances as fungi or bacteria (T/F)
   b. Some viruses are rod shaped while others are spherical (T/F)
   c. They have many properties similar to bacteria (T/F)
   d. Viruses may contain either ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) (T/F)
2. Banana bunchy top disease is transmitted by
   a) Aphid
   b) Thrips
   c) Whitefly
   d) Nematode
3. Persistent viruses are transmitted by the insect for
   a) few minutes
   b) few hours
   c) many days
   d) many months
4. Mosaic symptoms can be seen in
   a) Tomato leaf curl
   b) Tobacco mosaic
   c) Sesamum phyllody
   d) Sugarcane grassy shoot

1.5 Physiogenic or non-infectious diseases

The physiogenic or noninfectious diseases are due to lack or excess of any of the conditions required for normal growth and reproduction in plants. These diseases do not spread from infected plants to healthy plants. They may affect the plants at any stage of growth in the field and also during storage.

1.5.1 Nutritional disorders

Plants need various nutrients in different quantities. Plants are starved of these nutrients when they are deficient or unavailable. You have to know about the symptoms of the diseases due to deficiency of important nutrients.

a) Nitrogen : When nitrogen is deficient, the leaves become pale or yellow and narrow with irregular margins. Frenching disease of tobacco is due to nitrogen deficiency.

b) Phosphorus : Reddening or purpling of leaves is a common symptom of phosphorus deficiency. Reduced growth of plants and delayed maturity may also be recognized.

c) Potassium : Yellowish or brownish or whitish spots starting from leaf margin may be seen. In severe cases death of foliage may occur.

d) Magnesium : In citrus V-shaped green areas along the midrib of leaves may be observed. Other areas turn yellow.

e) Iron : Symptoms of iron deficiency are seen in many crops as yellowing of leaves. The young leaves may be entirely yellow or white in colour as seen in sugarcane or groundnut.

f) Zinc : The leaves of affected citrus plants show light and dark green areas and they are small in size. This deficiency disease is called foliocellosis.

g) Copper : Deficiency of copper causes exanthema disease in citrus. Many buds form in place of one normal bud. Young shoots begin to die back and gum-like exudations are seen in them.

1.5.2 Adverse environmental factors

Plants require certain optimum environmental conditions for their development. The factors which frequently affect the growth of crop plants are detailed below:

a) Acidity and alkalinity of soils : Under increased acidic conditions, mottling, crinkling and distortion of leaves may be seen. Plants may be stunted. In cotton, bolls are malformed. In alkaline soils, failure of seed germination, and death of seedlings may be noted. The plants grow very slowly and leaves turn yellow.

b) Soil-water relationship : The soil moisture levels should be optimum for good growth of plants. Poor supply of water results in drooping of plants and ultimate wilting of plants. Water-logged

conditions may reduce the oxygen supply to the roots. The root system become fibrous and are likely to be affected by many root diseases.

c) Oxygen supply : There should be adequate oxygen or air supply to the root system of plants. Lack of oxygen for prolonged period may lead to asphyxiation and death of plants. If potato tubers are stored where oxygen supply is poor, black heart disease develops in tubers. The central tissues of tubers become black in colour.

d) Temperature : When plants are exposed to higher temperatures, leaf burn, defoliation, heat cankers on trees and premature ripening of fruits may result. The plants may die, if exposed for long period.

e) Light : Under insufficient light, plants may grow taller and leaves become pale or yellow, productivity of plants is reduced considerably. Reduction in rice yields in thaladi season in Thanjavur district in Tamil Nadu is attributed to low light conditions during that season.

f) Atmospheric impurities : Factories and industries release gases and chemicals injurious to plants. Sulphur dioxide and compounds in effluents from tanneries affect plant growth adversely.

1.4. INTEXT QUESTIONS

1. Tobacco frenching disease is due to deficiency of
   a) Nitrogen
   b) Potassium
   c) Magnesium
   d) Iron
2. Asphyxiation is due to
   a) High acidity
   b) Lack of Oxygen
   c) Phosphorus deficiency
   d) Moisture stress.

WHAT YOU HAVE LEARNT

You have learnt the following after studying this lesson :

- General characteristics of fungal pathogens, reproduction and nutritional requirements
- Classification of fungi and life cycle of some pathogenic fungi
- Different kinds of plant diseases caused by fungal pathogens
- Properties to bacterial pathogens
- Types of diseases induced by bacterial pathogens
- Properties of plant viruses and their transmission
- Types of diseases caused by viruses
- Symptom and causes of non-infectious diseases.

TERMINAL QUESTIONS

1. Describe general characteristics of plant pathogenic fungi
2. Mention important diseases caused by fungi belonging to Ascomycotina
3. What are the different types of diseases due to fungal pathogens?
4. How will you distinguish bacteria from other plant pathogens?
5. How are plant viruses are transmitted ?
6. Describe the symptoms of common virus diseases.

brown eye spot are important.

Leaf rust - *Hemileia vastatrix*

You can see the spots of bright orange to red with yellow rusted bands on the under surface of the leaf. Powdery coating of spores can be seen in the spot.

If you take the cross section and observe in microscope you can see uredo and teliospores on club shaped erumpant stalks arising through the stomata. The uredospores are reniform with an orange segment like appearance. The teliospores are turnip like, hyaline and thick walled.

Anthracnose - *Glomerella cingulata*

Greyish spots on leaves, twigs and berries can be seen. Twigs die from tip down wards.

Brown eye spot - *Cercospora coffeicola*

Small circular necrotic spots with a dark brown margin and light brown centre occur on leaves. Berries become black with irregular sunken blotch with a purple halo.

If you observe in microscope you can see short conidiophore.

Now you can observe the symptoms of diseases affecting tea.

Blister blight - *Exobasidium vexans*

Small pale or pinkish, round spots are seen on the leaves. The spots enlarge to a diameter of 2 - 3 cm and protrude out to give a blister like appearance. Old spots turn powdery and whitish later becoming deep grey.

If you take the cross section and observe in microscope numerous cylindrical, thin walled basidia bearing ovate to oblong hyaline basidiospores at the tip can be seen.

Grey blight - *Pestalotia theae*

Irregular spots with grey patches can be seen on the leaves with fine concentric lines. Black dots of fructification can be seen on affected area.

Red rust - *Cephaleuros parasiticus*

The disease can be identified by small translucent water soaked spots on leaves. The spots become purple red then black with a purple margin.

Charcoal stump rot - *Ustulina zonata*

You can see the rotting of the root and the whole tea bush dies.

If you pull out the plant irregular black lines on the woody tissue and silky mycelium can be seen underneath the bark of both stem and root. If the bark is removed fan-shaped white or brownish mycelium can be seen.

Brown root rot - *Fomes sp.*

Rotting of roots and death of the tea bush are seen. If you pull out and examine the root, dirty encrustation of soil and the mycelial matrix at the root surface, brown cushions of mycelium and deep brown honey-comb like lines in the wood are visible.

Black root rot - *Rosellinia arcuata*

The disease can be identified by the spreading of mycelium on the soil surface. Roots upon infection turn black and mycelium radiates over the wood surface forming a while star of 12 mm diameter. Faint black lines on wood tissues can be seen.

Armillaria root rot - *Armillaria mellea*

The disease can be identified by the presence of longitudinal split formed at the collar region which gets filled with mycelium.

Red root rot - *Poria hypolaterita*

We can identify the disease by the presence of rough root exterior which shows reddish mycelial strands.

Observations to be recorded : Draw the symptoms you observed. Also draw the fungal characters to differentiate diseases you observed in this class.

UNIT 11

IDENTIFICATION OF DISEASES OF TAPIOCA, TURMERIC AND BANANA

Objective : To study and observe the fungal characters and symptoms of the important diseases of tapioca, turmeric and banana.

The following important diseases have to be observed

Powdery mildew, (*Erysipha graminis* var. tritici) characterized by the formation of white powdery growth appears on the leaf.

Management of wheat diseases :

Rusts :

a. Dusting sulphur 35-40 kg/ha
b. Growing resistant varieties like lerma roja, safed lerma, sonalika and choti lerma

Loose smut :

a. Solar energy treatment : Soaking of seeds in water for four hours in the forenoon followed by drying for four hours in the sun.
b. Growing resistant varieties, Kalyan 227, C 302 etc.

2.1 INTEXT QUESTIONS

1. Which is the fungal disease of rice?
   i. Rice blast
   ii. Bacterial blight
   iii. Rice tungro
2. Spraying ediphenphos is recommended for rice ———— disease control
3. Tungro disease is spread by————————.
4. Spindle-shaped lesions are the characteristic of———— disease
5. The important symptom of wheat ———— disease is that the earhead becomes a black powdery mass.
6. Three major types of wheat rusts are ————, ———— ————, and ————.

2.2. Diseases of millets

2.2.1. Diseases of maize

Downy mildew of maize (*Peronosclerospora sorghi*) is characterized by a downy growth (spore bearing structures emerging out of the stomata like young feathers of a chicken) on leaves. The disease is

spread mainly by oospores produced by the fungus and the secondary spread by air borne conidia.

Leaf blight of maize (*Helminthosporium maylis*) causes long elliptical necrotic lesions with straw coloured centres and brown margins. The fungus spreads through spores.

Charcoal rot (*Macrophomina phaseolina*) infects stalk and produces dark black spots and later black sclerotia which are scattered over the surface of the stalk which gets shredded.

Management of maize diseases :

Foliar spray of Metalaxyl + Mancozeb combi 2 kg/ha on 20th day after sowing and resistant varieties like Co.1, Co. H1 and Co.H2 are recommended for downy mildew.

Foliar spray of mancozeb @ 1.25 kg/ha is recommended for blight disease control and irrigation at the time of earhead emergence is advised to prevent charcoal rot.

2.2.3. Diseases of sorghum

Downy mildew (*Peronosclerospora sorghi*), smuts and sugary disease (*Sphacelia sorghi*) are important diseases of sorghum.

Symptoms of downy mildew in sorghum are essentially same as that of maize downy mildew. Occasionally green ear symptoms (transformation of earhead into leafy structure) may be found.

Several smut diseases affect sorghum. Grain smut (*Sphacelotheca sorghi*) converts many developing grains into sacs containing smut spores. Loose smut (*Sphacelotheca cruenta*) besides forming smutted grains gives the earhead a loosely packed appearance. Long smut (*Tolyposporium ehrenbergii*) affects a few of the grains which look longer than unaffected grains. Head smut (*Sphacelotheca reiliana*) transforms entire earhead into a single smut spore bearing sac.

Sugary disease of sorghum is characterized by formation of honey dew which oozes out of the infected spikelet.

Downy mildew spreads by oospores (soil-borne) and conidia (air-borne). Sugary disease is spread by sclerotia (resting spores of the fungus) and insects which carry the honey dew. Smuts and mostly seed borne.

Management of sorghum diseases

Growing Co25 or Co26 which are resistant to downy mildew are recommended. Foliar spray of metalaxyl + mancozeb 2 kg/ha 20

days after sowing is also advisable. For management of smuts seed treatment using thiram @ 4 gm/kg seed is recommended. Sugary disease can be minimized by adjusting the sowing time so that the crop does not flower during October when high humidity prevails.

2.2.3. Diseases of ragi

Ragi is affected by two important diseases. Ragi blast (*Pyricularia grisea*) produces typical spindle shaped lesions which appear on leaves, nodes, neck and fingers of the earhead. Infected fingers do not produce any grains.

Mottle streak of ragi is caused by a virus. The affected plants are pale green and stunted. Chlorotic streaks are formed on leaves. Early infection causes loss of grain yield. The virus is spread by leaf hoppers *Cicadulina bipunctella*.

Management of ragi diseases :

Growing Co 10, Co 11, Co 12 and Co13 is recommended for ragi blast. Kitazin @ 500 ml/ha may be sprayed as a prophylactic spray.

Foliar sprays of monocrotophos (500 ml/ha) is recommended to control the vectors of mottle streak virus.

2.2.4. Diseases of bajra

Downy mildew of pearl millet (*Sclerospora graminicola*) causes typical mildew symptoms as in maize and sorghum. The affected plants are stunted and fail to form earheads. Even if formed, the earhead is converted to green leafy structures which give the appearance of a green ear (Fig. 6.5.5). This fungus develops systemically.

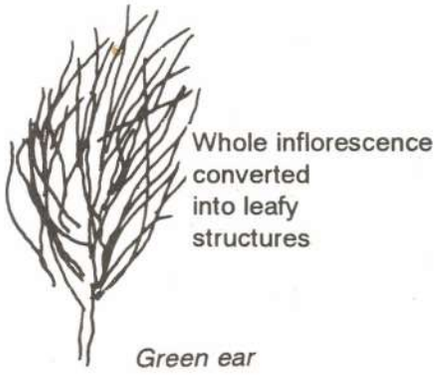


Fig. 6.5.5

Ergot (*Claviceps fusiformis*) disease induces sugary ooze which is formed on spikelets. The honey dew trickles down from the affected earhead.

Rust (*Puccinia penniseti*) forms minute pustules which expose rust spores on leaves. Affected leaves dry up.

Smut (*Tolyposporium penicilliariae*) infects a few grains which are replaced by oval shaped spore containing sacs.

Management of bajra diseases :

Resistant varieties such as X5, WCC 75 and Co7 composites and seed treatment with metalaxyl @ 6 g/kg of seeds are recommended for downy mildew control. Adjusting of sowing time is highly helpful for preventing ergot disease. Mancozeb @ 1.25 kg/ha spray is recommended for rust control.

2.2 INTEXT QUESTIONS

1. Maize downy mildew can be identified by
   a. Leafspotting
   b. Downy growth of the fungus on leaves
   c. Black discoloration
   d. dark black specks on stalk
2. Foliar spray of mancozeb is recommended for the control of
   a. Downy mildew of maize
   b. Charcoal rot of maize
   c. Leaf blight of maize
3. Peronosclerospora sorghi is the causal agent of maize _____ disease.
4. Smut diseases affecting sorghum are _____, _____, _____, and _____.
5. The sorghum varieties _____ and _____ are resistant to downy mildew disease.
6. Green ear symptom is characteristic of bajra
   a. smut disease
   b. ergot disease
   c. downy mildew
7. Ragi mottle streak is a
   a. viral disease
   b. bacterial disease
   c. fungal disease

2.3. Diseases of pulses

2.3.1. Diseases of pigeonpea

Wilt of redgram (*Fusarium oxysporum f.sp. udum*) affects young plants which show symptoms of water starvation. Leaves droop and vascular discoloration is seen.

Powdery mildew (*Leveillula taurica*) infects leaves. White patchy growth of the fungus appear on both the sides of leaves.

Sterility mosaic is a virus disease which induces a typical mosaic symptoms on leaves. Affected plant never produce pods. The virus is transmitted by a mite called *Aceria cajani*.

Management of redgram diseases

Heavy doses of green leaf manures to encourage activity of antagonists and seed pelleting using *Trichoderma viride*, the antagonist fungus are recommended for wilt control. For powdery mildew carbendazim 500 g/ha can be sprayed. The varieties, NPRR1 and VR3 are recommended for avoiding sterility mosaic.

2.3.2. Diseases of chickpea

Root rot and wilt complex : (*Rhizoctonia solani, Fusarium oxysporum f.sp. ciceri*): The affected chickpea seedlings gradually turn yellowish and show typical wilt symptoms. Distinct brown lesions are seen on the stem at the collar region. Stem and roots below collar region become rottened.

Rust of chickpea is caused by *Uromyces ciceris arietini*. Yellow to brown spots with typical rust spore bearing structures are seen on leaves. The disease spreads by airborne rust spores.

Management :

Seed treatment with carbendazim (2g/kg) or seed pelleting with *Trichoderma viride* is recommended for wilt complex. For rust control, spraying wettable sulphur (1 kg/ha) is advised.

2.3.3. Diseases of greengram and blackgram

Powdery mildew (*Erysiphe polygoni*) forms whitish powdery growth on leaves which leads to leaf drop.

Root rot (*Macrophomina phaseolina*) causes death of plants. Dark brown lesions are seen on the stem at ground level. Bark at collar region looks shredded. Minute sclerotial bodies are seen on the lesions.

Leaf crinkle of both the crops is caused by a virus which is transmitted by white flies (*Bemisia tabaci*). Tips of crinkled leaves curl downwards and the petioles become shortened. Inflorescence is bushy with small sized flowers. The plants look green even in senescence.

Management :

Growing powdery mildew resistant blackgram variety LBG 17 is recommended. Two sprays of carbendazim 500 g/ha at 15 day interval after the first appearance of powdery mildew are advised. Foliar spraying of monocrotophos 500 ml/ha is advised for management of leaf crinkle.

2.3 INTEXT QUESTIONS

1. Sterility mosaic is a viral disease of
   a. redgram
   b. greengram
   c. blackgram
   d. none of the above
2. Trichoderma viride is recommended for redgram
   a. powdery mildew control
   b. sterility mosaic control
   c. wilt control
3. Rootrot and wilt complex is an important disease of
   a. blackgram
   b. greengram
   c. chickpea
4. NPRR1 and VR3 redgram varieties are resistant to ———

2.4. Diseases of oilseeds

2.4.1. Diseases of groundnut

Leaf spots and rust (*Cercospora arachidicola*) and *Phaeoisariopsis personata*; *Puccinia arachidis*) are important foliar diseases. Leaf spots form dark brown circular lesions which cause drooping of leaves. Rust is characterized by formation of pustules erupting from the underside of the leaves which expose the rust spores. Both the types of diseases spread by air borne spores.

Seedling rots : This diseases appear in two phases. Preemergence rot causes failure of seed germination. Post-emergence rot causes collar rot of just emerged seedlings. Infected portions become soft

with profuse growth of the pathogens, *Aspergillus niger* and *A. pulverulentum*.

Root rot (*Macrophomina phaseolina*) induces typical symptoms of disintegration of root system.

Bud necrosis of groundnut is caused by tomato spotted wilt virus (TSWV) which is spread by thrips (*Frankliniella sp.*). First symptoms appear as ring spots on leaves. Leaves show various patterns of mottling. Necrotic spots also develop resulting in dropping of leaves. In severe cases, buds are killed.

Management :

For managing leaf spot and rust chlorothalonil at 1 kg/ha is recommended. ALR-1 a moderately resistant groundnut variety can be grown. Seedling rots and root rot can be avoided by seed treatment using carbendazim 2g/kg. Bud necrosis can be managed by adopting a spacing of 15 x 15 cm, spraying monocrotophos 500 ml/ha and by spraying antiviral principles from coconut or sorghum (10%)

2.4.2. Diseases of sesamum

Powdery mildew (*Oidium acanthospermi*) induces white powdery patches on leaves. Leaves dry up soon.

Phyllody of sesamum is caused by an MLO which is transmitted by leaf hoppers (*Orosius albicinctus*). The flowers are completely replaced by green leafy structures which form a cluster of malformed floral parts at the tip of the plant. (Fig. 6.5.4)

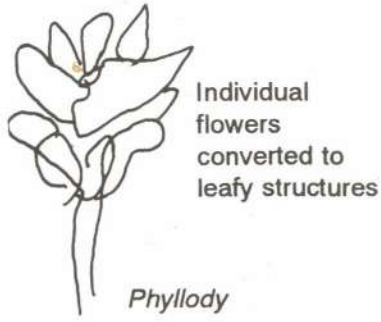


Fig. 6.5.4

Management :

Dusting sulphur 25 kg/ha can control powdery mildew and foliar spray of monocrotophos 500 ml/ha can bring down phyllody vector population.

2.4.3. Diseases of sunflower

Leaf blight (*Alternaria helianthi*) manifests as dark brown circular spots with concentric rings and yellow haloes. Spots enlarge in size and the leaves dry up.

Rust (*Puccinia helianthi*) induces typical rust pustules on the lower surface of leaves. Affected leaves turn yellow and dry up.

Head rot (*Rhizopus spp.*): Irregular water soaked spots appear at the lower surface of the head near the stalk end. Spots became soft and heads droop down.

Management

For all the diseases spraying mancozeb 1 kg/ha along with seed treatment using carbendazim @ 2g/kg. Caterpillars attacking the heads are to be hand picked and destroyed to reduce head rot incidence.

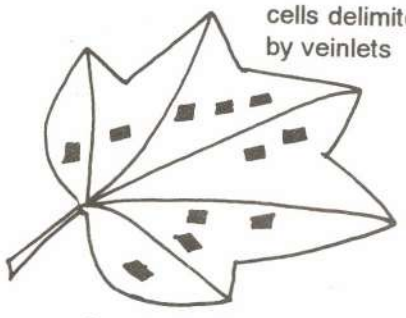
2.4 INTEXT QUESTIONS

1. ———————— and ———————— are important foliar diseases of groundnut
2. Bud necrosis of groundnut is a
   a. fungal disease
   b. viral disease
   c. bacterial disease
   d. none of the above
3. ———————— of sesamum is a mycoplasmal disease.
4. Leaf blight of sunflower is caused by ————————.
5. Dusting sulphur is recommended for sesamum ———— ——— disease control.

2.5. Diseases of cash crops

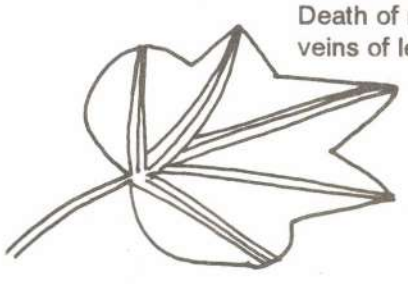
2.5.1. Cotton

Bacterial blight (*Xanthomonas campestris* pv. *malvacearum*) of cotton is the most important disease on cotton. It induces water soaked lesions on cotyledons (seedling infection) lesions delimited by leaf veins (angular leaf spots) (Fig. 6.4.5), necrosis of the major leaf veins



Angular leaf spot

Fig. 6.4.5



Veinblight

Fig. 6.4.6

(vein blight), darkening of the stem which gets necrosed (black arm) and rotting boll. (Fig. 6.4.6)

Areolate mildew *(Ramularia areola)* induces irregular pale patches on the upper surfaces with corresponding frosty white to grey mildew growth on the lower surfaces of leaves.

Leaf blight (*Alternaria macrospora*) : Typical brown leaf spots with concentric rings appear to cause premature defoliation.

Management :

Seed treatment by soaking seeds over night with streptomycin 1000 ppm and foliar spray of 500 ppm of the same chemical are recommended for bacterial blight control. Growing Suvin, Sujatha and Varalaxmi is advised to reduce areolate mildew incidence. Mancozeb at 2 kg/ha four times can be sprayed for leaf blight control.

Whipsmut

Fig. 6.3.4

2.5.2. Diseases of sugarcane

Red rot (*Colletotrichum falcatum*) : Internodes of split-up stalk present reddening of internal tissues. Rinds shrink longitudinally and fruiting bodies appear on the rind. Red spots also appear on the mid rib of leaves.

Smut (*Ustilago scitaminea*) : The central core of the meristem becomes transformed into a black whip like structure. The whip is covered by a thin white papery membrane which ruptures to release smut spores. (Fig. 6.3.4)

Sett rot (*Ceratocystis paradoxa*) planted setts develop a reddish colour which later develop into cavities emitting a typical pineapple odour.

Mosaic is caused by a virus which is transmitted by aphids, *Rhophalosiphum maidis*. The symptoms include chlorotic stripes alternating with normal green portions of leaf.

Grassy shoot of sugarcane is caused by an MLO. Diseased plants look pale with numerous lanky tillers which gives a grassy appearance. Plants look stunted.

Management of sugarcane diseases :

Growing red rot resistant varieties like CoC 62198, Co 7704 and CoC 8001 is recommended along with treatment by soaking in 0.05% carbendazim solution for 15 minutes. Smut resistant varieties like Co 7704 can be grown along with sanitary measures like removal of smutted clumps in the field. Hot water treatment of setts for 2 hours

at 50ºC or aerated steam treatment at 50ºC for one hour is advised for grassy shoot and mosaic control.

2.5.3. Diseases of tobacco

Damping off (*Pythium aphanidermatum*) of tobacco nursery cause both pre emergence and post emergence mortality of young seedlings.

Powdery mildew (*Erysiphe cichorocearum*) typical powdery mildew patches appear on leaves. Affected leaves become scorched.

Tobacco mosaic is caused by a virus. Infection starts as light discoloration along the veins which turns into alternating patches of dark and light green areas of leaf. The virus is highly contagious.

Orobanche parasite (*O. cernua var. desertorum*) It is a fleshy flowering plant lacking chlorophyll. The total root parasite depending fully on tobacco roots for its food requirement. Even about 50 shoots emerge from one tobacco base in cases of severe infestations.

Management :

Foliar spray of copper oxychloride 2 g/l one litre per one square metre nursery area is advised to keep damping off down. Excessive watering to nursery area is to be avoided. Application of sulphur 40 kg/ha in soil (not on plants) will control powdery mildew. Mosaic resistant varieties, TMVRR-2 and TMVRR-3 can be grown. Application of kerosene 5 drops per shoot of *Orobanche* will kill the weed.

2.5 INTEXT QUESTIONS

1. Black arm and vein blight are the important symptoms of cotton ———————— disease.
2. Streptomycin seed-soaking is recommended for cotton ———— disease control
3. Internodes of sugarcane get split-up when infected by ———— pathogen.
4. Growing tip of sugarcane becomes black whip-like structure in
   a. red rot
   b. Smut
   c. sett rot

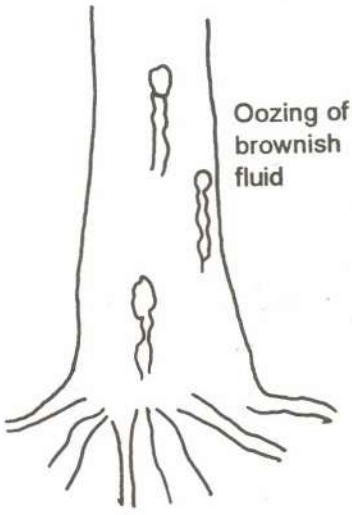
5. Mosaic of sugarcane is spread by ———— and grassy shoot by————————.
6. Coc 62198 is resistant to sugarcane ———— disease.
7. ———————— is an important viral disease of tobacco.
8. ———————— is a fleshy flowering plant parasitizing tobacco.

2.6. Diseases of Plantation Crops

2.6.1. Diseases of coconut

Bud rot (*Phytophthora palmivora*) causes paling of central shoot and the young leaf gets rottened. The rotting progresses downward to affect more leaves. The palm becomes defoliated within months.

Thanjavur wilt (*Ganoderma lucidum*): Wilting of trees is accompanied by stem bleeding (oozing of a reddish brown fluid) at the lower trunk. Bleeding extends upwards in patches. (Fig. 6.3.6) In advanced stage, fan like fructifications (semi circular in shape) of the fungus emerge out of the basal trunk.



Stem bleeding

Fig. 6.3.6

Grey leaf blight (*Pestalotia palmarum*) : Minute brown spots appear on lower leaves which enlarge to form greyish centre with yellow haloes. Numerous black pycnidia appear within lesion.

Pencil point disorder is caused by micronutrient deficiency. Gradual reduction of number of leaves newly formed coupled with general yellowing of leaves are main symptoms. The stem tapers towards the tip which bears a small crown of leaves.

Management :

Removal of rotten tissues and application of Bordeaux mixture (1%) as prophylactic spray before the onset of monsoon are recommended for bud rot control. For managing Thanjavur wilt, application of 5 kg of neem cake along with copious green manure, soil drenching of Bordeaux mixture (1%) 40 litres thrice at quarterly interval and stem infection or root feeding of aureofungin sol 2g + 1g copper sulphate in 100 ml of water. Foliar spray of copper oxychloride 3g/l is recommended for leaf spot control. Application of micronutrients borax, zinc sulphate, manganese sulphate, ferrous sulphate, copper sulphate each at 225 g along with ammonium molybdenum 10 g/10 litre of water around root zone while applying fertilizers is recommended for pencil point disorder.

2.6.2. Diseases of arecanut

Mahali disease or Koleroga disease (*Phytophthora arecae*). The disease is common in heavy rainfall areas. Rotting of immature nuts is followed by excessive shedding. Affected nuts become hallowed inside.

Foot rot or Anabe roga (*Ganoderma lucidum*) : Dark coloured liquid oozing from the base of the stem is the main symptom. When cut open central core of the trunk emits a bad odour due to invasion of the fungus into conducting vessels. The palm dries off.

Bordeaux mixture (1%) is recommended as foliar spray for Mahali disease control and soil drench for foot rot control.

2.6.3. Diseases of coffee

Leaf rust (*Hemileia vastatrix*) : Brightly coloured yellowish spots appear on young leaves which cause heavy leaf shedding subsequently. Because of defoliation berries remain underdeveloped.

Anthracnose (*Glomerella cingulata*) : Greyish spots appear on leaves twigs and berries resulting in blackened twigs. The plant begins to die from tip downwards.

Bordeaux mixture (0.5 per cent) as blossom spray pre-monsoon spray, mid monsoon spray and post monsoon spray will be helpful in managing coffee diseases.

2.6.4. Diseases of tea

Blister blight (*Exobasidium vexans*) : Yellowish translucent spots on the tender leaf appear and they subsequently become deep red shiny blisters which are bulged on their under surface. Leaves become curled and distorted. The attack kills young shoots and buds.

Charcoal stump rot (*Ustulina zonata*) : This is the commonest of all the root diseases of tea. Effused charcoal like adherent fructifications are formed at the collar region. If the bark is removed white fan-shaped patches of mycelia are seen on wood.

Spraying copper oxychloride 20 g + 210 g Nickel chloride at 5 days interval during June - September and 10 days interval during October - November is economical for blister blight control.

Soil fumigation with Vapam is recommended for stump rot control.

2.6.5. Diseases of rubber

Secondary leaf fall (*Phytophthora meadii*) : Rubber being a deciduous crop, normal leaf fall occurs in December while the leaf fall caused by the pathogen occurs in June - August. In addition, the branches show die-back symptoms. Affected fruits begin to rot while latex yield is reduced very much.

Powdery mildew (*Oidium heveae*) exhibits typical whitish powdery growth on leaves which turn purplish black or bluish.

Bordeaux mixture (1%) spray is advised for secondary leaf fall control and carbendazim (1 g/l) is advised for powdery mildew management.

2.6.6. Diseases of cardamom

Katte disease of cardamom is caused by a virus. The disease is characterized by spindle shaped chlorotic flecks which appear on youngest leaves. Mosaic symptoms are also frequently mixed.

Capsule rot (*Phytophthora meadii*) : Water soaked lesions appear on the capsule which turn from green to dull brown. The infected capsules emit a foul smell and drop off the rachis.

Destruction of infected clump is recommended for managing katte disease and capsule rot. Bordeaux mixture (1%) drenching will help reduce capsule rot incidence.

2.6.7. Diseases of pepper

Quick wilt (*Phytophthora capsici*) : A deep-seated dark patch appears at the collar region and spreads to one foot from the base both ways. Leaves turn yellow, become flaccid and droop. The vine dies off in 3 to 4 weeks.

Pollu disease : (Colletotrichum gloeosporioides) : Water soaked, brownish, sunken spots appear on the berries. Berries when split open show depletion of inner contents. Berries also exhibit cracking within the lesions.

Bordeaux mixture (1%) drenching is recommended for quick wilt control while pollu disease can be managed using the same compound as foliar spray.

2.6.8. Diseases of turmeric

Leaf spot (*Colletotrichum capsici*) : The spots are elliptic to oblong with greyish white centre which has black minutes dots.

Leaf blotch *(Taphrina maculans)* : The leaf spots appear on both the surfaces of the leaves. The lesions are dirty yellow in colour and turn brownish with chlorotic halo. The lesions coalesce to form necrotic blotches. The leaves dry off.

Prophylactic sprays of Bordeaux mixture (1%) will control both the diseases of turmeric.

2.6.9. Diseases of tapioca

Tapioca mosaic is caused by a virus. Typical mosaic symptoms with alternated chlorotic and dark green patches appear. The leaves are reduced in size, twisted and puckered. The diseased plants are stunted. Tuber size is reduced very much and they may develop cracks. The virus is transmitted by a whitefly, *Bemisia tabaci* and through diseased setts.

Planting setts from healthy plants, use of resistant varieties like Co2 are recommended for tapioca mosaic management.

2.6 INTEXT QUESTIONS

1. Rotting of central shoot occurs in the case of ———— — disease of coconut.
2. Oozing of a reddish brown fluid is characteristic of ———— —— disease of coconut.
3. ———————— disorder in coconut is due to micronutrient deficiency
4. Aureofungin Sol is recommended for ———— disease control in coconut.
5. ———— disease of arecanut causes excessive shedding of immature nuts.
6. Bright yellowish spots on leaf are characteristic of ———— ——— disease of coffee.
7. ———————— disease of tea causes death of young shoots and buds.
8. Secondary leaf fall of rubber is a ———— disease and occurs during June-August.
9. Foul-smelling capsules with water soaked lesions are the important symptom of ———— disease of cardamom.

10. ———————— disease of pepper causes cracking and depletion of inner contents of developing berries.
11. ———————— disease of tapioca is spread by ———————— ————————.

2.7.1. Diseases of banana

Panama wilt : This disease is caused by a fungus *Fusarium oxysporum f. sp. cubense*. This is a soil borne fungus. The symptoms of this disease include 1) yellowing of the lowermost leaves of the plant which extends upward slowly. 2) Only the heart leaf remains green, 3) The leaves break near the base and hang down around the pseudostem, 4) Longitudinal splitting of the pseudostem, 5) Discoloration of the conducting vessels and 6) Reddish brown radiating mycelial strands are seen in the affected corm when cut open.

How does the pathogen survive ? It survives as chlamydospores for longer period in soil. It also spreads through irrigation water. Continuous cultivation of banana also results in build up of the inoculum.

How to manage the disease ? 1. We can select varieties which are resistant to the disease. Variety Poovan shows resistance to a certain degree while Rasthali and Monthan are highly susceptible. So they should not be planted in endemic areas.

2. Corm application of carbendazim in capsule @ 40 mg/capsule/tree. The capsule is applied into the corm by making a hole at 45 angle at 10 cm depth.

3. To reduce the pathogen population, it is advisable to raise paddy in rotation with banana, as stagnant water necessary for rice growing kills the pathogen.

Sigatoka leaf spot : This disease is caused by another fungus called *Cercospora musae*.

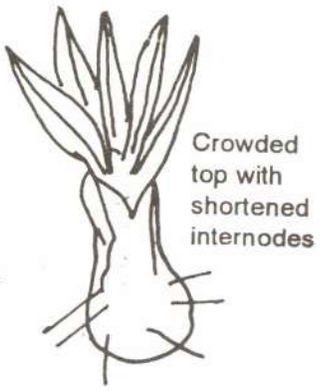
The disease appears as long yellowish spots on the leaves. The spots are usually surrounded by yellow halo. Several spots coalesce to cause drying of leaves.

How does the fungus survive ?

The fungus survives in the infected banana leaves and the spores of the fungus are flown by air-currents.

How to manage the disease ?

Sigatoka disease can be better managed by removal of the affected



Bunchy-top

Fig. 6.1.3

leaves from the infected banana plant and destroying them properly. Immediately after that spraying of copper oxychloride 2 g/litre of spray fluid carbendazim at 1 g/l along with liquid soap at 1 ml/l.

Bunchy top disease :

How to identify bunchy top diseased plant?

The infected banana plant looks extremely stunted. The size of the leaves is reduced and the leaves are brittle. Many leaves are crowded at the top because of the shortening of internodes and the plant has a bunchy appearance. If the petiole is carefully observed, we can see dark broken bands or green streaks could be seen. Usually the plant becomes sterile. The disease is caused by a virus called bunchy top virus. (Fig. 6.1.3)

The infection is mainly by planting infected suckers while it spreads to healthy suckers by an aphid vector called *Pentalonia nigronervosa*.

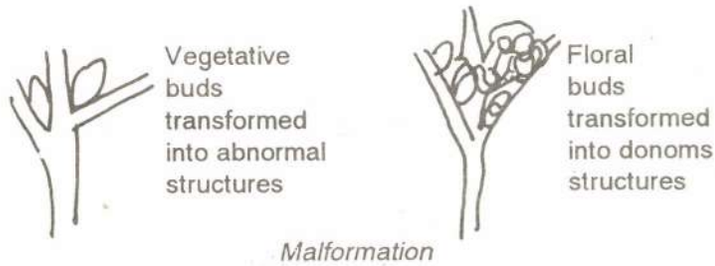
How to manage the disease ?

It is always advisable to destroy the infected suckers as soon as the symptoms are apparent using 2,4-D (4 ml of a 12.5% solution). Selecting disease free suckers for subsequent plantings is essential. Insect vector can be checked by spraying dimethoate 500 ml/ha.

2.7.2. Diseases of mango

Symptoms of anthracnose (*Colletotrichum gloeosporioides*) include leaf spotting, blossom blight, blighting of twigs and fruit rotting. Spots appear on fruits when they are of marble size at the stem end and enlarge to blacken the developing fruit.

Malformation (*Fusarium moniliforme var. subglutinans*) : Floral malformation includes transformation of flowering panicles in to compact bunch of hard flowers. The inflorescence become enlarged in size. Vegetative malformation is characterized by formation of bunchy leaves which dry up in black masses. (Fig. 6.1.5)



Malformation

Fig 6.1.5

Blacktip (Physiological disorder) : This disease occurs in orchards in close proximity to brick kilns. Small blackened area appears at the distal end of the fruit which spreads to cover the tip completely.

Management :

Spraying carbendazim 1 g/l at fortnight interval until harvest may reduce anthracnose and malformation. Locating brick kilns away from orchards will avoid black tip disorder.

2.7.3. Diseases of grapes

Downy mildew (*Plasmopara viticola*) : Irregular yellowish spots appear on the upper surfaces of the leaves. On corresponding lower surface, dull white-coloured powdery growth of the fungus appear. Berries when invaded by the fungus becomes leathery and shrivelled.

Powdery mildew (*Uncinula necator*) powdery growth appears mostly on the surface of the leaves. Floral infection results in shedding of flowers and poor fruit set. Infected berries crack.

Birds' eyespot

Fig. 6.6.2

Bird's eye spot : (*Gloeosporium ampelophagum*) : Leaf spots produce shot holes. On berries the fungus produce sunken spots with ashy grey centre and dark margin resembling eye of a bird. Severe infection results in mummification and shedding of fruits. (Fig. 6.6.2)

Spraying Bordeaux mixture (1%) is recommended to manage grapevine foliar diseases. Karathane (0.07%) spray is specific for powdery mildew control.

2.7.4. Diseases of citrus

Canker (*Xanthomonas campestris pv citri*) affects mainly acid lime, lemon and grapefruit. Lesions on leaves are typically circular, raised and rough to touch and are usually with yellow halo. The cankerous spots on fruits reduce market value. Injury caused by leaf miner and thorns helps the spread of the disease.

Tristeza or quick decline of citrus is caused by a virus. Acid lime is the most susceptible crop. The disease is characterized by appearance of symptoms of root decay and die back. Fine pitting of the affected stem is visible. Vein flecks are seen on leaves. The tree becomes stunted and dies off.

Management :

Removal of affected twigs and spraying of the crop with streptomycin sulphate 500-1000 ppm at fortnight intervals are recommended for

canker control. Pre-immunized acid lime seedlings are available for tristeza management.

2.7.5. Diseases of apple

Apple scab (*Venturia inaequalis*) produced large brown olivaceous spots on lower surface of leaves which become velvety. Fruit lesions are black and corky with white haloes and often cracks develop within the lesions. (Fig. 6.6.1)

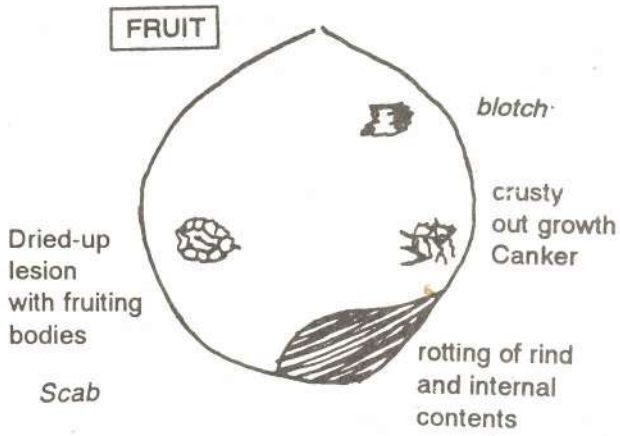


Fig. 6.6.1

Powdery mildew (*Podosphera leucotricha*) induces white greyish powdery growth on the lower surface of leaves. Leaf becomes distorted and brittle.

Management :

Five sprays of captafol (2g/l) or mancozeb (4g/l) at silver tip, pink bud, petal ball stages and 10 days after and 15 days after the fruit set are recommended for scab control. Spraying Karathane 1 g/l is recommended for powdery mildew control.

2.7.6. Diseases of papaya

Foot or stem rot (*Pythium aphanidermatum*) manifests itself as water soaked lesions near the base level. Affected tissue becomes black. Terminal leaves droop and fruits, if any, drop away. The pathogen also cause death in nursery.

Leaf curl of papaya is caused by a virus. Symptoms include curling, crinkling and distortion of leaves. Leaves give an inverted crop appearance due to downward rolling of leaf margin. Affected plants never bear fruits.

Management :

Drenching soil with 1% Bordeaux mixture is advised for foot rot control and spraying dimethoate (0.1%) is recommended for leaf curl vector control.

2.7. INTEXT QUESTIONS

1. ———————— disease of banana causes longitudinal splitting of pseudostem
2. Corm injection of carbendazim is recommended for the control of banana ———————— disease.
3. Shortening of internodes with crowding of leaves at the top is characteristic of banana ———————— disease.
4. ———————— on citrus fruits reduces market value
5. Tristeza disease of citrus causes pitting of ———————— and die-back.
6. In mango ————————, the inflorescence gets hypertrophied.
7. Black tip of mango is a ———————— disorder.
8. ———————— mildew and ———————— mildew are the important foliar diseases of grapevine.
9. ———————— of apple causes olivaceous brown spots on leaves and black lesions on fruits.
10. Leafcurl of papaya is a
    a. fungal disease
    b. viral disease
    c. mycoplasmal disease.

2.8.1 Diseases of tomato

Damping off (*Pythium spp.*): Poor germination and toppling of seedlings are collectively called damping off. Large patches of seedling die in the nursery.

Tomato spotted wilt is caused by a virus. Plants are stunted with leaves reduced in size. Numerous necrotic lesions are seen on the compound leaves which show browning also. Concentric rings

appear on fruits. The plants show wilting symptoms. The virus is thrips - transmitted.

Spraying copper oxychloride or zineb (2g/l) is recommended for damping off management, while spotted wilt can be controlled using dimethoate as a vector control measure.

2.8.2. Diseases of brinjal

Alternaria leaf spot *(Alternaria melangenae)*. The fungus produces typical lesions with concentric rings. Extensive necrosis may defoliate the plant.

Phomopsis blight and fruit rot : (*Phomopsis vexans*) : In leaves the pathogen induces circular grey to brown spots with light coloured centre. The affected leaves turn yellow and withers off. When the stem base is affected, bark peels off and the plant topples down. When fruits are infected, sunken spots develop and the internal contents get decayed.

Veinclearing

Fig. 6.4.15

Spraying captan (0.2%) will help manage both the diseases of brinjal.

2.8.3. Diseases of bhendi (Lady Finger)

Yellow vein mosaic of bhendi is caused by a virus. All the leaf veins turn yellow with the interveinal areas remaining green. Infected leaf looks like a network of veins. At later stages, entire leaf turns yellow in colour. Fruit size is reduce and malformed. The virus is spread by *Bemisia tabaci*, a white fly. (Fig. 6.4.15)

Powdery mildew (*Erysiphe cichorocearum*) Typical whitish powdery growth is seen on the leaves. In severe cases of infection the leaves dry off.

Co3, a moderately resistant bhendi variety can be grown to reduce losses due to yellow vein while dinocap (Karathane) (0.07%) spray is recommended for powdery mildew control.

2.8.4. Diseases of potato

Late blight (*Phytophthora infestans*) is the most serious disease of potato. Water soaked spots appear on leaves which turn black in due course. Stem infection is seen frequently at nodes. Stems break at these point and plant topples over. Tubers are also affected. They rot before harvest.

Bacterial wilt : (*Pseudomonas solanocearum*): Affected plants wilt at the tuber formation stage. Some times wilting may be restricted to

one branch. The wilting plants recover in the morning only to wilt in the afternoon. Slimy masses ooze out of cut stems. When cut tubers show typical circular browning. Affected tubers rot at harvest.

Common scab, (*Streptomyces scabies*): The affected tubers show small reddish spots which develop into lesions. The lesions are corky and may develop star shaped cracks. The bacterium survives in affected tubers.

Prophylactic sprays of mancozeb (2 g/l) at 10 days interval are recommended along with growing resistant Kufri Jyothi, or Kufri Badshah for late blight management. Disease free seed tubers and phytosanitation measures are advised for bacterial wilt. Irrigation to field capacity during tuber formation is helpful in reducing scab incidence.

2.8.5. Diseases of cauliflower and cabbage

Club root (*Plasmodiophora brassicae*) is characterized by formation of abnormally enlarged roots due to enormous cell division and cell enlargements. Wilting of plants occur due to the decay of the roots.

Head rot: (*Sclerotinia sclerotiorum*). The fungus invades the central core inducing soft cortical rot and producing white cottony mycelia and brownish sclerotia. The affected heads collapse.

Management :

Crop sanitation is advised for both the diseases. Spot drenching of carbendazim 1 g/l will reduce further spread. Seed treatment with carbendazim 2g/kg is advised for club root control.

2.8.6. Diseases of beans

Anthracnose : (*Glomerella lindemuthianum*): Black spots seen on leaves, stem and pods. Black sunken lesions appear on pods. The central portion of the lesions shows pinkish colour. The lesions reduce the market value of the produce besides causing total germination failure of the seeds.

Rust : *Uromyces phaseoli*. Reddish brown pustules are seen on the lower surface of the leaves. The leaves turn yellow and wither away.

Bean common mosaic is caused by a virus. The leaf becomes chlorotic and smaller in size. Downward curling and yellow mosaic are the commonest symptoms on leaves. Aphids spread the disease.

Foliar sprays of mancozeb (2g/l) will help reduce anthracnose and rust while that of monocrotophos 500 ml/ha will reduce the vector population to bring down mosaic incidence.

2.8.7. Diseases of beet root

Cercospora leaf spot (*Cercospora beticola*) : Lower leaves near ground are attacked first. The spots are small, ash coloured with deep violet borders. Affected leaves wrinkle and dry.

Foliar sprays with mancozeb (2g/l) at 15 days interval will reduce foliar diseases of beet root.

2.8.8. Diseases of chillies

Fruit rot and die back : *Colletotrichum capsici* : Due to infection of pedicels and tips of branches, flowers begin to shed off. Die back is the commonest symptom. Ripe fruits are more susceptible. Water soaked leaf spots appear on the skin of the fruits. Such fruits become white and lose their pungency. Dot like fructification appear on the drying fruits.

Seed treatment with thiram 4g/kg and spraying mancozeb (2g/l) will reduce fruit rot attack in the main field.

2.8 INTEXT QUESTIONS

1. ———— disease of tomato causes necrotic lesions on leaves and concentric rings on fruits.
2. ———— causes death of tomato seedlings in nursery.
3. Interveinal greening with yellow coloured veins are the characteristic of ———— disease of bhendi.
4. ———— is the most serious disease of potato causing rotting of tubers.
5. Oozing of slimy masses from tubers is an important symptom of ———— disease affecting potato.
6. ———— causes dot-like fructifications on chilli fruits.
7. Abnormally enlarged roots are formed in cabbage following infection by————.
8. Aphids spread ———— viral disease of bean.

2.9. Diseases of other horticultural crops

2.9.1. Diseases of rose

Black spot (*Diplocarpon rosae*): Circular black spots with a very irregular thread like border on the leaves, stems and flowers. Spraying captan 0.2% along with destruction of fallen leaves reduces the incidence.

2.9.2. Diseases of crossandra

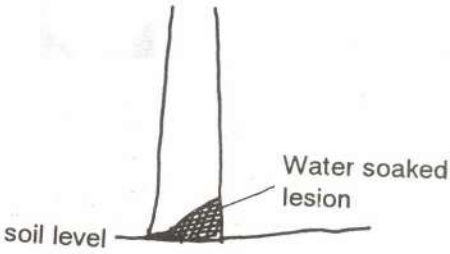
Wilt complex : (*Fusarium solani* and the nematode, *Pratylenchus delateri*): Leaves become yellow colour and changes to pink at later stages. The plants wilt and leaves drop off. Application of phorate 1g/plant and soil drenching with copper oxychloride (2.5 g/l) are recommended.

2.9.3. Diseases of jasmine

Phyllody (a mycoplasmal disease) : Affected plants are bushy with smaller leaves. Flowers are transformed into green leafy structures. The disease is transmitted by Dialeurodes kirkaldii, a whitefly. Vector control with any systemic insecticide is recommended as a management practice.

2.9.4. Diseases of betelvine

Foot rot/wilt (*Phytophthora parasitica var piperina*) Circular black spots appear on leaves which eventually drop off. The foot region along with finer young roots get rottened, leaving a fishy odour. Under sever conditions the whole plant collapses. (Fig. 6.3.7)



Fot rot/collar rot

Fig. 6.3.7

Management : Application of neem cake @ 150 kg N/ha/year near the root zone along with 0.5% Bordeaux mixture drenching at monthly intervals @ 500 ml/hill is recommended.

2.9 INTEXT QUESTIONS

1. _____ of rose causes lesions with irregular thread-like border.
2. Wilt complex of crossandra is a disease caused by
   a. a fungus
   b. a nematode
   c. both of them
   d. none of them, but a viral disease.

3. _____ of jasmine induces small, green leafy structures
4. _____ of betelvine causes collapse of the whole plant.

WHAT YOU HAVE LEARNT?

- important diseases of all crop plants
- their causal agents
- how to diagnose them
- how to control them

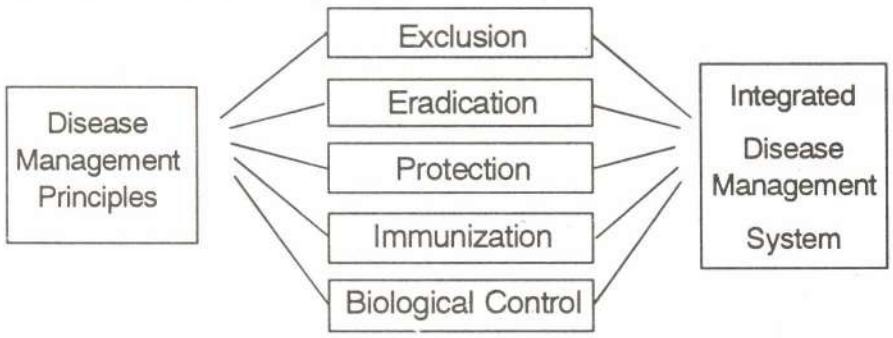
TERMINAL QUESTIONS

1. What are the major disease of rice and wheat and how will you diagnose them and manage them?
2. What are the important symptoms of groundnut diseases and how would you distinguish between them?
3. Write a detailed note of diseases of banana.
4. Write in detail about the management practices to control important diseases of vegetables.

Module 3

Management of Crop Diseases

KEY CONCEPTS



INTRODUCTION

You have learnt about the characters of the plant pathogens and the different diseases affecting various crops. In this lesson you will know about the methods of managing the crop diseases. Disease management methods vary depending on the nature of pathogen/ disease and the crop that is to be protected. Different principles of disease management are integrated to make the protection more effective.

OBJECTIVES

After reading this lesson you will be able to do the following :

i. prevent/reduce disease incidence;

ii. know the nature of chemicals and methods of application of chemicals;

iii. use of biocontrol agents;

iv. choose the effective disease management methods.

3.1. Exclusion

You should know that new pathogens and diseases should not be allowed to enter areas free from such diseases. For this purpose, Quarantine law and Diseases and Pests Acts have been formulated by Central and State Governments.

3.1.1 Plant Quarantines

Plant Quarantine stations have been established to check the seeds and other plant materials which may carry new diseases. Quarantine stations are at important sea ports and airports like Bombay, Delhi, Calcutta and Madras. Seeds and seed materials have to be accompanied by Phytosanitary certificate from the exporting country. Only disease free plant materials are permitted to enter the country.

Domestic quarantines take care to see that diseased plant materials are not taken from one part of the country to another area where the disease is absent. The spread of banana bunchy top disease could be reduced by prohibiting banana suckers from Kerala, Orissa and West Bengal. Introduction of many other diseases has been prevented imposing restrictions on the movement of plant materials from one area to another area within the country and also from one country to another country.

3.2. Eradication

A plant disease spreads from the sources of infection. The infected crop plants, and infected weeds from important sources of infection. You can reduce the spread of the disease by eliminating all sources of infection. The following methods will be useful.

a) **Surgery or removal of infected plant parts :**

The infected plants or plant parts are cut out and destroyed to remove sources of infection. Removal and destruction of affected branches or shoots is effective for the control citrus canker and grapevine anthracnose diseases.

b) **Rogueing** :

The infected plants have to be removed at early stages of crop growth, to check the spread of the disease. Banana bunchy top and other virus diseases of crops, sugarcane smut and banana wilt may be contained by destroying infected plants.

c) **Destruction of weeds :**

The weeds support the pathogens in the absence of crops. Some weeds remain symptomless although they are infected by viruses. Destruction of these weeds is necessary to reduce the sources of infection.

d) **Elimination of infected seeds and seed materials :**

Disease free seeds and seed materials, should be selected, by

removing all infected ones to have a healthy crop. This practice of careful selection will help to reduce the incidence of several diseases like redrot and smut diseases of sugarcane, banana wilt and virus diseases of asexually propagated crops.

e) Crop sanitation : Many fungal and bacterial pathogens can live on dead organic materials in the soils. All infected plant materials should be burnt and destroyed. This method is important for reducing diseases such as groundnut leaf spots, cotton bacterial blight, citrus canker and potato late blight.

3.3. Protection

Protection of plants by the application chemicals becomes necessary to reduce the pathogen population. This is achieved by treating different plant parts, seeds and soil, depending on the primary mode of disease spread. The methods of chemical application as follows:

i. Soil borne diseases :

The pathogens live in the soil and enter the plants through roots, for example root rot of pulses. The pathogens may be killed by sterilizing the soil or by applying the chemicals. Certain fungi can attack the soil borne pathogens like *Rhizoctonia* or *Fusarium*. Such fungi also can be added to the soil to reduce the diseases caused by these pathogens.

ii. Seed borne diseases :

Several pathogens are spread through infected seeds. Some are found externally on the seed surface and some are inside the seeds. Mechanical, physical and chemical methods are employed to remove the infected seeds and to protect healthy seeds. Infected seeds which are smaller and lighter, and ergot sclerotia can be removed by sieving or winnowing. Alternatively, the seeds may be immersed in 20% salt solution. Lighter infected seeds or sclerotia will float and they can be easily removed. Chemicals like sulphur, dithiocarbamates or carbendazim may be used for seed treatment to eliminate the pathogens and to protect the seeds and young seedlings against pathogens.

iii. Airborne diseases :

The spores of pathogens causing diseases like leaf spots, powdery mildews and rusts, spread through air. Several chemicals are applied using sprayers or dusters. Time of application and uniform coverage of foliage with chemicals (fungicides) are important for

successful control of these diseases.

iv. Insect-borne diseases :

The virus diseases of various crops are spread by insect vectors. By using appropriate insecticides, the spread of the virus diseases can be reduced to some extent. In addition to the application of insecticides, other preventive methods also have to be followed to manage virus diseases effectively.

3.4. Immunization

Development of cultivars resistant to diseases is the most effective method of managing the diseases. Resistance to disease is inherited by the plants from their parents. The genes responsible for disease resistance can be transferred to crop varieties. But there are several difficulties in transferring resistance genes to crops. Again a variety resistant to one disease may be susceptible to another disease or pest. Attempts are being made to get cultivars having resistance to many diseases by different breeding methods.

3.5. Biological control

Some fungi like *Trichoderma viride* and bacteria like *Bacillus* subtilis have the capacity to inhibit the growth of some pathogens or kill them. They produce substances called antibiotics which affect the pathogens. These microbes can be used for the control some pathogens like *Rhizoctonia spp* and *Fusarium* spp. These microbes are called as antagonists. They can be applied on the seeds or introduced into the soil.

3.6. Fungicides

Fungicides are the chemicals used for the management of diseases due to fungi. It is desirable to have fungicides which are :

- effective, simple and cheap
- available easily
- not toxic to plants, animals and human beings
- effective against many pathogens
- compatible with insecticides

You have to select suitable and effective fungicides with the above mentioned characteristics.

3.1 INTEXT QUESTIONS

1. Spread of which of the following diseases was reduced by domestic quarantines ?
   a) Rice blast
   b) Banana bunchy top
   c) Wheat smut
   d) Potato late blight
2. Plant surgery effectively controls
   a) Citrus canker
   b) Mango anthracnose
   c) Tomato wilt
   d) Bajra downy mildew
3. Use of disease-free seed material is important for the control of
   a) Sugarcane red rot
   b) Groundnut rust
   c) Redgram sterility mosaic
   d) Grapevine powdery mildew
4. Which is a soil-borne disease among the following
   a) Root rot of pulses
   b) Sheath rot of rice
   c) Sugarcane smut
   d) Gingelly powdery mildew

3.6.1. Classification of fungicides

The fungicides may be classified based on the chemical nature of the active ingredients.

3.6.1.1. Copper fungicides

Copper fungicides are available as spray formulations or can be easily prepared.

a) Bordeaux mixture

This fungicide is prepared using the following components :

Copper sulphate	1 kg
Lime	1 kg
Water	100 litres

Copper sulphate is dissolved in 50 litres of water in earthen or wooden or copper vessels. The lime is dissolved in another 50 litres of water in a separate vessel. After removing the unburnt stones from lime solution by filtering, the copper sulphate solution is added to the lime solution, with constant stirring. The mixture should be either neutral or slightly alkaline but not acidic. The mixture is tested by dipping a polished knife into the solution. If there is any brown deposit some more lime solution should be added to the mixture. Now, this mixture known as Bordeaux mixture, can be used for spraying on the plants.

Bordeaux paste is a concentrated forms with the same ingredients. The amount of water is reduced to 10 litres and a thick paste is prepared in the same manner as Bordeaux mixture. The Bordeaux paste is used to protect cut ends of branches and wounded plant surfaces.

b) Copper oxychloride/copper carbonate

These are called as fixed copper fungicides. They can be readily mixed with water and sprayed against leaf spot diseases. They can be used for drenching the soil against soil-borne diseases. These fungicides may be used at the rate of 2 g/litre.

3.6.1.2. Sulphur fungicides

These fungicides may be used either as dusts or sprays.

a) Sulphur dust

Finely powdered sulphur is used for seed treatment for the control of externally seed borne diseases like sorghum grain smut at the rate of 4g/kg of seeds. It can be dusted on the leaves against powdery mildew or rusts at the rate of 8-10 kg/acre.

b) Wettable sulphur

This fungicide can be used as spray fluid against powdery mildew diseases at 0.2% concentration. The fungicide should be sprayed in the cool hours to avoid phytotoxicity.

3.6.1.3. Organomercuric compounds

These chemicals are highly poisonous and they have to be handled with great care. The use of many of these compounds has been stopped because of the poisonous nature. Wet ceresan is useful for the control of soil borne diseases. It is applied at the rate of 1 g /litre of water for drenching the soil.

3.6.1.4. Non-mercurial organic compounds

These compounds are less poisonous and they are used against many diseases.

a) Dithiocarbamates :

These fungicides are sold as Dithane M45, Dithane Z 78, thiram, zineb etc. They are effective against several leaf spot diseases. Thiram can be used for seed treatment also.

b) Organic nitrogen compounds

The fungicides like Karathane, cycloheximide, and captan are effective against many diseases affecting leaves.

3.6.1.5. Miscellaneous chemicals

a) Tin compounds

These fungicides are sold as brestan and Du-ter. These fungicides are effective against potato late blight and grapes anthracnose diseases.

b) Nickel chloride

This chemical effectively controls tea blister blight disease.

c) Antibiotics

These compounds are obtained from microorganisms. They may be applied as seed dresser, foliar sprays and soil drenching substances. Some of them are effective against fungal diseases, while some are effective against bacterial or mycoplasmal diseases.

d) Chlorothalonil

This compound is effective against leaf spot and rust diseases affecting groundnut, tomato and potato.

3.6.1.6. Systemic fungicides

Some of the fungicides when applied on the seeds, leaves or soil, they are absorbed by the plants and these compounds are able to move to different plant parts internally. They protect the plants more

effectively when compared to contact fungicides.

3.6.1.6.1 Benomyl compounds

These compounds protect plants against diseases like rice blast and root diseases caused by *Fusarium spp.* or *Rhizoctonia* spp.

3.6.1.6.2. Carboxin and Oxycarboxin compounds

These compounds are effective against wheat smut, tea blister, blight and cotton blackarm diseases.

3.2. INTEXT QUESTIONS

1. Fungicides is used against
   a) Insects
   b) Viruses
   c) Fungi
   d) Mycoplasma
2. Bordeaux mixture contains
   a) Copper
   b) Zinc
   c) Iron
   d) Mercury
3. Copper oxychloride is effective against
   a) Leaf spots
   b) Wilts
   c) Powdery mildew
   d) Smut
4. Say the following are true or false
   a) Sulphur can be sprayed T/F
   b) Bordeaux mixture is available readily T/F
   c) Wet ceresan is used for drenching the soil T/F
   d) Antibiotics are produced by microorganisms T/F
   e) Wettable sulphur effectively controls sugarcane redrot T/F

5. Choose a systemic fungicide from the following
   a) Benomyl compound
   b) Brestan
   c) Thiram
   d) Captan

3.6.2. Methods of application of fungicides

The fungicides are applied on the seeds, foliage or soil against different diseases.

3.6.2.1. Seed treatment

The fungicides are applied in the seeds to eliminate seed borne fungi (like sorghum short smut) and also to protect the seeds against soil borne diseases (like greengram root rot). The fungicides may be applied as a dry treatment using seed treating drum. The required quantity of the fungicide and the seeds are placed in the drum and rotated to give uniform coating of the fungicide on the seeds.

3.6.2.2. Foliar application

The fungicides are commonly sprayed on the aerial plant parts, for example foliar application in leaf spot of groundnut using sprayers or dusted using dusters. Different kinds of sprayers either manually operated or power-operated are available. They may be used depending on the area to be covered. Low volume sprayers are also used for spraying when the disease is found in large areas.

3.6.2.3.. Soil application

The fungicides are drenched in the soil around the root zone of plants to protect them against soil borne diseases. The soil application is expensive and it is restricted to the affected patches in a field.

3.6.3. Phytotoxicity

The fungicides may affect the plants, when they are applied at higher concentrations or when they are applied during host periods. Seed treatment with higher doses of fungicides may lead to failure of seed germination or seedling death. When the fungicides are sprayed at higher doses, leaf scorching, or irregular brownish spots may be seen. Leaf margins usually show such phytotoxic symptoms. You must know that the chemicals should be applied only at the recommended doses.

3.6.4. Compatibility

The fungicides may have to be combined with insecticides. It is essential to find out whether a fungicide is compatible with an insecticide. If they are not compatible, the effects of both the chemicals may be either reduced or phytotoxic injuries may be produced on plants. It is essential to know the compatible nature of the chemicals before using them together.

3.7 Biological control

Different kinds of chemicals are used for the control of diseases, pest and weeds. The chemicals pollute the atmosphere and change the composition of soil microflora. They also induce resistance in pathogens and pests. This leads to use of higher doses of chemicals increasing the cost of cultivation of crops. Biological control methods help to avoid these difficulties.

3.7.1. Application of organic manures

Application of green manures, farmyard manure, and agricultural wastes, stimulates the activities of micro-organisms in the soil. This helps to suppress the development of plant pathogens like *Fusarium spp.* and *Rhizoctonia* spp which cause wilt and root rot diseases.

3.7.2. Use of antagonists

Some microbes like *Trichoderma viride, Bacillus subtilis. Pseudomonas fluorescens* are able to reduce the development of pathogens inducing serious diseases. Under favourable conditions they are able to over grow the pathogens or kill the pathogen by producing antibiotics (toxic substances). These microbes are antagonists and they have been used for controlling root infecting pathogens like *Fusarium* spp and *Rhizoctonia* spp. They can be applied on the seeds or introduced into the soil.

3.7.3. Botanicals

Many plant products like leaf extracts, oils and cakes have the property of inhibiting the development of plant pathogens. The plant extracts and oils are sprayed on the crops. The cakes are applied in the soil. Neem oil, and neem cake have been found to be effective against crop diseases when applied as prophylactic sprays.

3.8 Integrated disease management

Disease management can be more effective when different principles are integrated. The advantage of such integration of disease

management principles may be felt as the disease incidence decreases progressively.

Selection of suitable cultural practices such as time of sowing, spacing and application of fertilizers at recommended doses results in reduction in incidence of diseases.

Now cultivars with resistance to diseases are available is many crops. Instead of growing high yielding susceptible variety, cultivation of disease resistant variety with moderate yield will be advantageous during seasons when particular disease normally occurs.

Clean cultivation will greatly reduce the inoculum build up. Destruction of all infected plants and weeds will result in reduction in the incidence of diseases. Application of chemicals should be done at right time, and correct doses. The number of applications should at minimal levels. The use of biocontrol methods provides added advantage in certain crops. It is being increasingly realized that non-chemical disease management practices are preferable to chemical methods. Effective diseases management is dependent on skillful combination of suitable practices.

3.3. INTEXT QUESTIONS

1. Seed treatment with sulphur eliminates
   a) Sorghum short smut
   b) Rice Helminthosporium
   c) Groundnut rust
   d) Redgram wilt
2. Foliar sprays are applied for the control of
   a) Leaf spot diseases of groundnut
   b) Cotton wilt
   c) Potato ring disease
   d) Sugarcane smut
3. Compatibility refers to
   a) favourable combination of more than one chemical
   b) application of chemicals on sensitive plants
   c) formation of toxic symptoms
   d) Use of chemicals against specific disease

4. Biological agents are preferred to chemicals because
   a) they are easily available
   b) they help to avoid environmental pollution
   c) they can be stored for long periods
   d) they give resistance to the plants
5. Which one among the following is an antagonist ?
   a) *Pythium sp.*
   b) *Fusarium sp.*
   c) *Trichoderma viride*
   d) *Helminthosporium sp.*

WHAT YOU HAVE LEARNT

After studying this lesson you have learnt the following :

- Prevention of disease introduction by establishing plant quarantines
- Eradication of infected plants and plant parts may result in less disease incidence
- Different methods of protection have to be employed for soil, air and seed borne diseases
- Development of cultivars resistant to diseases is the most economical method of disease management.
- Fungicides used for disease management are classified based on the nature of active chemicals
- Depending on the nature of disease, fungicides are applied in the soil or on the seeds or foliage
- Use of biocontrol agents against plant pathogens is more desirable than application of chemicals
- Various principles of disease management can be integrated to have an effective system of management of various diseases affecting a crop(s).

TERMINAL QUESTIONS

1. What are the methods that can be followed to avoid disease introduction/ incidence

2. How will you protect the plants against

   a) seed borne disease b) soil borne disease c) air borne disease

3. Mention one fungicide under different groups and their uses

4. What is meant by biological control of crop diseases ? Mention the different methods employed for the same.

5. What are the advantages of adopting integrated disease management system.

KEY TO INTEXT QUESTIONS

1.1

1.1a true; 1b False; 1c True; 1d False; 1e True
2b, 3a, 4a 5a

1.2

1.1a true; 1b False; 1c True; 1d true;
2a, 3b

1.3

1.1a False; 1b True; 1c False; 1d True;
2a, 3c, 4b

1.4

1a; 2b

2.1

1. rice blast; 2. Blast; 3. leaf hoppers; 4. blast; 5. loose smut; 6. stem rust, leaf rust; brown rust

2.2

1b; 2c; 3. downy mildew; 4. grain smut, loose smut, long smut and head smut; 5. Co25, Co 26; 6.c; 7a.

2.3

1a; 2c; 3c; 4. sterilty mosaic

2.4

1. leaf spot and rust; 2. b; 3. phyllody; 4. *Alternaria helianthi*, 5. powdery mildew.

2.5

1. bacterial blight ; 2. bacterial blight 3. Red rot; 4.b; 5. aphid, MLO; 6. red rot; 7. mosaic 8. Orobanche

2.6

1. bud rot; 2. stem bleeding; 3. Pencil point disorder; 4. Thanjavur wilt; 5. Mahali; 6. rust; 7. blister blight; 8. pathogenic; 9. capsule rot; 10. pollu; 11. mosaic, whitefly

2.7

1. wilt; 2.wilt; 3. bunchy top; 4. canker; 5. stem; 6. malformation; 7. physiological disorder; 8. downy, powdery; 9. scab; 10b.

2.8

1. tomato spotted wilt; 2. damping-off; 3. yellow vein mosaic; 4. late blight; 5. wilt; 6. Fruit rot & die back; 7. club root ; 8. mosaic.

2.9

1. Black spot; 2. b; 3. Phyllody; 4. Foot rot, wilt

3.1

1b; 2a; 3a;

3.2

1c; 2a; 3a; 4a true; 4b false; 4c true; 4d true; 4e false; 5a

3.3

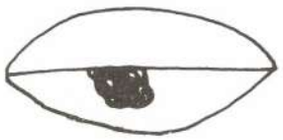
1a; 2a; 3a; 4b; 5c

* With reference to page No. 6

LEAF

Stem rot

Fig. 6.3.2

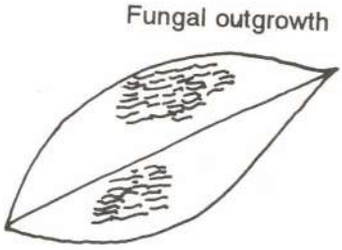


Leaf spot

Fig. 6.4.1

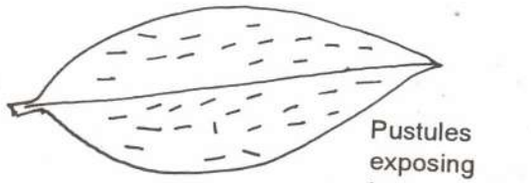
Leaf blight

Fig. 6.4.2



Mildew

Fig. 6.4.3



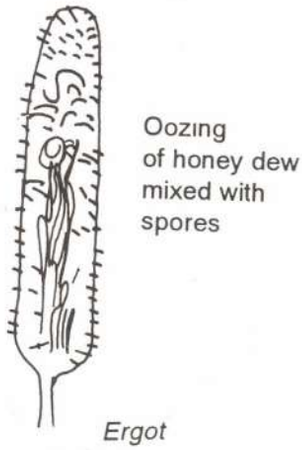
Rust

Fig. 6.4.4

FLOWER

Smut

Fig. 6.5.1



Ergot

Fig. 6.5.2