B. Sc. SEMESTER-I, PAPER-II

Unit II (PLANT PATHOLOGY AND LICHENS)

Plant pathology:– Host, pathogen, symptoms, Causes and Control of following diseases:-

Leaf curl of Papaya,

Citrus canker and

Red rot of Sugarcane

Lichens :- Types, Reproduction and Economic importance

LEAF CURL OF PAPAYA:

Papaya leaf curl disease was first reported in India in 1939 (1). Caused by begomovirus, Papaya leaf curl virus (PaLCV) (2), this disease was discovered in the papaya orchards of southern Taiwan in 2002. Infected papaya developed symptoms such as downward curling of leaves, twisted petioles, vein enation, and stunting. Diseased plants produced small and distorted fruits that tend to fall prematurely.

Symptoms: The diseases of PaLCuV-infected plants are characterized by wrinkled and curled leaves that roll downward or inward and appear as an inverted cup. The leaf becomes leathery, rigid, and reduced in size with thickened vein and zig-zag twisted petioles. Moreover, infected plants show defoliation, fail to bear flowers or fruits, and have restricted growth during the advanced stages of infection.

Chemical Control

There is no chemical treatment for viral infections. However, holding the population of whiteflies in check can reduce the severity of the infection. Soil application at the time of sowing and 4-5 foliar sprays of metasystox at an interval of 10 days can effectively control whitefly populations.

Leaf curl is a common problem that papaya growers encounter, which reduces the crop yield and quality. The leaf curl disease is caused by a virus that spreads through plant sap and insect vectors, such as whiteflies. If the symptoms of the disease are not detected and treated early, the disease can lead to stunted growth, scorched leaves, and eventual death of the plant. Here are some essential tips on how to control leaf curl in papaya.

1. Remove Diseased Plants: One of the primary control measures for leaf curl is to remove the diseased plants as soon as possible. This will prevent the spread of the virus to healthy plants. Do not compost infected plants as this will only spread the disease further.

2. Use Insecticides: Whiteflies are one of the primary vectors of the leaf curl virus.

Using a systemic insecticide to control the whiteflies population can help reduce the spread of the virus. However, make sure to follow the manufacturer’s instructions carefully when using insecticides.

3. Use Resistant Varieties: Planting resistant varieties can provide some level of protection against the leaf curl virus. Several hybrid varieties of papaya have been developed that have shown significant resistance to the virus.

4. Maintain Good Plant Health: Maintaining good plant health can help reduce the incidence of the disease. Ensure that the plants are adequately fertilized and watered, and remove any weeds from around the plant, as they can act as hosts for whiteflies.

5. Practice Good Sanitation Measures: Practicing good sanitation measures is critical in controlling the spread of the leaf curl virus. Keep the growing area clean and free of any plant debris or other materials that could harbor the virus.

In conclusion, the control of leaf curl in papaya is essential to protect the crop yield and quality. Early detection and removal of diseased plants, using insecticides, using resistant varieties, maintaining good plant health, and practicing good sanitation measures are all critical control measures. By following these tips, you can reduce the incidence of the disease and improve the growth and quality of your papaya crop.

CITRUS CANKER:

Citrus canker, caused by the bacterium *Xanthomonas citri* subsp. *citri*, affects the leaves, twigs and fruit of citrus plants causing the leaves to drop and unripe fruit to fall to the ground. All types of citrus are affected by the disease.

Citrus canker is most severe in hot, wet areas. The infected sites ooze sap which can carry the disease from tree to tree by irrigation or rain splash. Citrus canker can spread quickly over long distances on infected citrus fruits and leaves, as well as on people and equipment.

Symptoms of citrus canker

The disease affects all above-ground parts of the tree, but most susceptible a.re the leaves, twigs and fruits. It particularly produces scabby lesion on the surface of the fruits (Fig. 390D) and there by reduces their market value. The lesions first appear on host surface as small watery translucent spots which increase in size turn dark-green with age.

The host tissues surrounding the spots become raised resulting the spots to develop convex surface. The central region of the spots gradually turns light-brown and spongy and breaks down producing a. crater-like appearance. With age, the spots become corky and brown, sometimes pinkish, assuming a cankerous appearance.

Causal Organism of Citrus Canker:

The disease is induced by the bacterial pathogen, Xanthomonas citri (Hasse) Dows. The organism is rod-shaped monotrichous with yellow, water-soluble pigment. It is an aerobic bacterium.

Transmission:

Citrus canker is easily spread. The canker lesions ooze bacteria when wet. Over short distances, wind-driven rain, air currents, insects, birds, human movement and equipment such as overhead or spray irrigation systems can spread the bacteria.

Control of Citrus Canker:

It is rather very difficult to control the disease**.**

Following are some of the effective control measures:

(i) Sanitation:

Destruction of all affected trees by burning. Pruning of infected parts, particularly during dry season reduces source of inoculum.

(ii) Spraying of Fungicides:

Spraying of fungicides like Bordeaux mixture and lime-sulphur is often very effective to protect the fruits against infection. It should be done during the first three months of the development of fruits.

(iii) Use of Disease Resistant Varieties:

There is a possibility that cultivation of disease resistant citrus varieties may produce good results.

LICHEN

Study of lichen called lichenology.

Lichens are composite thalloid structure containing algae and fungi.

Lichens are distinct group of plant having two components i.e. algal components called Phycobiont and fungal component called Mycobiont.

Algal component of lichen synthesize carbohydrates by photosynthesis and provides nutrition of fungi and themselves while fungal component helps in water absorption and water retention. Hence lichen is an example symbiosis.

The term "Lichen" was first given by Theopharastus for superficial growth on bark of Olea europea (olive) tree.

Erik Acharius – father of Lichenology.

De Bary – gave this association the name Symbiosis.

Crombie – gave the master-slave hypothesis for this association (also called husband-wife relation ship). It is also called helotism (Most accepted association now a days).

In this association, the fungal component shows predominance over algal component and the later is a subordinate partner. Such type of association is known as helotism.

HABIT & HABITAT

The lichen are mostly perennial, aerial, slow growing and long lived plant.
Lichens are cosmopolitan. Lichens are even in areas which appear unsuitable for normal plant like bare hard rock and cold arctic region.
Lichens are most sensitive to air pollution specially SO2-pollution.
In India lichen are most common in eastern Himalaya as compare to western Himalaya
Lichens are absent in planes.
On the basis of habitat, lichen are of following type :
Saxicolous – Lichens growing on rocks. eg. – Dermatocarpon, Pornia
Corticolous – Lichens growing on tree bark eg. – Parmelia, Usnea
Terricolous – Lichens growing on soil eg. Cladonia, Collema.
Lignicolous – Lichens growing on wood eg. – Cyphelium.

The lichen may also occur in fresh water eg. – "Hymenelia lacustris"
Few marine species eg. "Caloplaca marina"

Classification of Lichen

Major part of lichens thalli are composed of fungal component.

I. On the basis of their fungal component:

A. Ascolichen : - Fungal partner is the member of ascomycetes.

Algal partner is mostly member of green algae and rarely blue green algae.

Most of the lichens are Ascolichen

B. Basidiolichen : Fungal partner belongs to basidiomycetes.

In basidiolichen, algal partner is always a member of Myxophyceae (B.G.A.).

Example – Cora pavonia

Important Notes

In 80% cases of lichen algal partner is member of green algae or chlorophyceae and in 20% cases blue green algae.

80% Lichen have Ascomycetes Fungus and 20% is Basidiomycetes.

Important member of green algae in lichens is Trebouxia [most common unicellular green alga], Pleurococcus, Cladophora.

Blue green algae – Nostoc, Scytonema, Anabaena, Gloeocapsa, Rivularia etc.

II. classification of the basis of types of thallus :

Lichens are of three types -

1. Crustose lichen:

Thallus are flat. The thallus is closely adhered to the substratum and provides a crust like appearance.

These lichens are partially or completely embedded in to substratum.

These can't be separated from the substratum without breaking them.

Fruiting bodies are visible above the surface of the substratum.

e.g – Rhizocarpon, Graphis, Lecanora, Verrucaria, Haemotomma.

2. Foliose lichen:

Thallus are flat leaf-like and lobed.

They are attached to the substratum with the help of rhizoid like rhizines.

These hariy structures are developed from lower side of thallus e.g. Parmelia, Peltiger, physcia and collema.

3. Fruiticose lichen

Thallus is well developed, shrub like, cylindrical and branched thallus.

They grow erect (Ex. Cladonia) or hang from substratum (Ex. Usnea).

They are attached to the substratum by their basal mucilagenous disc

Internal Structure

V.S. of foliose lichen:

a. Upper cortex – It is made up of compactly interwoven fungal hyphae. Intercellular spaces are absent. If present then filled with gelatinous substance. In some lichens (Parmelia) breathing pores are present on upper cortex.

b. Algal layer – It occurs just below the upper cortex. This layer forms photosynthetic zone of thallus. In this layer algal cells are present and some fungal hyphae are randomly oriented. This layer also called "gonidial layer".

c. Medulla – Beneath the algal zone there occurs medulla. It is made up of loosely interwoven fungal hyphae with large spaces between them which are randomly oriented.

d. Lower cortex – It is made up of compactly interwoven fungal hyphae some of these hyphae become specialized and extend downward from the lower surface of the cortex and helps in the attachment of thallus to the substratum. These specialized hyphae are known as rhizines.

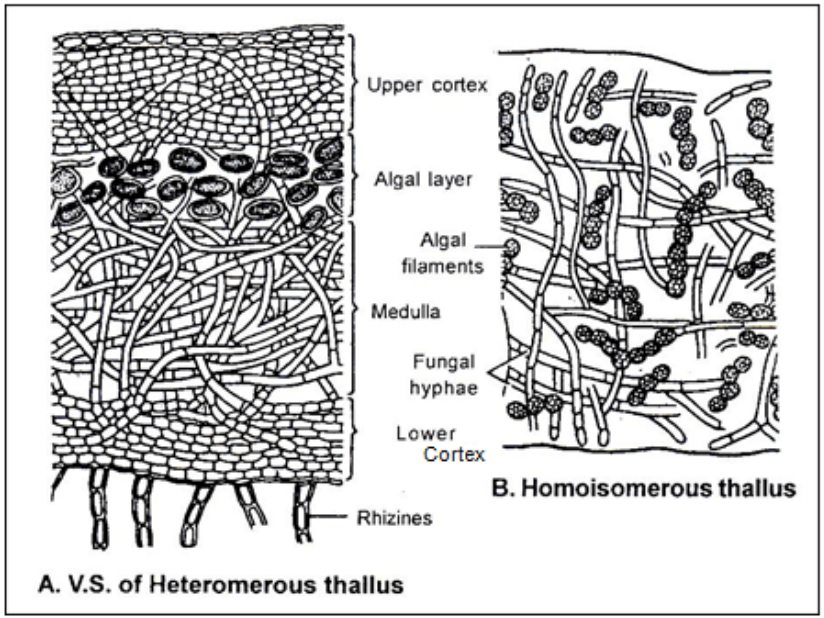
Internal structure of curstose lichens is also more or less similar to foliose lichens.

The lower cortex does not occur in fruiticose lichens due to their cylindrical structure and medulla forms the central part of the axis.

Important Points :

(i) **Breathing pores** – The upper surface of some lichen have loosely arranged areas called breathing pores. They help in gaseous exchange. eg. Parmelia

(ii) **Cyphellae** – These are small, almost circular depression on the lower side of thallus (In foliose lichen). They are meant for exchange of gases. Cyphellae [cyphella-singular] are analogous to stomata of higher plants.



Reproduction

These are of following type -

(i) Vegetative Reproduction

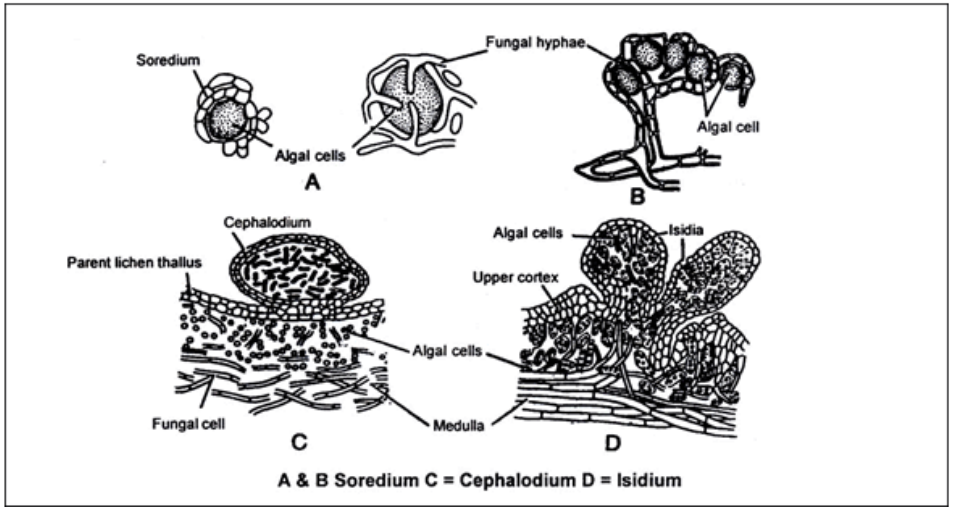
(a) Fragmentation : The main thallus breaks into small pieces and each piece grows to form new lichen thallus.

(b) Soredium : Some small bud-like outgrowths, known as soredia, develop on the surface the thallus. A soredium contains one or few algal cells closely enveloped by a weft of fungal hyphae. They are detached from the thallus by the impact of wind or rain. The soredia germinate on suitable substratum and form new thalli.

(c) Isidium : Isidia are small, stalked, greyish-black coral-like outgrowths which develop on the upper surface of the thallus. The isidium has an outer cortical layer enclosing the algal and fungal components. It is usually constricted at the base and is easily detachable from the parent thallus. It germinates under favourable conditions and forms new thallus.

In addition to propagation, isidia also help in increasing the photosynthetic surface of the thallus. They vary in shape may be rod like (e.g. Parmelia), coral-like (e.g. Peltigera), scale-like (e.g. Collema) or cigar like (e.g. Usnea).

(D) Cephalodium : These are small wart-like structures formed on the surface or inside of the thallus. One of the characteristic feature of cephalodium is that its algal and fungal components differ from that of the thallus. It is due to the fact that cephalodia develop on the younger parts of the thallus from soredia of some other species. Hence, the cephlodium may be regarded as sterile thallus of some other lichen. They retain moisture. In some species, the cephalodium contains the same fungal hyphae as in thallus but the algal component is always different.



(ii) Asexual Reproduction

(a) Oidia : The fungal hyphae form small thin walled bodies called oidia. On coming in contact with suitable algal component they form new lichen thallus.

(b) Conidia : In several lichens, the fungal component form conidia. Conidia produced on conidiophores.

(c) Pycnidiospores : These spores are formed in flask shaped structures, called Pycnidium. Pycnidiospores form new fungal mycelium and Mycelium form new lichen in contact with suitable algal component.

(iii) Sexual Reproduction

Sexual reproduction is the function of fungal component.

The fungal component of most of the lichens belongs to the class ascomycetes.

Female sex organ is called "Carpogonium".

Carpogonium differentiated into two parts – lower coiled part is called "ascogonium" and upper straight part is called "trichogyne".

The ascogonium remains embedded with in the algal layer of the thallus, whereas the trichogyne projects over the surface of the thallus.

Male sex organ is called "Spermogonium"

It is flask shaped. It open out side by ostiole.

Inside spermogonium non motile sperms or spermatia are formed.

The spermatia are ooze out through ostiole in the form of slimy mass and attach with the trichogyne and wall of both soon dissolves.

Nucleus of spermatia reaches in ascogonium.

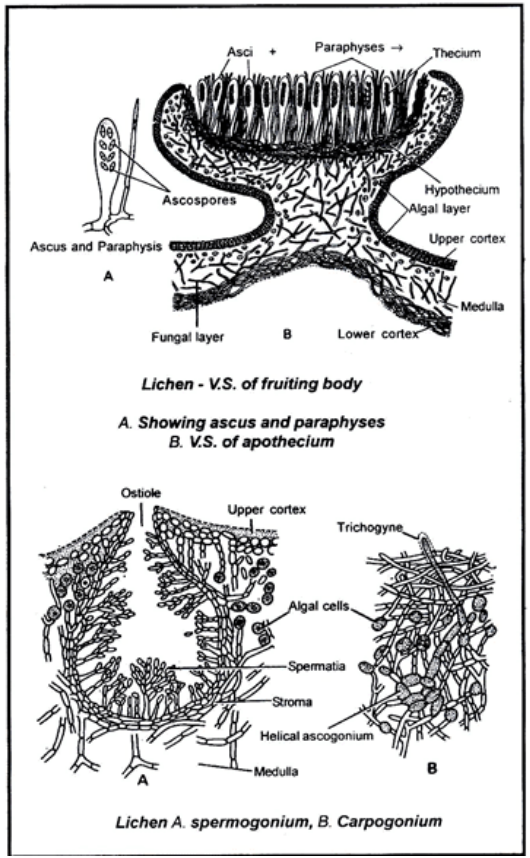
Many "Ascogenous hyphae" arises from the fertilized ascogonium.

These cells are uni or binucleated and the terminal or penultimate (sub-terminal) binucleate cell of the ascogenous hyphe develops into an ascus. In ascus both nuclei fuse to form a diploid nucleus.

In ascus one meiosis and one mitotic division take place and 8-ascospores are formed in each ascus by paraphysis.

Asci (Ascogenous hyphae, ascus mother cells, ascospores) and some sterile hyphae form fruiting body called "apothecium" eg. Parmelia or Perithecium eg. Dermatocarpon, Verrucaria.

Ascospores are liberated from ascus and on coming in contact with suitable algae form new lichen thallus.



Economic importance of lichens.

A. Useful Aspects:

(a) Ecological significance:

(i) Pioneer colonizers:

Lichens are said to be the pioneers in establishing vegetation on bare rocky areas (lithosere). They are the first members to colonize the barren rocky area. During development they bring about the disintegration of rock stones (biological weathering) by forming acids e.g., oxalic acid, carbonic acid etc. Thus, they play an important role in nature in the formation of soil (a phenomenon called pedogenesis).

(ii) Role in environmental pollution:

Lichens are very sensitive to atmospheric pollutants such as sulphur dioxide. They are unable to grow in towns, cities and around industrial sites such as oil refineries and brickworks. So, the lichens can be used as reliable biological indicators of pollution. By studying lichens on trees, a qualitative scale has been devised for the estimation of mean SO_2 level in a given season. Thus lichens are used as pollution monitors.

(b) Food and Fodder:

The lichens serve as important source of food for invertebrates. A large number of animals for example, mites, caterpillars, termites, snails, slugs etc. feed partly or completely on lichens. Lichens as food have also been used by man during famines. They are rich in polysaccharides, certain enzymes and some vitamins.

Cetraria islandica (Iceland moss) is taken as food in Sweden, Norway, Scandinavian countries, Iceland etc. Lecanora esculenta is used as food in Israel and Umbilicaria esculenta in Japan. Species of Parmelia (known as rathapu or **'rock flower'** in Telgu) are used as curry powder in India. In France the lichens are used in confectionary for making chocolates and pastries.

Cladonia rangiferina (Reindeer moss) is the main food for reindeers (a kind of deer) in polar countries. Cetraria islandica is also used as fooder for horses. Species of Stereocaulon, Evernia, Parmelia and Lecanora are also used as fodder.

(c) Source of Medicines:

Since very early times the lichens are used to cure jaundice, fever, diarrhoea, epilepsy, hydrophobia and various skin diseases. Various lichens are of great medicinal

A yellow substance usnic acid is obtained from species of Usnea and Cladonia. It is a broad spectrum antibiotic and is used in the treatment of various infections. It is effective against gram positive bacteria. Some lichen compounds e.g., lichenin, isolichenin have anti-tumour properties.

Protolichesterinic acid, a compound obtained from some lichens, is used in preparation of anti-cancer drugs. Erythrin obtained from Roccella montagnei, is used to cure angina. Many antiseptic creams such as Usno and Evosin are available in the market and are well known for their antitumour, spasmolytic and antiviral activities.

(d) In Industry:

(i) Tanning and dyeing:

Some lichens are used in leather industry. Cetraria islandica and Lobaria pulmortaria show the astringent property. This astringent substance is extracted from the thallus and is used in tannin industry. Lichens are also used in preparing natural dyes. Orchil, a blue dye obtained from Roccella and Leconara, is used to dye woollen articles and silk fabrics.

It is purified as orcum and used as a a biological stain. A brown dye is obtained from Parmelia spp. whereas Ochrolechia spp. yield a red dye. Litmus used as a acid-base indicator, is also a dye and is obtained from Roccella tinctoria and Lasallia pustulata.

(ii) Cosmetics and perfumes:

Evernia, Ramalina, Pseudorina are reported to have perfumed volatile oils. Due to the aromatic substances present in the thallus, the lichens are used in the preparation of various cosmetic articles, perfumery goods, dhoop, hawan samagris etc.

(iii) Brewing and distillation:

Some species of lichen for example, Cetraria islandica contain carbohydrates in the form of lichenin. In Sweden and Russia alcohol is produced from these lichens. These lichens are also used in confectionary.

(iv) Minerals:

Lecanora esculenta is found in lime stone deserts and yields large amount of calcium oxalate crystals. These are 60% of its dry weight.

(e) Natural products:

Lichens are known to produce over 550 natural products. Some important natural products are:

Product	Produced From
Salazinic acid	Ramalina siliquosa
Squamatic Acid	Cladonia crispate
Lecanoric acid	Parmelia Subrudecta

(f) Poison from Lichens:

Lichen	Poisonous due to
Letharia vulphina (wolf moss)	Vulpinic acid (used as poison for Wolves)
Cetraria juniperina	Pinastrinic acid
Parmelia molliuscula	Selenium
Xanthoria parietina	Beryllium
Everina furfuracea	Chlorine

B. Harmful Aspects:

(a) Lichens growing on young fruit trees and sandal trees are harmful to the plant.

(b) During hot season some species of lichens (e.g., Usnea barbarata) become so dry and inflammable that they often help in spreading forest fire.

(c) Some lichens act as allergens.

(d) The commercial value of glass and marble stone is reduced because of itching of their surface by lichens.

(e) Some lichens e.g., Cladonia rangifera, Cetraria islandica accumulate large quantities of radioactive strontium (Sr^{90}) and caesium (Cs^{137}) from atomic fall-outs. These may be incorporated in the food chain, lichen → reindeer → man, leading to their accumulation in human tissues.

THE END