SERICULTURE
SEMESTER II
CORE THEORY 4
UNIT 1

Botanical Name(s): *Morus alba*
Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Urticales
Family: Moraceae
Genus: Morus L
Species: Morus Alba L.

Popular Name(s): White Mulberry, Silk Worm Mulberry and Sang Zhi
Parts Used: Bark, leaves and roots
Habitat: Native to warm temperate and subtropical regions of Asia, Africa and North America, with the majority of the species native to Asia.

Description
Mulberry is the name given to a genus of 10-16 species of deciduous trees. The tree is fast growing when young, but soon become stagnant and rarely goes beyond 10-15 m in height. The leaves are alternately arranged, simple, often lobed (more commonly lobed on juvenile shoots than on mature trees) and serrated on the margin. The fruit is 2-3 cm long, red to dark purple on ripening, edible and sweet (with a good flavor), in several Mulberry species. The plant species is native to China, while it is extensively cultivated in the other parts of the world as well.

Plant Chemicals

Amino acids identified in the free form are phenylalanine, leucine, valine, tyrosine, proline, alanine, glutamic acid, glycine, serine, arginine, aspartic acid, cystine, threonine, sarcosine, gamma-amino-butyric acid, pipecolic acid, and 5-hydroxy pipecolic acid. The leaves are a good source of ascorbic acid. Volatile constituents found in steam-distillates of the leaves are: n-butanol, beta-gamma-hexenol, methyl-ethyl acetaldehyde, n-butylaldehyde, isobutylaldehyde, valeraldehyde, hexaldehyde, alpha-beta-hexenal, acetone, methyl-ethyl ketone, methyl-hexyl ketone, butylamine, and acetic, propionic, and isobutyric acids. Leaves also contain calcium malate, succinic, and tartaric acids, xanthophyll and isoquercitrin (quercetin 3-glucoside) and tannins; adenine, chorine, and trigonelline bases are present in young leaves.

Uses & Benefits of Mulberry

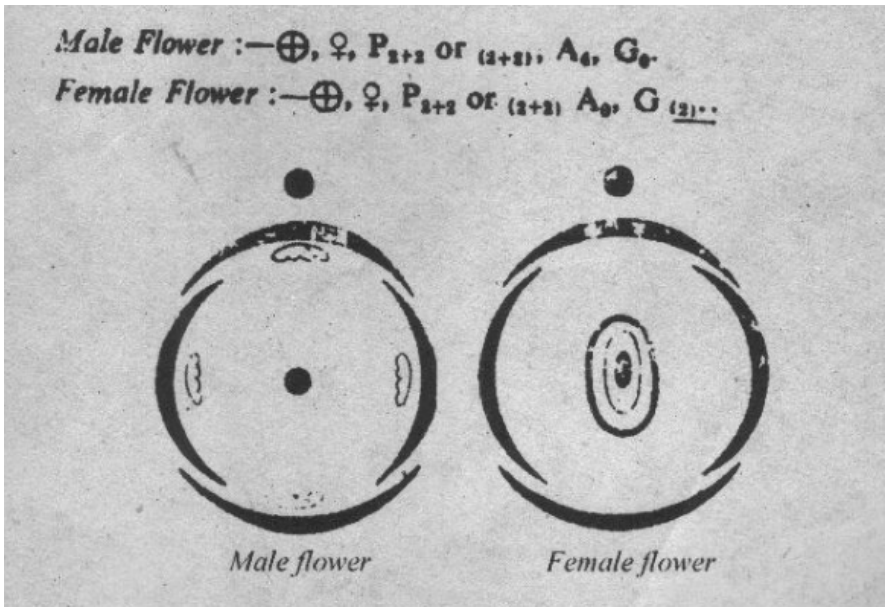
- Mulberry fruit is used to treat weakness, dizziness, tinnitus, fatigue, anemia, and incontinence.
- Its leaves are used to promote sweating, and the branches and bark help lower blood pressure.
- It can help treat chronic diseases of the digestive tract, improve digestion, stimulate the appetite, promote gastric juice secretion and eliminate constipation.
- White mulberry leaves are used as feedstock for silkworms. They are also cut as food for livestock, such as cattle and goats, especially in areas that experience dry season, restricting the availability of fodder.
- The fruits of Mulberry plant are eaten raw and also used to make wine, by drying them.
- The fruit has much significance in traditional Chinese medicine, which uses it to treat prematurely graying hair. It is also used to purify blood and treat constipation and diabetes in Chinese medicine.
- The bark is used to remedy cough, wheezing, edema, fever, headache, and red, dry and sore eyes. It also promotes urination.
- The leaves of the plant work to stimulate the nervous system and help in maintaining proper functioning of the digestive tract. It also has a positive effect on the respiratory and cardiovascular system, as well as the uterine system.

1. **Fruits:** Some of trees of this family yield edible fruits. Some of these are Mulberr bread fruit.
2. **Used for shade:** Some trees of this family are grown for their excellent shade from sun rays. These trees are peepal banyan Rubber: *Fiscus elasticu* (rubber tree) is cultivated form obtaining commercial rubber.
3. **Cultivation of silk worm**: The leaves of mulberry are used for cultivation of silk worms. Silk worms produce silk which has great commercial value.
4. **Paper**: The bark of Paper mulberry is used for paper making.
5. **Commercial fibers**: Cannabis yields commercial Fibers. These fibers are used in making ropes.
6. **Drugs**: Some plants of this family give important drugs andnarcotics U4…4 Some of these are bhang Charas.
7. **Paints and soaps**: The seeds of cannabis (hemps) give oil which is used in paints and soaps.

<u>Salient features of family Moraceae</u>

1. **Habit:** Mostly tree herbs, shrubs or vines.
2. **Roots:** Tap root
3. **Stem:** Woody; gum exudes from the stem.
4. **Leaves:** Petiolate; alternate; simple; stipulate;
5. **Inflorescence:** Catkin or flypanthodium

6. **Flower:** Small inconspicuous; bracteate and bracteolate; actinomorphic; incomplete; unisexual; hypogynous
7. **Perianth:** 4, in two whorls,
8. **Stamens in male flowers:** 4-5 stamens; opposite to the perianth.
9. **Carpel in female flowers:** Carpels 2; Simple, ovary superior; apocarpous; basal placentation.
10. **Fruits:** An achene, drupe or nuts. sometimes syconus
11. **Seed:** Endospermic or non-endospermic.



Moraceae
Mulberry Family

♂ $Ca^4\ Co^0 A^4\ G^0$

♀ $Ca^4\ Co^0 A^0 G\ \underline{2}$

Catkin of mulberry

Male catkins are usually longer than the female **catkins**

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MULBERRY VARIETES

Kanva-2. Belongs to *M. indica.* Diploid. Widely cultivated in southern India after it was recommended for cultivation in 1969 by CSRTI (Mysore). Selection from natural population of Mysore local variety. Inflorescence and sorosis: Female, profuse flowering, many soroses. Production characteristics: Medium leaf maturity, yields 30-35 tonnes/ha/year under irrigated conditions. Leaf moisture content 70 percent, protein content 21 percent and sugar content 11.5 percent. Resistant to leaf spot. Moderately resistant to leaf rust and powdery mildew. High rooting ability (80 percent) and wide adaptability.

S-36. Belongs to *M. indica*. Developed at CSRTI and recommended during 1984. Evolved from Berhampore local by chemical mutagenesis. Cultivated in southern India. Moderate rooting ability. Production characteristics: yields 38-45 tonnes/ha/year under assured irrigated conditions of South India. Moisture content 76 percent, CP 22 percent and carbohydrate content 28 percent. Tolerant to leaf spot and powdery mildew. Moderately susceptible to leaf rust and to tukra infestation. Most suited to young age silkworm rearing. Sapling plantation recommended because of moderate rooting ability.

S-54. Belongs to *M. indica*. Developed at CSRTI and recommended during 1984. Selected from Berhampore local by chemical mutagenesis (EMS). Recommended for assured irrigated conditions of South India. Production characteristics: yields about 45 tonnes/ha/year under assured irrigated conditions. Highly responsive to agronomical input. Moisture content of leaf 70.5 percent, CP 23.9 percent and sugar content 13.8 percent. Moderately resistant to powdery mildew and leaf rust and resistant to leaf spot. Loses moisture very quickly. Good rooting ability.

DD. Selected from natural population of Dehra Dun variety and recommended by Karnataka State Sericultural Research and Development Institute, Thalaghattapura. Recommended for southern India. Morphology: erect, thin branches, coarse leaves, greenish grey bark. Lower branches spreading, leaves unlobed, big size, ovate shape. Yields 35-40 tonnes/ha/year under assured irrigation conditions.

MR-2. Belongs to *M. sinensis.* Diploid. Selection from open pollinated hybrid population. Developed at CSRTI and recommended for propagation in Tamil Nadu. Mainly cultivated in

Tamil Nadu under both irrigated conditions in the plains and rainfed conditions in hilly regions. Production characteristics: yields 30-35 tonnes/ha/year under irrigated conditions of Tamil Nadu. Moisture content 68 percent, protein content 23.2 percent, sugar content 13.2 percent (Fig. 7). Resistant to powdery mildew disease. Suitable for hilly areas.

Victoria-1 (V-1). Belongs to *M. indica*. Recently developed from a cross of S-30 and Berc 776 at CSRTI. Recommended during 1996 for assured irrigated conditions. Flower: male, profuse flowering, occasionally few soroses. Production characteristics: yields about 70 tonnes/ha/year under assured irrigated conditions. Very high sprouting. Moisture content 78.9 percent and 72.5 percent in young and matured leaves respectively, protein content 24.6 percent and total sugar content 16.98 percent. Moderately resistant to leaf rust and tukra infestation and resistant to leaf spot. Quick sprouting ability and very high rooting ability (> 94 percent) high photosynthetic rate and higher water use efficiency are additional advantages. Moreover, leaves are suitable for both young and grown bivoltine silkworm rearing.

Mulberry varieties in India

Variety	Region	Developed at	Origin
Kanva-2	South India Irrigated	CSRTI, Mysore	Selection from natural variability
S-36	South India Irrigated	CSRTI, Mysore	Developed through EMS treatment of Berhampore Local
S-54	South India Irrigated	CSRTI, Mysore	Developed through EMS treatment of Berhampore Local
Victoria-1	South India Irrigated	CSRTI, Mysore	Hybrid from S30 x Berc 776
DD	South India Irrigated	KSSRDI, Thalaghattapura	Clonal selection
S-13	South India Rainfed	CSRTI, Mysore	Selection from polycross (mixed pollen) progeny
S-34	South India Rainfed	CSRTI, Mysore	Selection from polycross (mixed pollen) progeny
MR-2	South India Rainfed	CSRTI, Mysore	Selection from open pollinated hybrids.
S-1	Eastern and NE India Irrigated	CSRTI, Berhampore	Introduction from (Mandalaya) Myanmar
S-7999	Eastern and NE India Irrigated	CSRTI, Berhampore	Selection from open pollinated hybrids
S-1635	Eastern and NE India	CSRTI, Berhampore	Triploid selection

	Irrigated		
S-146	N. India and Hills of J and K Irrigated	CSRTI, Berhampore	Selection from open pollinated hybrids
Tr-10	Hills of Eastern India	CSRTI, Berhampore	Triploid of Ber. S1
BC-259	Hills of Eastern India	CSRTI, Berhampore	Back crossing of hybrid of Matigare local x Kosen with Kosen twice
Goshoerami	Temperate	CSRTI, Pampore	Introduction from Japan.
Chak Majra	Subtemperate	RSRS, Jammu	Selection from natural variability
China White	Temperate	CSRTI, Pampore	Clonal selection

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UNIT 4
DISEASES OF MULBERRY LEAF

- **Leaf spot (*Cercospora moricola* Cooke)**

Introduction

The leaf spot caused by *Cercopsora* to mulberry was first reported by Patel *et al*. (1949) from Kamataka. The disease is reported to cause 10-12 % leaf yield loss even up to 20 % -35 % in severe conditions (Sikdar and Krishnaswamy, 1980; Sikdar, 1987). Maximum severity was found during July to October in Kamataka (Siddaramaiah *et aI*., 1978). The disease causes reduction in moisture, proteins and sugars in infected leaves (Madhava Rao *et al*.. 1981). Rearing with infected leaves affects health of silkworms and in turn quality and quantity of cocoons produced (Sikdar *et al*., 1979).

Symptoms

The causal fungus produces minor circular light brown spots on the leaves which gradually increase in size and turn darkbrown. The tiny spots coalesce to form bigger ones. The dead

tissues fall off resulting shot holes lining yellow circle around the shot hole. The highly affected leaves fall off prematurely

Causal organism

Cercospora moricola

Systematic position

Kingdom -Fungi

Division-Ascomycota

Class-Dothideomycetes

Order- Capnodiales

Family-Mycosphaerellaceae

Genus-*Cercospora*

Species-*moricola*

Description of the pathogen

The conidia are born on conidiophores. Conidiophores 2-15 in a fascicle, pale olivaceous brown, straight, rarely septate and geniculate, unbranched, scars conspicuously thickened,10-50 x 4-5.5 µm. Conidia are hyaline, solitary, acicular, multi-septate base-truncate, tip-acute hilum thickened and darkened, 40-150 x 2-3.5µm.

Pre disposing factor

The disease is generally found during rainy season followed by winter. High disease development was recorded in the month of August and September when outdoor temperature and relative humidity are 25-30 ºC and above 80%.The disease starts progressing 35-40 days after pruning (DAP)/ leaf harvesting and becomes severe 70th day after pruning.

Disease cycle

The disease is very common during June –December, conidia germinate on both surfaces of the leaves. However, germ tubes (single or branched) enter through stomata only whether open or closed, indicating the absence of direct penetration (Sukumar and Ramalingam, 1983). In

mulberry, the stomata are distributed only on the lower surface of the leaves (hypostomatous). Therefore, successful infection of *C. moricola* is possible only when the conidia are deposited on the lower surfaces. Interestingly, conidia are carried to the undersurface by rain splashes ensuring natural portal for entry and assured moisture for germination and penetration (Sukumar and Ramalingam, 1981). The conidia are capable of producing new hyphae from any cell. It takes about 10-12 days after inoculation of conidia to produce a spot and another 3-4 days for the production of conidia

Control measures

Cultural control:

Follow wider spacing of plantation (90 cm x 90 cm) or paired row planting system [(90 +150) × 60 cm]. Avoid sprinkler irrigation.

Chemical control:

Various fungicides are identified for control of the disease.

1. Spraying 0.2 % Bavistin (Carbendazim 50% WP) solution on the leaves. This can be made by dissolving 800g Bavistin in 200 liter water for spraying in 1 acre mulberry garden. The leaves can be used for silkworm rearing 7 days after the spray.

2. Spray 0.2% Karathane. About 400-500 ml Karathane is to be mixed with 200-250 liters of water. A second spray can be made if the disease is more severe. The leaves can be used for silkworm rearing 10 days after final spray.

❖ Powdery mildew (*Phyllactinia corylea*)

Introduction

Powdery mildew caused by *Phyllactinia corylea* is a most common, serious and wide spread disease of mulberry. The disease is reported from different countries. In India, it was first reported by Ramakrishnan and Sudan (1954) from Madras. The disease is prevalent during September to March with maximum incidence in January and February (Krishna Prasad and

Siddaramaiah, 1979; Biswas *et al*., 1991). The disease reduces protein (Shree *et al*., 1986). The infected leaves are characterised by less moisture and disrupt the metabolic activities of the host leading to reduction in leaf yield and nutritive value (Chanturia, 1963).

Symptoms

White circular powdery patches appear on the lower surface of the leaves. The concomitant upper surface develops chlorotic lesions. In the later stage, the white powdery patches turn to brownish-gray black; leaves turn yellowish, leathery and defoliate prematurely.

Causal organism

Phyllactinia corylea (Pers.) Karst

Systematic position

Kingdom-Fungi

Division-Ascomycota

Order-Erysiphales

Family-Erysiphaceae

Genus-*Phyllactinia*

Species-*corylea*

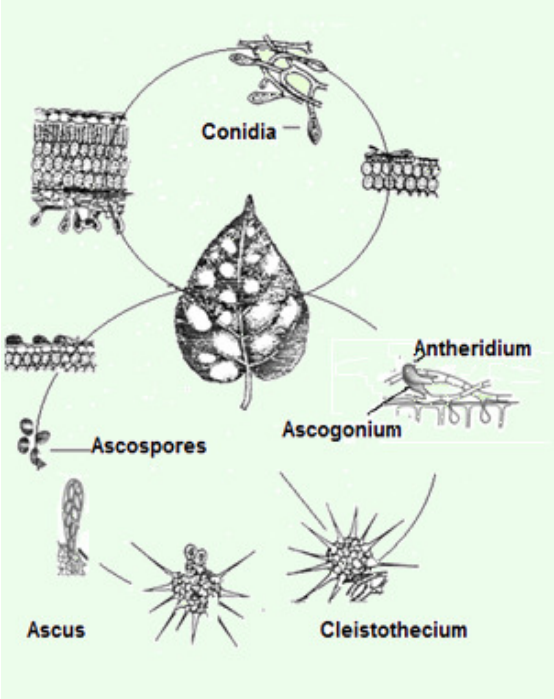
Description of the pathogen

The vegetative hyphae of *Phyllactinia corylea* produce a large number of long hyaline septate conidiophores on which conidia measuring 20 x 70 µ are borne. The pathogen differs from other powdery mildew fungi in having germinating cells terminally while the others have sub-terminally The mycelium may be abundant and persistent, or scant and short-lived (evanescent). The cleistothecia are large (216–245 µm), with soft wall tissue, and obscure cellular structure and cracks and wrinkles (reticulations) showing appendages with bulbous base. The cleistothecia typically develop 8–12 easily detachable hyaline appendages that vary in length from 191–290 µm long. The asci are 4 to 5 to 20 or more, ovate, supported by small stalk-like structures (pedicellate), with dimensions of 72–83 by 32–40 µm. They are typically 2 per ascus, sometimes 3 or 4, and they are 31–36 by 21–25 µm. The filaments can gelatinize by absorbing water and are thought to function in helping the ascomata adhere to the surface on which they

grow, like the underside of leaves. The feet are cylindrical, irregular in width, 32–72 by 7.5–25 µm, and divided into 2–10 branchlets in the upper part. Each branchlet is short, bulbous, with filaments being 20–42 µm, somewhat shorter than the foots, which are 2–4 µm wide.

Pre disposing factors

Temperature 24° to 28°C is optimum for conidial growth. Conidia begin germinating within two hours at 28°C and 100% humidity and the disease appears two weeks after inoculation.



Disease cycle

Dissemination of conidia takes place through air current. The fungus perennates unfavourable conditions through sexual fruiting bodies known as cleistothecium. These are flat, sphere-shaped, dark-coloured structures having several asci. Development of cleistothecia takes place at low temperature (14 to 17°C average day temperature) and moderate relative humidity fluctuating from 60 to 70% during the months of December and January on living intact leaves. Initially they appear as tiny orange-coloured oval bodies which turn brown to black in due course. These act as a primary source of inoculum under favourable conditions.

Cultural control

Follow wider spacing of plantation (90 cm x 90 cm) or paired row planting system [(90 +150) × 60 cm]. Avoid stagnation of water and shade in the mulberry plantation.

Biological control

Hyphomycetes fungi, *Cladosporium oxysporum* and *Cladosporium* spp., have been reported to be hyperparasitic on *P. corylea* (Raghavendra and Pavgi, 1977; Rao and Sullia, 1981). Besides, Reddy *et al*. (1989) reported a coccinellid insect, i.e. *llleis cincta*, eating the mycelium and spore mass of powdery mildew. Another species of this insect (*I. indica*) has been found to feed very commonly upon spores, mycelia and young cleistothecia in West Bengal, India (Teotia *et al*., 1992).

Chemical control

Chemical control: Spray 0.1% Carbendazim 50% WP (Bavistin) [2 g/lit. water] or 0.2% Sulphur 80WP (Sulfex) [2.5 g/ lit.].

❖ Leaf rust (*Cerotelium fici*)

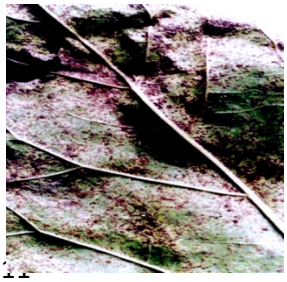
Introduction

Leaf rust, caused by *Cerotolium fici* also called as black rust is a very important foliar disease of mulberry in India. The disease generally appears during late winter and prolong up to early summer (September to February). Black rust generally appears on mature leaves and cause 5-10 % loss in leaf yield (Siddaramaiah *et al*., 1978). Besides, the disease significantly reduces moisture, crude protein, sugars and total sugars in infected leaves (Sundeswaran *et al*., 1988).

Symptoms

The infected leaves shows pin head like eruptive brown pustule on the lower side of the leaves and dark tiny angular spots on the concomitant upper surface of the leaves. As the disease become severe, leaves become yellow, wither off and fall prematurely.

Causal organism: *Cerotelium fici*



Systematic position

Kingdom: Fungi

Division: Basidiomycota

Class: Teliomycetes

Order: Uredinales

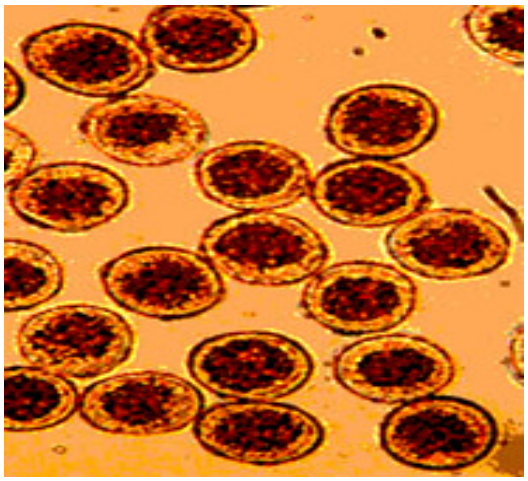
Family: Phakopsoraceae

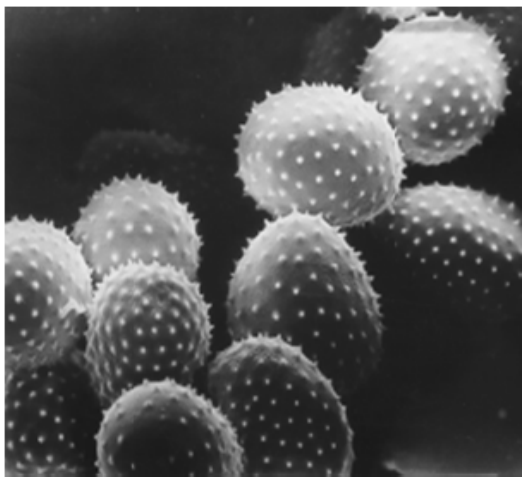
Genus: *Cerotelium*

Species : *fici*

Description of the pathogen

Hemi-form. Pycnia and aecia unknown. Uredia hypophyllous, scattered ± irregularly or in groups, sometimes on conspicuous angular spots between the veins, often dense and often profuse over part or all of the leaf, pale to ferrugineous, circular, 0,15-0,4 mm diam., like minute blisters open in the centre, often with inconspicuous cylindric-clavate, thin-walled, hyaline paraphyses. Urediospores globose, ellipsoid or obovoid, sometimes rather irregular and angular, 19-30 x 15-23 µm; wall hyaline to cinnamon, occasionally even darker, 1-1,5 (-2) µm thick, finely to strongly echinulate with spines 1-3 µm apart and 0,5-1 µm high; pores usually very obscure, but definitely 3 (-4?) and equatorial in some of the deeper coloured spores .

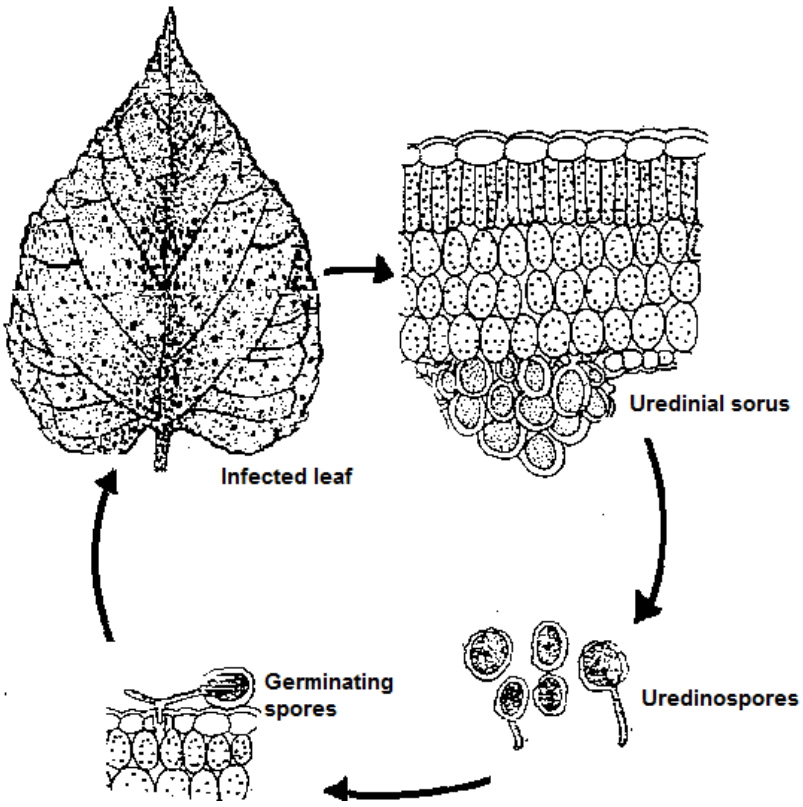




Predisposing factors

The disease is highly influenced by environmental factors, host age and genotype. The low atmospheric temperature (22-24°C) following monsoon (September-February) is highly favourable for the disease development. The leaves on the branches more than 45 days older are more prone to the disease and the younger leaves are generally free from the disease. The pathogen perennates through the dried leaves and plant parts found in the mulberry gardens.

The pathogen *Cerotelium fici* is an obligate microcyclic rust fungus. It exists primarily as mycelium, uredium and uredinospores. The uredinospores are oval to round produced singly on uredophores in uredia. In favourable conditions for the growth of pathogen is 22-24°C temperature and high humidity favour the disease. Uredospores germinate and produce hyphae which enter the leaf through stomata. The hypha grow inter cellular in the host tissues sending haustoria in to the host cells to draw nutrients. Uredospores disperse through water droplets and wind currents and spread the disease.



Disease cycle

Control

Cultural control

Adopt wider spacing, do not allow the plants to over mature and prune off the whole plant immediately after rearing. Keep the mulberry garden clean and remove the dried leaves from the garden and burn.

Chemical control

Spray Kavach (Chlorothalonil 75 WP) 0.2% i.e. dissolve 3 gram Kavach in 1 lit. water and thoroughly drench the leaves while spraying the fungicide.

Safe period: The leaves can be used for silkworm rearing 14 days after the fungicide spray.

- **Alternaria leaf blight (*Alternaria alternata* Fr. Keissler)**

Introduction

The disease is common in southern part of India. The disease cause severe defoliation and mortality during winter months (Gunasekhar and Govindaiah, 1990-91). It manifests by the appearance of burning at leaf tip initially and spread towards the middle which later become brownish, black. Infected leaves dry up within 10 days and ultimately mulberry seedlings die after few days. *Alternaria*belongs to the division Deuteromycota. The spores of *Alternaria alternata* are multi-celled and pigmented and they are produced in chains or branching chains. The spores have a distinctive appearance that makes them easy to recognize. They are broadest near the base and taper gradually to an elongate beak.

Symptoms

Burning of leaves at the leaf tip and become brownish.

Causal organism

Alternaria alternata

Systematic position

Kingdom-Fungi

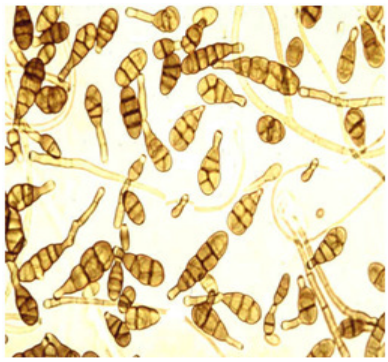
Division-Deuteromycota

Order- Hyphomycetales

Family- Dematiaceae

Genus- *Alternaria*

Species- *alternate*



Description of the pathogen

The genus Alternaria is characteristic by the large conidia. They are produced on chains, light brown to brown, ovoid or obclavate.d, muriform and divided by transverse and vertical walls, with or without beak at the tip. The hyphae and conidiophore are light brown and septate. Generally, the maximum width of spore is from 5-13 to 6-24 µm (the mean is 9 to 17 µm), and the length of spore is from 16-37 to 35-110 µm (the mean is 37 to 69 µm). The number of transverse septa is from 0 to 23. The beak length is from 4 to 90 nm. The conidiophore length is from 20 to 300 µm. Usually, The conidia formed in natural habitats are larger, have longer beaked tip, and are more uniform than those formed in common agar media. Under low temperature and dry conditions, larger conidia with shorter beak are produced. On the culture it is grey to brown, downy or cotton colony.

Pre disposing factors

Alternaria blight is worse in late summer because longer periods of dew and higher relative humidity above 95% are recorded in August and September than in June and July. At the same time, aging leaves are more susceptible. High relative humidity and dew favor the disease. The disease starts on leaves of the exposed shoots on the top of trees and eventually moves towards the lower parts of the tree.

Disease cycle

Alternaria survives winter as mycelium or spores in infected plant debris left on or in the ground, under favorable conditions in the spring, the spores quickly mature into fungal leaf spots

that release more spores carried to other plants by wind and splashing rain. This cycle repeats throughout spring and summer for as long as favorable conditions persist.

Cultural control

Removing plant debris from garden plots each fall and then tilling the plot. Prune off the over maturedshoots.

Chemical control

Apply 0.2% Indofil M45. A second spray may be done if the disease is more severe. The leaf can be used for silkworm rearing 14 days after the fungicide spray.

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