Plant Pathology

Dr.M.Gopi

Unit - I

History of Plant Pathology

The literature on human civilization from ancient times speaks of the truth that ever since man started depending on plants for his needs the enemies of plants have been harming the organized agriculture and creating conditions of food shortage. The plant diseases and the science of plant pathology was drawn first only in the European countries.

The Greek philosopher Theopharastus who recorded some observations on plant diseases namely 2400 years ago. However the agriculture itself is nearly 4000 years old.

In Ancient religious literature the role of plant diseases has been quoted. Rigveda, Atharveda (1500 – 500 BC) the Artha shashtra (321 – 186 B.C), Vishnu puranam (500 A.D.), Agnipuranam (500 – 700 A.D.) etc. are ancient books from India where plant disease and other enemies of plant have been mentioned along with the methods to control them. Agriculture had developed nearly 4000 years ago and special attention was given to plant disease and pests. They were blight, wilt, root rot etc. Vraksha Ayurved, a book written by Surapal in ancient India mentioned the plant disease. The plant disease were divided into two groups. 1. Internal (Physiological disease) and 2. External (Infection disease). The Internal disease were due to the disorder in the system of plant while extend disease were due to the attack by the microorganisms and insects.

Hygiene, tree survey, protective covering with parts and special culture of plants, practices which are in many diseases still recommended were known in ancient India. In chemical treatments use of honey, ghee, milk, barley flour, pastes made from herbs, plant extracts etc were recommended. For control of root disease oil cakes of mahuva, mustard, sesamum, castor etc. were used.

Symptoms of plant disease are mentioned in Bible, shakespeares poems and dramas and other christian literature. The diseases rust, smut, downy and powdery mildews, blight are quoted very often in Bible.

In 1675 Dutch worker Leeuwen Hook developed the first microscope and in 1683 he described bacteria seen with this microscope. The Italian botanist Micheli (1679 – 1737) was the first scientist who studied fungi and their spores.

In 1755 French botanist published paper on burnt / stinking smut of wheat. In early 19^{th} century scientists like Parsoon (1801) and Fries 1821 were studied the classifications and nomenclature of fungi believed that microorganism originated from disease, the French scientist Prevost proved in 1807 that disease were caused by microorganisms.

During 1830 – 1845 when late blight of potato was fast spreading in England and Europe. Berkeley (1846) Morren (1845) and Von Martius (1842) were who believed that late blight of potato was caused by the fungus.

Modern plant pathology was laid by the German Scientist Anton de Bary (1831 – 1888). He studied the heteroecism nature of rust fungi and their parasitic nature, and role of enzymes in the interaction between pathogens and the host.

In 20th century the scientists were studied the genetics of plant disease resistance they were Biffen (1905, 1912) and Orton (1900, 1909). They worked on control of rust and of wilt disease of cotton, water melon, cow pea etc. The Swedish scientist Erikson (1984) found the existence of physiologic races in rust fungus. Ward 1903 and Salmon 1903, discovered physiologic specialization in rust and powdery mildews of cereals.

Burgeff in 1912 and 1914 stated that with in a cell of fungus fusion between dissimilar nuclei can occur. This phenomenon he called heterokaryosis. The first demonstration of origin of physiologic races through heterokaryosis was given by Hansen and Smith in 1932.

Louis Pasteur and Robert Koch had proved in 1876 anthrax of cattle was caused by a spcific bacterium. American scientist T.J. Burrill in 1878 the blight disease of apple was caused by bacterium

The plant disease with which association of nematode could be noticed was first reported by Needham in England in 1743 AD. In 1857 Brekeley and Schacht had discovered root knot nematodes. The discovery of Tobacco Mosaic by Meyer in 1886. Smith 1891 first time demonstrated that budding or grafting could be another method of transmission of plant viruses. 1892 Ivanowski demonstrated the TMV can pass through bacterial cells. In 1898 Beijerinck proved that the viruses inciting TMV is not a microorganisms.

Discovery of viruses was published in 1935 by Stanley. In 1936 Bawden in England found that the crystalline powderof the viruses contains protein and nucleic acid. In 1956 Gierver and Schramm separated the protein from nucleic acid and reproduced the virus by inoculating the acid on healthy plant. In 1967 Japan scientist proved that mycoplasmas could be responsible for most of the yellow disease supported to be caused by viruses in Plants.

The study of fungi in India was initiated by Europeans in 19th century. They used to collect the fungi in India and send them for identification to laboratories in Europe. K. R. Kirtikar was the first Indian scientist who collected and identified fungi in this country. Then British Government established the Agricultural Research Institute, at Delhi in 1934. E.J. Butler initiated the study of Indian fungi and disease caused by them. He may be considered as the father of Plant Pathology in India.

Bulter for the first time identified the disease like wilt of cotton different disease of Rice, Palm, Sugarcane and potato. His best contribution to plant pathology in India is Fungi and Disease in Plants written by him and published from Calcutta in 1918.

The detailed study of fungi and plant disease by J.F. Dastur 1986 – 1971. His special field of study was the genes phytophythora and disease of castor and potato. After the Butler in 1920 B.B. Mundkur started work on control of cotton wilt. He is also responsible for identification and classification of a large number of Indian smut fungi. K.C. Mehra of Agra made an outstanding contribution to plant pathology by discovering the disease cycle of cereal rust in India.

Plant Diseases

Non – Parasitic

Diseases incited by

1. Low Temperatures
2. High Temperatures
3. Unfavourable oxygen relations
4. Unfavourable soil moisture relations
5. Accumulations of injurious impurities
6. Lightening injury
7. Mineral dificiencies
8. Mineral excesses
9. Injurious atmospheric gases etc.

Parasitic

Disease incited by animal parasites

1. Insects
2. Nematodes
3. Protozoa
4. Birds
5. Other animals

Virus

Disease incited by Plant – Parasites

1. Bacteria
2. Fungi
   a) Myxomycetes
   b) Phycomycetes
   c) Ascomycetes
   d) Basidiomycetes
   e) Deuteromycetes
3. Algae
4. Phanerogams

THE IMPORTANCE OF PLANT DISEASES

The plant diseases are important because of the loss they cause. The loss can occur in the field or in the store and at any time between sowing and harvest. In India alone crop diseases are destroying food grains and other products to the tune of Rs. 500 crores every year. Standing crop in the field is attached by a disease and plants start drying or their capacity to yield satisfactorily is reduced. Thus the farmer gets only a portion of the estimated yield. In apple orchards collar rot attacks 10 – 15 years old trees and they are destroyed. These trees would have, otherwise, survived and produced fruits for another 25 to 30 years. The harvest is transported and fruits and vegetables start rotting during this period. Microorganisms destry fresh food materials in the store.

The late blight of potato is a famous example of what a plant disease can do to change the course of history. In 1845 this disease destroyed the potato crop. In England and certain parts of Europe potato was the stable diet of the population. This disease had started in this countries as early as 1830 and every year was caring some damage resulting in food shortage. In England Import of food grains was not permitted. When late blight destroyed potato crop in 1845. There was a problem in these countries. Due to their population of 80 lacs was reduced to 60 lacs. A large number of people died of hunger and many more because diseased due to physical weakness. There was migration of the population to other countries including the North American. This single disease forced man to realised the importance of plant disease. As a result scientific investigations were taken up, the cause of the disease was identified and use of chemicals for plant disease control came in to existence. The late blight epidemic not only brought the science and plant pathology, it caused many social and political changes in the affected countries. Free trade of England was permitted and food grains and other food stuffs were allowed to be imported from abroad. In order to product shipping to country had to strengthen its navy. People who had migrated settled in other countries and helped in the development of nations like the USA.

Principles of Plant Pathology

"Diseases exact a heavy toll of crop yields and cause considerable damage to crops year after year. Diverse methods have been adopted from time to time to mitigate the ravages caused by these diseases with varying amounts of success. The acute shortage of food supplies in several countries and the rapid increase in population have, in recent years, brought to the forefront the dire necessity to conserve as much of the crop yields as possible by reducing the losses caused by diseases".

To check the plant diseases, it becomes necessary to know about the cause of the disease, of the life-history of the causal organism and of the meteorological conditions which influence the host and parasite interaction.

Control measures may be divided into two main groups (1) Prophylaxis and (2) Immunization / disease resistance.

Prophylaxis – protection of the host from exposure to the pathogen, from infection / from the environmental factors favourable to disease development.

Immunization / disease resistance - implies the improvement of resistance of the host to infection and to disease development. This method is generally used as a means of control by the development of strains of the host through hybridization and / or selection, which are more resistant to one / more pathogens.

Prophylaxis is implies to a wide range of control measures. Such variations of control measures are being considered under three sub groups.

(i) Exclusion (ii) Eradication and (iii) Direct protection.

Symptoms

The diagnosis of a disease means the discovery of its identity of nature. Symptoms are the outward signs by which a diagnosis is assisted.

Symptoms caused by FUNGI – (1) Withering and wilting – The first indication of fungus infection is often the withering of the whole plant / off some part of it. The term wilting is applied to those cases where a whole plant dries up more / less suddenly from fungus attack at the roots / base of stem. (2) Pallor – This is due to destruction of chlorophyll in the leaves. It is common sign of the presence of a parasite in / on the pale area. (3) Damping-off – This is applied to the sudden collapse of seedlings, which are affected at the base of the stem and fall over from weakening of the tissues at this point.

(4) Leaf spot – Various types of leaf-spots are produced by many fungi. These spots are very varied in colour, according to the plant and parasite. The pallid spots are commonly seen in the mildews and in early stages of several other parasitic attacks. (5) Shot-hole – In certain cases, the dead tissue of the spot is shed, and a circular perforation known as shot-hole is left. They are common in fruit trees such as peach and plum. The fungi responsible for causing shot-holes are mainly the species of Cercospora, Phyllosticta, etc.

(6) Scab – This is applied for cracking of the outer layers of fruits / tubers. The broken skin becomes dry, flaky and corky. The scabs of apples and pears are caused by the species of Venturia and that of peaches by Cladosporium.

(7) Cankers – This is applied to the open wounds, often of a spreading nature, and sometimes surrounded by a raised, tumour-like margin are generally found on woody stems.

(8) Rotting – This is often caused by the species of Phytophthora (wet and dry rot of potato) and Pythium (stem and foot rot of papaya).

(9) Gummosis and fluxes – It is applied to several diseases of trees which are characterized by an exudation from the bark of the stem.

(10) Leaf and fruit dropping – In many cases, the leaves are dropped down by the action of leaf parasites such as Cercospora personata. Hemileia vastatrix. Dropping of fruits is caused by the attack of Phytophthora on palms and in some other cases.

(11) Blight and Blasts – Here the tissues of the affected parts are being destructed. They involve destruction of growing succulent tissues like shoots, leaves, blossoms and twigs. The common blights are – Shoot blight, twig blight, late blight, etc.

(12) Witches brooms – These symptoms appear on some trees and shrubs. The branch from which they arise is often swollen, and the shoots usually all turned upwards, short and with small leaves such as witches broom of mango.

Symptoms caused by BACTERIA

The symptoms of disease caused by bacteria are in main, similar to those caused by many fungi. The disintegration of parenchyma may be produced by species of Pythium as well as by species of bacterium.

Curling, spotting and blotching of leaves are caused by bacteria, fungi and viruses. Cankers and proliferation of shoots are also caused by bacteria and fungi. Stunting and wilting are caused by fungi, bacteria and viruses.

Crown gall and leafy gall are caused by bacteria.

The formation of pale chlorotic areas surrounding leaf spots are indications of bacterial attack.

The other common symptoms produced by bacterial attack are – blight, fire blight, angular leaf-spot, black rot, ring rot, hairy rot, scab, etc.

Symptoms caused by VIRUSES

Plant viruses can be recognized easily by the symptoms they produce on the host. Sometimes the same virus can cause widely different symptoms on different host plants, and the symptoms may vary in the same plant according to its age, nutrition and other environmental factors. Symptoms may sometimes be produced by a mixture of two / more viruses on the same plant. A few more common and easily detectable symptoms are given here:

Chlorosis – Due to the presence of plant viruses, the chlorophyll of the green parts disappears at places, leaving yellowish spots, this is known as Chlorosis. The presence of yellow spots at places in the green tissue appears like a "mosaic" diseases. The viruses causing most mosaic diseases are mechanically transmitted and usually have aphid vectors in nature.

Yellow – When the chlorophyll disappears completely (Chlorosis, yellowing, bronzing / reddening) from the host tissue, the organs turn yellow and the symptoms are known as yellows. These viruses are generally transmitted by leaf-hoppers, and they are relatively sensitive to heat treatment.

Vein clearing and vein banding – The disappearance of chlorophyll along the veins of the leaves is known as vein clearing and when chlorophyll surrounding the veins disappears the symptom is known as vein banding.

Necrosis – The brownish spots due to the death and ultimate drying of the tissue are known as necrotic spots and the phenomenon is known as necrosis. Necrotic spots are also known as lesions.

Ring spots – These symptoms are characterised by the appearance of chlorotic / necrotic rings on the leaves and sometimes also on the fruit and stem. Most ring spot-causing viruses are being transmitted by nematods.

Other symptoms – Bunchy top, galls, hypertrophy, atrophy, rolling, curling, crinkling.

Unit - II

Dissemination of Pathogens

A plant disease may spread from plant to plant and from one locality to another. When the disease is caused by the plant pathogen, the plant pathogens are being carried by one means / another to uninfected plants and uninfected localities. The spread of such diseases of plants, depends on some agency of dissemination such as air, water, animals, birds, insects and man.

Dissemination by air – The air serves the largest number of pathogens and permits the most rapid and widespread distribution of them. Strong wind gusts are effective in dislodging and carrying the masses of fungal spores, bacteria, pollen, etc., to a reasonable height, and thus making them available to the convection currents of wind which carry them to great height. Dissemination by two ways (1) by wind distribution of diseased plant parts and (2) by wind dispersal of spores and vegetative cells. Rusts and smuts are produce large number of spores.

Dissemination by water – by two ways (1) as a medium in which actively motile organisms / spores may swim about, and (2) by the mechanical action of run off of rain; the flowing of irrigation water / by stream flow. Actively motile cells may be produced by some bacterial pathogens, the chytrids, the white rusts and few downy mildews. Such forms depend wholly or partially upon liquid moisture as a medium in which they may develop and through which they may migrate by the movement of their flagella.

Transmission of plant viruses

Plant viruses rarely come out of the plant, and therefore, they cannot be disseminated as such by wind / water. However, viruses are being transmitted from plant to plant in a number of ways such as vegetative propagation, mechanically through sap and by seed, pollen, insects, mites, nematodes, dodder and fungi.

Insect transmission – The most common and economically most important means of transmission of viruses in the field is by insect vectors. The most important insect vectors belong to the order Homoptera, which includes aphids and leaf hoppers. The other important insects are the white flies, the mealy bugs, the scale insects and the tree hoppers. The other important insects are the white flies, the mealy bugs, the scale insects and the tree hoppers. However, these insects also belong to the families of the same order (Homoptera). A few insect vectors belong to other orders. For example, true bugs belong to Hemiptera, the thrips to Thysanoptera; the beetles to Coleoptera and the grass hoppers to Orthoptera. The most important virus vectors such as aphids, leaf hoppers, etc., possess piercing and sucking mouth parts. The other unimportant insect vectors have chewing mouth parts. All the insect vectors can not transmit different viruses indiscriminately. For example early top virus of beet root is transmitted only by a leaf hopper Eutettix tenellus, and cannot be transmitted by any other sucking insects found on beetroot leaves. The period taken by the virus for developing infectivity within the vector is known as incubation period.

Mite Transmission – The mites belonging to two families, Eriophidae and Tetranycidae, have been found to transmit several plant viruses. They transmit the wheat streak mosaic and peach mosaic virus and potato virus Y. These mites possess piercing and sucking mouth parts.

Nematode transmission – About a dozen plant viruses have been reported to be transmitted by soil-inhabiting ectoparasitic nematodes. The nematodes belonging to the genera Longidorus and Xiphinema are vectors of polyhedral-shaped viruses such as tomato black ring, rye grass mosaic viruses, etc. whereas the nematodes of the genus Trichodorus are the vectors of rod-shaped viruses, such as tobacco rattle and pea early browning viruses. Nematode vectors transmit viruses by feeding on roots of infected plants and then moving on to roots of healthy plants.

Fungus transmission – A few fungi have been found to be responsible for transmitting the viruses. The root-infecting fungus Olpidium brassicae transmits three plant viruses, tobacco necrosis, lettuce big vein and tobacco stunt viruses. Synchytrium endobioticum transmits potato virus X and potato mop top virus, while Polymyza graminis tranmits wheat mosaic virus.

Dodder transmission – Several plant viruses are being transmitted by the parasitic plant dodder (Cuscuta sp.). Usually the virus is being transmitted passively in the food stream of dodder plant, which has been acquired from the vascular bundles of the infected plant by the haustoria of Cuscuta and after translocation through the phloem of Cuscuta, it is introduced in the next plant by the newly developed haustoria produced in contact with the vacular bundles of the host plant. Many viruses have been reported to be transmitted by this method between plants belonging to widely separated taxonomic orders.

Unit - IV

Disease Forecasting

The forecasting of plant diseases requires the complete knowledge of the influence of weather conditions on the appearance and severity of disease, and of epidemiology of plant disease. Sometimes, the forecasting of plant diseases may be known as applied epidemiology. The knowledge of weather conditions and epidemiology in relation to plant diseases may be utilized in the prediction of plant diseases. When the favourable weather conditions for the disease incidence prevail, the disease epidemic can be predicted. The host, parasite and weather interactions are always responsible for any epiphytotics.

The forecasting services are utilized for giving information to the farmers of a particular area, that weather conditions are favourable for the appearance of disease in epidemic form, and control measures should be adopted in due course of time, to check the disease incidence.

On the basis of disease-weather relationship, the forecasting services have been introduced in several countries. Forecasting services have been organized in Great Britain, France, Germany, United States of America, Canada, Netherlands and Russia for late blight of potato; in France, Germany and Italy for downy mildew of vine; in New Zealand, Australia, Netherlands, USA for wheat leaf rust and in Russia for ergot of rye.

Forecasting of the blight of potato is of much importance in European countries, the United States of America and Japan. It is based on weather-blight relationship of different localities and the synoptic weather data collected in meteorological observations. Records obtained by United States of America and Japan. It is based on weather-blight relationship of different localities and the synoptic weather data collected in meteorological observations. Records obtained by United States Weather Bureau indicates that blight makes its most rapid development when the daily average temperature is 22.2 °C. A relative humidity of 95 % / more for a duration of eight hours is necessary for free production of viable sporangia. When such conditions prevail, the spraying of fungicides may be taken in advance of the attack.

No forecasting services are available in this country. However, some work on epidemiology has been done in Darjeeling district of West Bengal. The analysis of synoptic weather data for seven consecutive years has shown that temperature is always favourable for the spread of late blight of potato, but the humidity is not so.

Unit - V

Blast Disease of Rice

Rice (Oryza sativa Linn.)

Diseases Incited by Fungi – Blast Disease

Pathogen – Pyricularia oryzae Cav.

Systematic Position of Pathogen :

Class - Deuteromycetes,

Order - Moniliales,

Family - Moniliaceae

Distribution - All the rice growing countries of the world. In India – Southern rice growing areas. Heavy loss in Tamil Nadu, Andhra Pradesh & Orissa. Reported in Other states : Maharastra, Gujarat, Punjab, Kashmir, Bihar, West Bengal, Uttar Pradesh & Assam.

Symptoms – Blast disease affects the crop in all stages. All the aerial parts of plants are being infected. Symptoms found on the leaf blades, leaf sheaths, rachis, joints of the culms and sometimes even on the glumes. The characteristic, isolated, bluish-green, necrotic lesions, with a water-soaked appearance are formed on the leaf-blades. Lesions are broad in the centre and possess narrow elongations on its top and bottom. Favourable condition lesions increase in number, ultimately drying of the leaves, seedlings wither and die. Symptoms appear in the form of necrotic leisons both on the leaf-lamina and the leaf sheath. Necrotic lesion is spindle shaped, grey in the centre, remains surrounded by brown and yellowish zones. Outer rim of the lesion changes to a dark brown colour. Due to heavy lesions, the leaf looks blasted appearance.

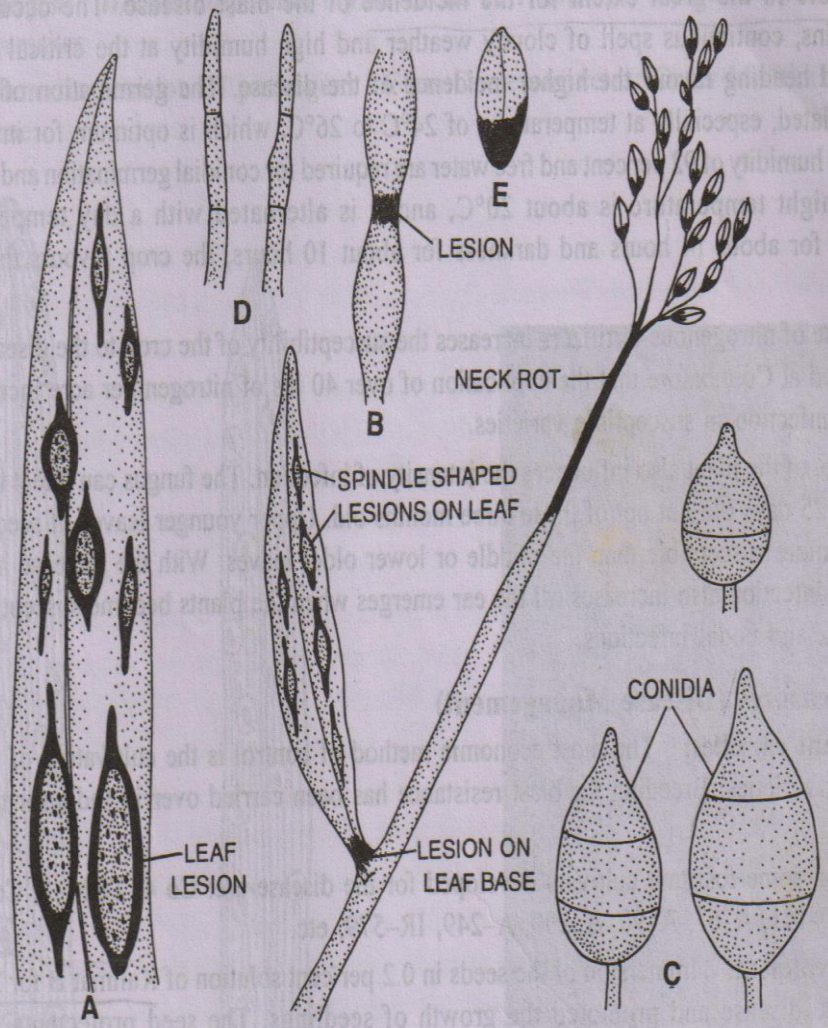

Fig. 14.2 Blast disease of rice (*Pyricularia oryzae*). A, a portion of infected leaf showing characteristic spindle-like lesions; B, infected leaf and culm; C, pyriform conidia; D, conidiophores; E, infected grain.

Pathogen – Blast disease of rice is caused by an imperfect fungus Pyricularia oryzae Cav. The perfect stage of fungus is not known as yet. Fungus when young possess hyaline and septate mycelium. On maturity the colour of mycelium changes to olive – brown. Mycelium may be inter / intracellular within the host tissues. Conidiophores are given out through the stomata / through the epidermal cells, singly / in small clusters. Conidiophores are septate (2/4 septa, rarely branched, greyish). 7 – 9 conidia are produced on each conidiophore. Each conidium is obpyriform / obclavate, hyaline, septate and with small basal appendage. Size ranges from 14 – 40 µ in length & 6 – 15 µ in width. Physiologic races of the fungus are found in different regions. Nature of disease – Seed borne in nature. Predisposing Factors – Infection is greatly influenced by the environmental factors.

Control Measures :

Resistant Varieties - Most economic method of control – cultivation of resistant, high-yielding varieties. Breeding programme in last 3 – 4 decades.

Seed treatment – Immersion of seeds in 0.2 % solution of Kalimat B for 24 hours. Seed protectants such as agrosan GN, arasan, phygon and spergon – control the diseases. Treatment with organomercurial compounds is effective. Hot water treatment also effective. 0.1% solution of uspulum for six hours gave effective control.

Spraying and dusting – Bordeaux mixture has been proved quite effective against neck and node infection after the flowering of the crop. Other copper fungicides – perenox, coppesan & cupravit. Dusting of organomercurials has been suggested for controlling blast.

Sanitation – plant debris collected and destroyed.

Proper manuring – reduce the nitrogenous fertilizers. Manuring should be balanced by the application of potassic and phosphatic manures.

Red rot of Sugarcane

Sugarcane (Saccharum officinarm Linn.)

Pathogen : Colletotrichum falcatum Wint.

Systematic Position :

Class : Deuteromycetes

Order : Melanconiales

Family : Melanconiaceae

Distribution - Most serious and destructive disease in India. This disease is found in all the sugar-cane growing States of our country. It occurred in a destructive form in eastern Uttar Pradesh and northern Bihar between 1939 and 1942.

Symptoms - External : upper leaves of a shoot, begin to lose colour and wither at the tip. Symptoms are conspicuously seen on the stems and midribs of leaves. Infected stems are completely rotted, loses its bright natural colour, shrinks at the nodes. The black dot-like structures appear on the shrunken internodes. On splitting open a cane, an alcoholic smell is emitted, tissues are found to be reddened, it is most intense in the vascular bundles, but extends to the pith. Cavities develop in the pith, usually containing a dense growth of mycelium. The conspicuous symptoms also appear on the mid-rib of leaves. Dark-reddish area develops on the mid-rib. It soon elongates and a blood – red lesion with dark margins is developed. IN mature lesions the centre becomes straw-coloured, and the black dot-like acervuli develop in it.

Pathogen – Caused by Colletotrichum falcatum Wint. The stage is known as Physalospora tucumanensis Spegazzini of class Ascomycetes,order Sphaeriales and family Mycosphaerellaceae.

Mycelium of the fungus is inter-cellular and chiefly formed in the parenchymatous cells of the pith. The hyphae are thin, hyaline septate, profusely branched and containing oil globules. The acervuli, developed on rind as well as on mid-rib of leaves, are minute dot-like, black and velvety. The long septate, rigid, bristle-like setae arise from the hymenium of the acervulus. The are upto 200µ long and 4µ broad. Numerous clavate, single celled hyaline conidiosphores also arise from this hymenial layer. Each conidiophore is 20µ long and 8 µ broad. The conidia which are developed singly on the conidiophores, are single-celled, hyaline, falcate, thin-walled, granular and measuring 16 – 48µ x 4 – 8 µ. In artificial cultures, terminal or intercallary, thick-walled, greenish-black chlamydospores are formed.

Nature and Recurrence of Disease – Seed borne as well as soil borne. Primary & secondary infection by Conidia in Leaves and the stem infections takes place through insect borers and root primordia.

Control Measures

Inspection – crop should be thoroughly inspected several times & infected plants should be destroyed by burning them.

Avoid water-logging – water logging should always be avoided.

Inspection of sets – Prior to sowing, if any type of reddening is found, they should be discarded for sowing.

Sanitation – After harvesting the crop and plant debris should be destroyed carefully by burning them.

Crop – rotation - crop rotation of two years should be practiced, so that the inoculum present in the soil may be destroyed completely.

Discourage ratooning – ratooning of infected plants should always be discouraged.

Avoid sowing of susceptible varieties – Co. 312, Co.331, Co.213, Co.290, Co.210, Co.313, Co 513.

Resistant varieties – Only resistant varieties should be grown. Co. 453, Co.393, Co.356, P.O.J. 7878 were found to be fairly resistant.

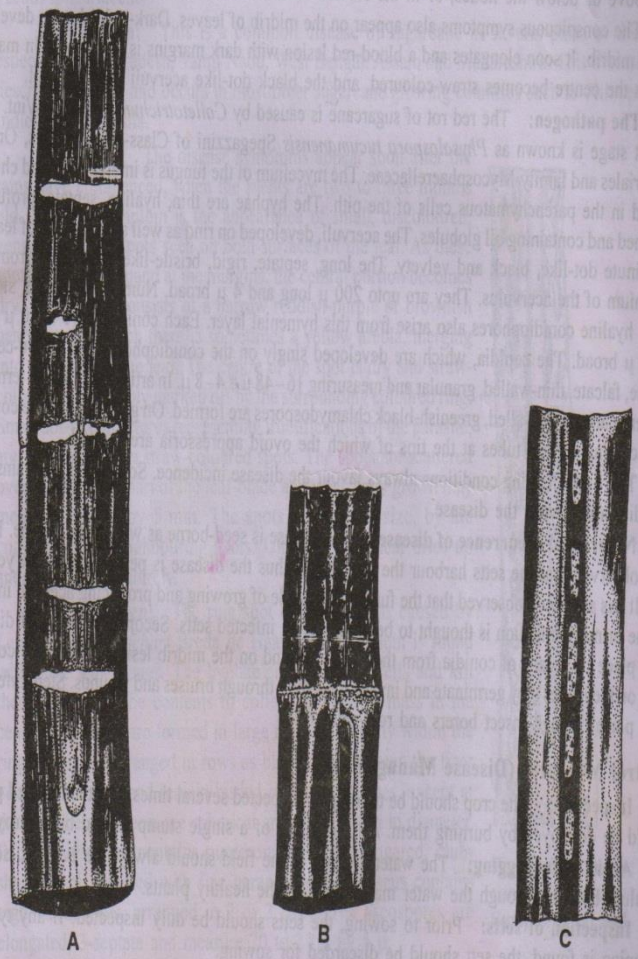

Fig. 21.4 Red rot of sugarcane (C.O. *Colletotrichum falcatum; perfect* stage, *Physalospora tucumanensis*). Symptoms, A. stem cut lengthwise showing longitudinal red streaks transversely cut by white patches; B, shrunk stem of cane; C, affected midrib of leaf.

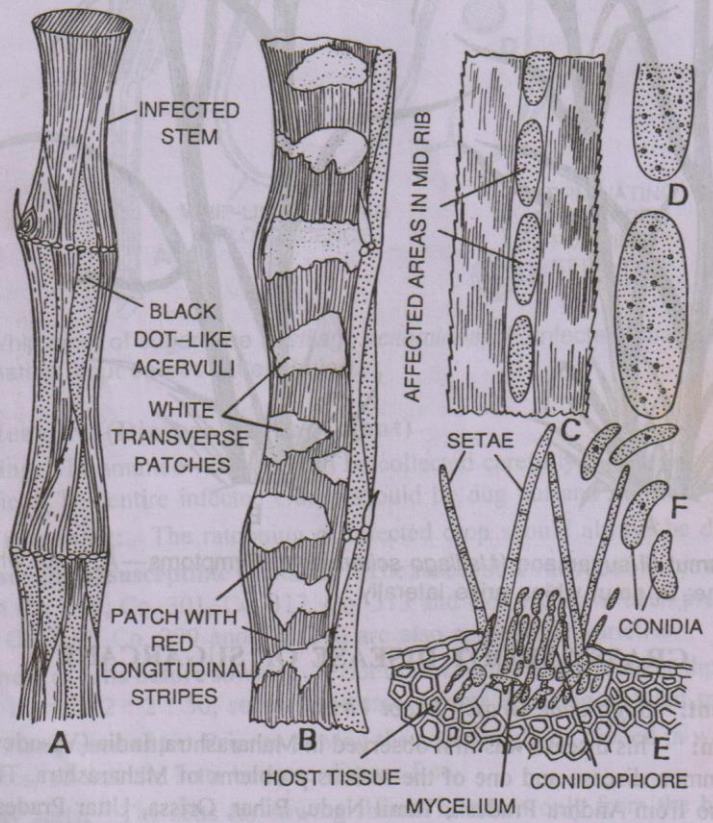

Fig. 21.3 Red rot of sugarcane (*Colletotrichum falcatum*). A, infected stem showing black dot-like acervuli; B, L.S. of infected stem showing red longitudinal stripes and white transverse patches; C, infected leaf showing black dot-like acervuli on straw coloured midrib patches; D, magnified straw-coloured midrib patches with acervuli; E, section of infected leaf through acervulus showing mycelium, conidiophores, conidia and setae.

Tikka disease of Ground Nut

Ground Nut / Pea Nut : ***Arachis hypogea*** L.

Pathogen : (i) *Cercospora personata* (Berk. and Curt.) Ell. and Ever Perfect stage *Mycosphaerella berkleyi* Jenkins.

(ii) Cercospora arachidicola Hori. Perfect stage – Mycosphaerella arachidicola Jenkins.

Systematic Position :	Imperfect stage	Perfect stage
Class :	Deuteromycetes	Ascomycetes
Order :	Moniliales	Sphaeriales
Family :	Dematiaceae	Mycosphaerellaceae

Distribution - world wide disease. United states, many african countries, Philippines, Indonesia, India, Australia, etc., Every year in Uttar Pradesh.

Symptoms – (i) *C. personata* - All the parts are affected, especially lesions on the leaves about 1 – 6 mm in dia. rounded. The spots are dark brown / black and found on both the surfaces of the leaf. (ii) *C. arachidicola* – irregular and bigger in size. 4 – 10 mm in dia.

Pathogen – (i) *C. personata* - Mycelium is intercellular, brown, septate, branched and slender. To absorb food materials from the host tissue, the branched haustoria are developed. Conidiophores are 24 – 54 m long and 5 – 8 m broad. They are either septate / 1-2 times septate. Conidia – terminal, cylindrical, obclavate, 1 – 7 times transversely septate, 18 – 60 m long and 6 – 11 m broad. (ii) C. arachidicola – Mycelium is intracellular, brown, septate, branched, slender and without any haustoria. The conidiophores are yellowish-brown. Conidiophores are aseptate, 22 - 41µ long and 3 – 5 µ broad. Conidia – yellowish, obclavate, 3 – 12 time septate, curved, 38 – 108 µ long and 3 – 6 µ broad.

Nature and recurrence of disease - Soil borne disease. The primary infection is caused by means of conidia found on the plant debris in the soil. Spreading of disease by means of conidia which are dispersed by wind.

Control Measures (Disease Management) – Sanitation & Crop rotation. Use of Phosphatic and Potassic manures, and mixed cropping with arhar. The spraying with 2:2:50 Bordeaux mixture, 0.15 % perenox & 1.5 % cupravit. Sulphur dusting (400 meshes per sq. inch) is quite effective. Resistant varieties should be sown.

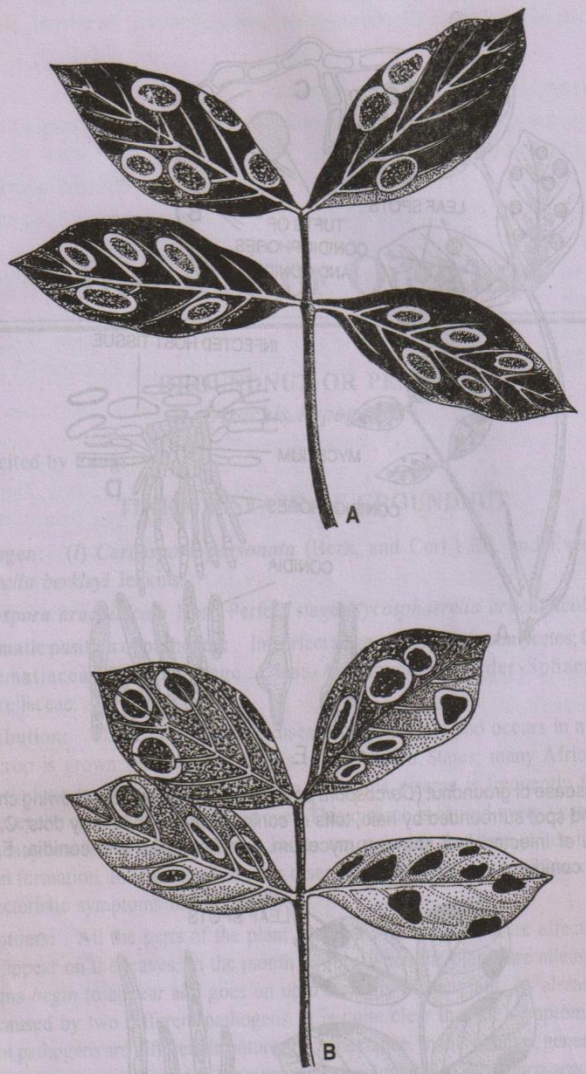

Fig. 17.3 Tikka or leaf spot disease of groundnut. Symptoms on leaflets. A, leaf spots caused by *Cercospora personata;* B, symptoms on leaflets by same fungus;

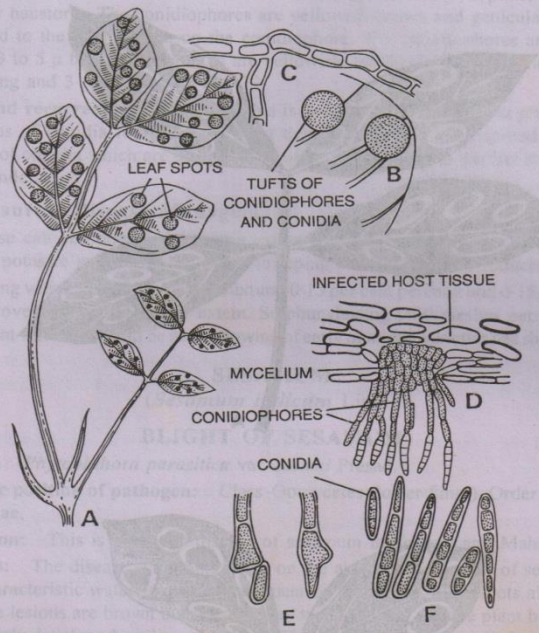

Fig. 17.1 Tikka disease of groundnut (*Cercospora personata*). A, infected leaf showing characteristic leaf spots; B, round spot surrounded by halo, tufts of conidiophores denoted by dots; C, geniculate mycelium; D, V.S. of infected leaf showing mycelium. conidiophores and conidia; E, apices of conidiophores; F, conidia.

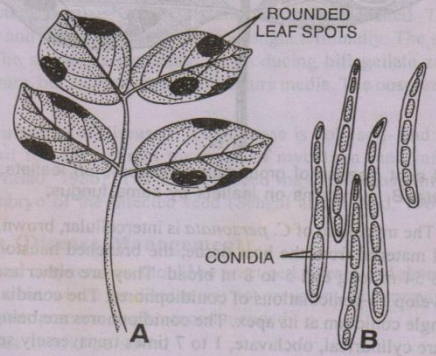

Fig. 17.2 Tikka disease of groundnut (*Cercospora arachidicola*). A, affected leaf showing characteristic round spots; B, elongated, transversely septate conidia.

Bacterial Leaf Blight of Rice

Pathogen : *Xanthomonas oryzae* (Uyeda and Ishiyama) Dowson.

Systematic Position of Pathogen :

Class	:	Schizomycetes
Order	:	Pseudomonadales
Family	:	Pseudomonadaceae

Distribution - recorded from Japan, Philiippines, China and Mexico. In India, it is observed in South India, later Bihar and other parts of North India, now it is in all parts of the country.

Symptoms – Appears early in August. Along the margin of the leaf – blade / along the prominent veins. In seedling stage the tips of the leaves are affected. Ultimately the leaves dry up and the plants die. The vascular bundles remains filled with bacteria.

Pathogen – Bacteria is rod shaped 0.5 – 0.8 x 1 – 2 µ. They occur singly / in pairs, Gram negative, aerobic with single polar flagellum, non-sporing.

Infection – takes place through wounds. Nitrogenous fertilization of the crop increases the incidence of the disease.

Predisposing Factors – Rainy weather, dull windy days and a suitable temperature of 22° - 26°C favour the incidence of the disease.

Control Measures :

Resistant varieties – Most economic & easy method of control is to sow the resistant varieties. Kidama variety is highly resistant for this disease.

Use of fungicides – Spraying of copper fungicides alternately with Streptocycline (250 ppm) has been proved to be useful to some extent. Soaking of seed for eight hours in Cereson (0.1 %) & Streptocycline has been recommended.

Citrus canker

Pathogen : *Xanthomonas citri* (Hasse) Dowson.

Systematic Position :

Class : Schizomycetes (Bacteria)

Order : Eubacteriales

Family : Xanthomonadaceae

Distribution – World wide distribution, recorded from Gulf States of North America, South Africa, Mediterranean region, Pacific region, Ghana and India. In India this is the most commonly prevalent disease of kagzi lime during the rains.

Symptoms – The disease affects the leaves, twigs, thorns and fruits. All parts with brown spots surrounded by dark-brown, glossy margins. The lesions appear as small yellowish spots, 3 / 4 mm dia.

Pathogen - Caused by Xanthomonas citri. Bacteria enter through the stomata and wounds caused by spines and multiply in the cortex to which they are confined.

Control measures (Disease Management) – Removing the infected branches and spraying the plants with Bordeaux mixture (5 : 5 : 50) / spraying 3 – 4 times in a season with antibiotic the streptocycine (Hindustan antibodies) at the rate of 1 gm in 45 litres of water / intermitantly spray of a suspension of “Neem cake” at 1 Kg in 20 lt of water.

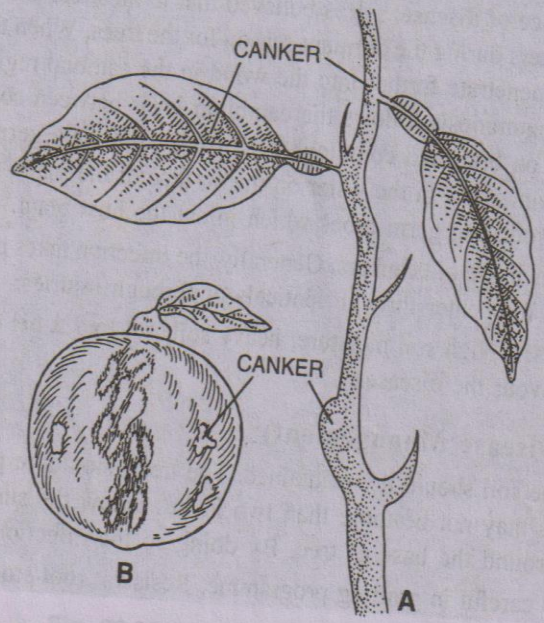

Fig. 20.23 Citrus canker (*Xanthomonas citri*). A, infected citrus fruit showing canker symptoms B, infected twig, showing canker symptoms on leaves and stem.

Fig. 20.24 Citrus canker. A bacterial disease. Symptoms (canker) seen on leaves and fruits.

Leaf Curl of Papaya

Causal Agent : A virus transmitted by white fly *Bemisia tabacai* Gen.

Very common disease of Papaya. First time, the disease was observed in TN in 1939. Now commonly found in the states of Uttar Pradesh, Bihar, Andhra Pradesh, Karnataka, Kerala. Young and old plants are affected by this diseases and produce poor crop of the fruits.

Symptoms : symptoms of the disease are very conspicuous. Almost all the leaves are reduced in size and show malformation and severe curling. The margins of the leaves curve inward. The affected plants are sterile.

Control Measures : Diseased plants must be uprooted and destroyed. Insecticidal sprays should be used to control whitefly vector.

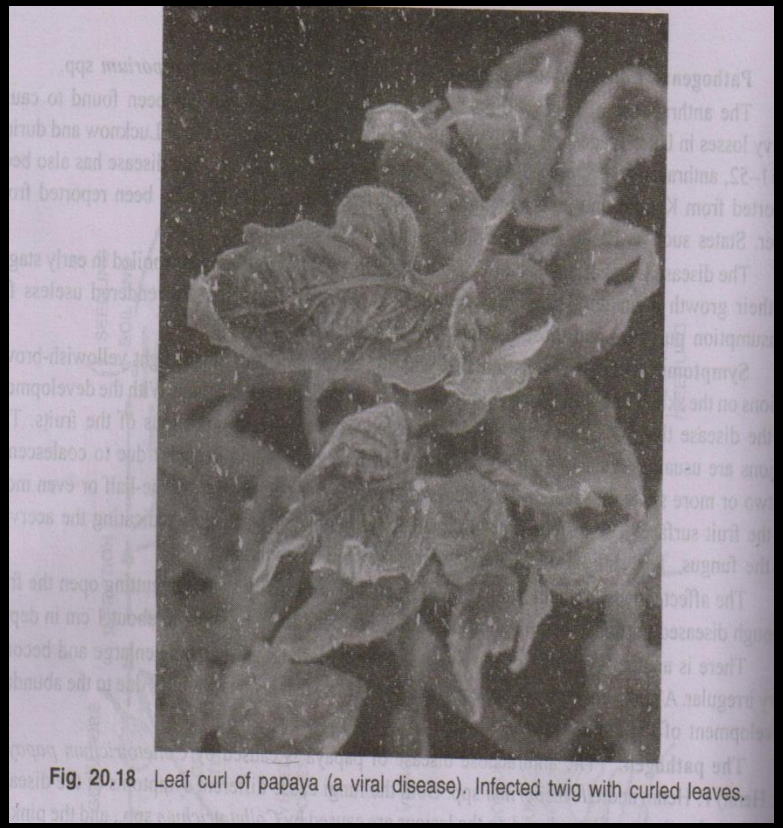

Fig. 20.18 Leaf curl of papaya (a viral disease). Infected twig with curled leaves.

Fusarium Wilt of Cotton (Gossypium hirsutum)

Pathogen – *Fusarium oxysporum* f. *vasinfectum* (Atk.) Snyder and Hansen; Syn. *F. vasinfectum* Atk.

Systematic Position –

Class	:	Deuteromycetes
Order	:	Moniliales
Family	:	Tuberculariaceae

Distribution – All over the world. It is believed that it has started from Mexico / Central America. Reported from many other countries such as Africa, France, Italy, West Indies, etc., In India, the disease has been recorded from several states especially Maharashtra, Madhya Pradesh, Gujarat and other parts of central India. It is restricted to black cotton soils.

Symptoms – The fungus attacks the host when the plants are 1 – 3 week old. The leaves become yellow and wither. The plants soon wilt and die. The vascular system of roots and shoots are blackened.

Pathogen – Caused by Fusarium oxysporum. Fungus found both inter-and intracellulary in the host tissue. Mycelium of fungus plugs the xylem vessels. The fungus secretes toxic substances, which also cause the wilting of the plants. It produce macro and micro conidia. Macroconidia 1 – 5 septate, thin walled, linear and falcate, whereas the microconidia – elliptical / spherical, thin – walled and 1 / 2 celled.

Nature and recurrence of disease – Soil borne as well as seed borne disease, facultative parasite and can remain visible in the soil for a long time. The fungus enter the host root. Fungus multiplies and moves to xylem vessels, ultimately vessels are plugged by abundance of mycelium. The soil borne fungal hyphae and chlamydospores play the major role in perpetuation of the disease.

Predisposing factors – Soil temperature ranging from 20°C to 30°C favour the disease incidence. Hot and dry periods followed by rains also favour the disease. Nitrogenous fertilizer increase the incidence. Restricted to the black cotton soils which are heavy clay with an alkaline reaction.

Control Measures (Disease Management) –

Resistant varieties – Use of resistant varieties is the only appropriate method of controlling this disease. Some resistant varieties are Vimar, daulat, G-22, G- 46, Vijalpa Digvijay, Sujaya and interspecific hybrid GDH – 22.

Seed Treatment – Treating the seeds with organo mercurials to some extent.

Exposure of soil to the sun – In north India, after deep ploughing, the soil is exposed to sun in June – July to kill the pathogen.

Proper manuring – Potash application reduces wilt incidence, whereas nitrogenous fertilizers are responsible for increasing disease incidence.

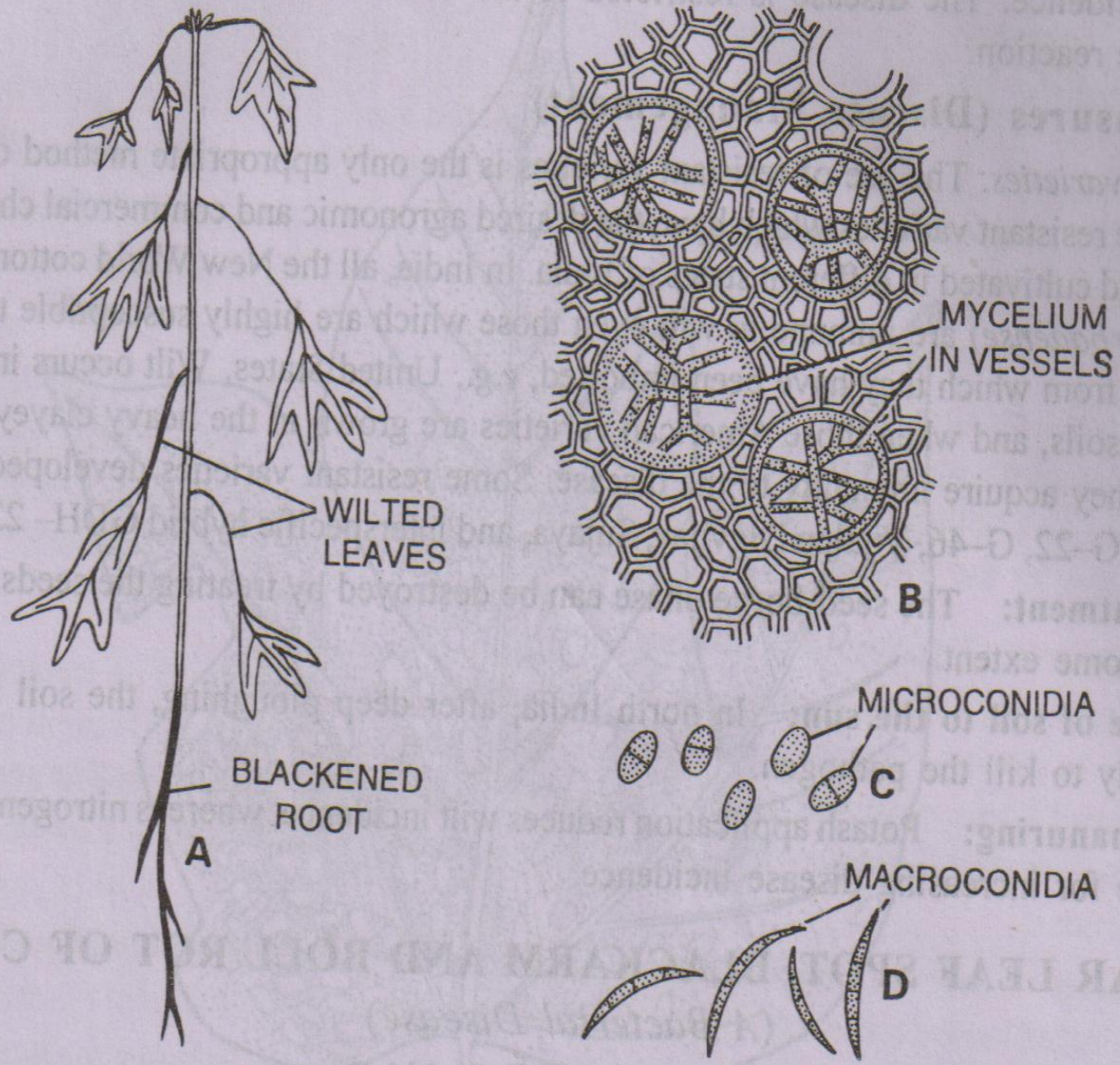

Fig. 18.3 Wilt of cotton (*Fusarium oxysporum f. vasinfectum*). A, wilted plant; B, mycelium in vessels of infected plant in transverse section; C, microconidia; D, macroconidia.