Introductory Lectures

PP-202 Introductory Plant Pathology 3(2-1)

Plant Pathology

Plant Pathology or Phytopathology is the branch of agriculture, which deals with the study of plant diseases. The detailed study includes the importance and occurrence, symptoms, cause, etiology, disease cycle, epidemiology and management of diseases.

The major objectives of plant pathology are:

i. To study the causes (biotic & abiotic) of plant diseases.
ii. To study the mechanism of plant disease development.
iii. To study the interaction between plant and pathogen in relation to environment and time.
iv. To develop effective system of management of plant diseases to minimize the losses caused by them.

Disease

Disease may be defined as "abnormal changes in physiological processes which disturbs the normal activity of plant organs" (Kuhn, 1858).

Disease is a condition in which the functions of the organism are improperly discharged or, in other words, it is a state, which is physiologically abnormal and threatens the life of the being or organs (Ward, 1896).

Disease is a variation from normal physiological activity, which is sufficiently permanent or extensive to check the performance of normal functions by the plant or completion of its development (Butler, 1918).

Disease is a deviation from normal functioning of physiological processes of sufficient duration of intensity to cause disturbance or cessation of vital activities (American Phytopathological Society, 1940).

Disease is a harmful deviation from the normal functioning of process (British Mycological Society, 1950).

Disease is defined as all the malfunctions, which result in unsatisfactory performance of the plant or which reduce ability of the plant to survive and maintain its ecological niche (Wheeler, 1975).

Importance and losses caused by Plant Diseases

Plant diseases are of immense importance to human beings by making the difference between a happy life and a life haunted by hunger or even death from starvation.

1. The death of a quarter million people from starvation in Ireland in 1845 is just one example.
2. Wheat rusts have been appearing in epidemic form from time-to-time in many countries forcing the farmers to change their cropping pattern and food habits.
3. Leaf blight of rice (*Helminthosporium oryzae*) was one of the main reasons contributing to the Bengal famine in 1943.
4. Regular occurrence of coffee rust in Sri Lanka was responsible to reduce the coffee export by 93 percent from 1871 to 1893, which ultimately forced the growers to substitute it with tea. This situation promoted coffee cultivation in Brazil and it became the major coffee producing and exporting country.

On global basis, of about 35 percent annual crop loss, 12 percent is due to diseases other than nematodes, 11 percent due to nematodes, 7 percent due to insect pests and 3 percent due to weeds (Cramer, 1967).

1. Plant diseases also result in increased prices of products to consumers.
2. They destroy the beauty of the environment by damaging plants around homes, along streets, in parks and in forests.
3. Plant diseases may limit the kind of plants and industries in an area.
4. Plant diseases reduce the quantity and quality of plant produce.
5. Plant diseases may make plants poisonous to humans and animals.
6. Plant diseases may cause financial losses.

Causes of Plant Diseases

1. Abiotic
2. Mesobiotic
3. Biotic

Classification of Plant Diseases on the basis of occurrence

1. **Endemic Diseases**: The diseases, which are of regular occurrence from year to year in moderate to severe form but are confined to a particular country or district.

2. **Epiphytotic Diseases**: The diseases, which occur widely but periodically. It may be present constantly in a locality but assumes a severe form only occasionally due to conducive environment.
3. **Sporadic Diseases**: The diseases, which occur at very irregular intervals and locations and in relatively few instances.
4. **Pandemic Diseases**: When a disease is prevalent throughout the country, continent or the world, it is known as pandemic disease.

Symptoms of Plant Diseases

Most plant diseases are named after their most characteristic symptoms. Symptoms are plant response against pathogenic attack.

Following is a list of common symptoms produced by plant pathogens

I. NECROSIS: Death of plant tissue, which often becomes blanched, and brittle.

1. **Leaf spots**: Well defined lesions of limited extent.
2. **Shot holes**: When the dead tissue of a leaf spot falls away as a characteristic feature of disease.
3. **Blights**: A general, extensive and rapid killing of leaves, flowers and twigs.
4. **Stripe**: Narrow elongated lesion
5. **Blotch**: Large, irregular spots or blots on leaves, shoots and stem.
6. **Scorch**: Burning of leaf margins, generally due to extensive heat.
7. **Pustules**: Small blister-like elevations of dead host epidermis as spores of the pathogen emerge. They may be white (white rusts) or yellow, orange, brown or black (true rusts)
8. **Downy mildews:** Foliage blights or leaf spots characterized by a fine silky growth of a fungus belonging to the family Peronosporaceae. They attack young, tender green parts.
9. **Seedling blight and Damping off**: Seedlings die suddenly and fall on the ground.

II. Change of color

1. **Chlorosis**: Yellowing of normally green tissue due to chlorophyll degradation or failure of chlorophyll formation. It may appear by itself or may appear as a zone around a necrotic spot. It may be due to nutrient deficiency or due to a pathogen.
2. **Silvering**: The change of colour of an organ to silver due to an increase in the air spaces between host cells or due to loosening of the cuticle.
3. **Reddening**: Development of red pigment (anthocyanin).

4. **Mosaic:** Symptoms of certain virus diseases of plants characterized by intermingled patches of normal green and light green or yellow.
5. **Soothy molds**: There is no actual change in colour of the plant organ. Instead there is a sooty coating on foliage etc., formed by dark fungal mycelium that lives on honeydew secreted by insects.
6. **Powdery mildew**: Like sooty molds, there is a fungal growth on the host surface, which in this case is white to grey and powdery. But the pathogen, in this case is an obligate parasite.

III. Wilting: Drooping of foliage and tender shoots of plants caused by interference with the normal movement of water within the plants. In pathological wilts, the lower leaves generally wilt first.

IV. ABNORMAL ENLARGEMENT IN PLANT TISSUES: This results from increase in size (hypertrophy) and/or number of cells (hyperplasia).

1. **Witches' broom**: Broome like growth caused by dense clustering of branches of woody plants.
2. **Galls**: Swelling produced on plants as a result of infection by certain pathogens.
3. **Canker:** The area of necrosis caused by a pathogen becomes surrounded by successive layers of cork cells.
4. **Scab**: Roughened, crust like diseased area on the surface of a plant organ. The development of cork layers is less conspicuous than in canker.
5. **Root Knots**: Galls caused by nematodes in roots especially of vegetable crops.

V. Reduction in size

1. **Stunting**: The whole plant becomes smaller than the normal due to disease.
2. **Smalling of leaves**: The leaves of affected plants remain smaller than the normal ones.

VI. Unusual development or transformation of organs

1. **Smut**: Plant parts especially grains are replaced by soot like spore masses.
2. **Ergot**: Grains are replaced with dark hard bodies of fungus hyphae.
3. **Fruit mummies**: Diseased fruits dry out rapidly and become hard or mummified due to fungus growth.

VII. Disintegration of tissue

1. **Wet rot**: Disintegration of diseased tissues, especially succulent parts, accompanied by a release of cell fluid.
2. **Dry rot**: Disintegration of plant tissues, which crumble to a dry mass.
3. **Wood rot**: Wood or trees are rotted by the fungus. When lignin component of the wood is broken down by the fungus, it results into a **white rot** and when the cellulose component of the wood cell walls is broken down, it results into a **brown rot**.
4. **Root and Foot rot**: Rotting and shredding of cortical tissue of the roots and lower part of the stem. First signs of root and foot rot appear in the form of wilting of shoot. Plants with root rot can generally be pulled out of the soil very easily.

VIII. Gummosis: In certain diseases of trees, there is an excessive gum formation.

History of Plant Pathology

The history of Plant Pathology is as old as human civilization. Even when the humans lived as nomads and used to eat only leaves, fruits and seeds, plant diseases took their toll, causing leaves to mildew and blight and fruit and seeds to rot. When man began to grow one or few kinds of food plants, part of the crop was lost to diseases thus delimiting food supplies and hunger was common.

Homer (1000 B.C.) mentioned the therapeutic properties of sulphur on plant diseases. Democritus (470 B.C.) recommended the control of blights by sprinkling plants with the olive grounds left after extraction of the olive oil.

The Greek philosopher Theophrastus (300 B.C.) was the first to study and write about diseases of trees, cereals and legumes.

Magnus (about A.D. 1200), in Germany proposed that the mistletoe plant was a parasite that obtained its food from the host plant, which it makes sick. He also noted that pruning out the parts carrying the mistletoe could cure the host plant.

Cotton Leaf Curl Disease (CLCuD)

Description:

A major (in terms of qualitative and quantitative losses) and devastating (huge economic losses and social impact) disease of cotton in Asia and Africa in general and Pakistan in specific.

History and Importance:

1st reported in 1967 from Multan.

In 1993-95 appeared in epidemic form in Pakistan.

80% yield losses.

In 2001: During the growing season, symptoms of CLCuD were observed on all resistant varieties at Burewala, District Vehari

In 2002: disease symptoms were seen throughout the district.

11 million bales lost due to CLCuV.

All resistant varieties became susceptible in 2002 to a new strain of virus known as Burewala strain. So far no resistant variety is available against this strain.

Strain: A genetic variant (alteration in DNA nucleotide sequence) of virus.

Etiology:

Causal Organism: Cotton Leaf Curl Virus (CLCuV)

Genome: ssDNA

Genus: Begomovirus

Family: Geminiviridae

Symptoms:

1. Infected plants bear leaf-like enations on the underside along with vein thickening.
2. Upward and downward curling of leaves.
3. Thickening of small as well as main veins on leaves, more obvious on underside.
4. If a diseased leaf is viewed from beneath against the light, thickened vein found darker green and opaque than the normal.
5. The newly produced leaves are small, excessively crinkled and curled at the edge.
6. Bolls remained small in size and failed to open.
7. All parts of badly hit plants are very brittle and ready broken.
8. Twisted (Bent) leaf petioles.

Transmission:

CLCuV is transmitted by whitefly *Bemisia tabaci*.

Order: Hemiptera

Family: Aleyrodidae

Whitefly transmits virus during phloem feeding of the plant.

Whitefly has 53 host species.

Latent Period (Inoculation to infection): 24 hours.

Incubation period (Inoculation to symptoms appearance): 7-10 days.

Inoculation feeding period: 30 mins.

Inoculation access period: 5-7 hours.

Retention period (Time period for which virus retains in the body of vector): throughout life.

Disease cycle:

The purpose of studying the disease cycle is to find out the possible disease development ways. After knowing the disease cycle one could be able to disrupt the cycle and disease may be avoided.

Primary source: Overwinters on alternate host (Tomato, okra, eggplant, datura).

Acquired by the whitefly during phloem feeding.

Acquisition access period: 7-10 hours.

Acquisition feeding period: 30 mins.

Transmitted to healthy cotton plants during whitefly feeding.

Secondary source: Symptomatic plants again may be the source of virus acquisition.

Epidemiology:

Study of disease development events in relation to environmental factors.

Minimum temperature: 25-30°C

Maximum temperature: 33-45°C

Optimum temperature: 32°C

Relative humidity: 48-60%

Management

1. Cultivation of disease resistant variety is only safe measure (NIBGE-2, NIAB-884, PB-899, FH-900, FH-1000, VH-148, CIM-446)
2. Proper use of irrigation and chemical fertilizers improves the disease resistant power in cotton plants.
3. Plants must be nourished with micronutrients to boost up their defense system against CLCuV and whitefly (Zn and Boron solution).
4. Whitefly transmits CLCuV from diseased plant to healthy one, hence whitefly must be controlled.
    a. Imidacloprid@5ml/liter
    b. Acetamiprid@5ml/liter
    c. Plant extracts (Neem extract, Eucalyptus extract@5ml/liter)

5. Lady's finger (okra), beans, tomatoes, tobacco, chilies, soybean, egg plant, holly hock (gul-e-khera), zinnia, sesame, Ak (*Calotropis*), shesham, citrus species etc. are recorded as alternate host plants of cotton leaf curl virus as well as whitefly. Therefore, they all must be eradicated before and during cotton cropping season.

Potato Leaf Roll Disease (PLRD)

Description:

Emerging and resurging disease.

Emerging (have recently appeared within a population or whose incidence or geographic range is rapidly increasing or threatens to increase in the near future).

Resurging (That was almost finished previously but again increasing).

History and Importance:

Potato grown from infected seeds results in 88% yield losses.

Global annual yield reduction is 20×10^6 tones.

1st reported in Pakistan in 1978.

Etiology:

Causal organism: Potato leaf roll virus (PLRV)

Genome: ssRNA

Genus: Polerovirus

Family: Luteoviridae

Symptoms:

1. Mostly appears on lower leaves
2. Leaves roll upward
3. Margins and tips of leaves become yellow.
4. Leaves become leathery (having a tough and hard texture like leather) and brittle (hard but liable to break easily).
5. Stunted growth (arrested growth) and upright appearance (Straight upwards).
6. Necrosis (death of tissues) in tubers.

Transmission:

Aphid *Myzus persicae*

Persistent (requires long time to be disseminated to new host), circulative (virus completes a trip of the insect body) and non-propagative manner (does not replicate in insect vector).

Disease cycle:

Aphids acquire from phloem feeding of diseased plants and weed hosts.

Aphid transmits the PLRV to healthy plants during feeding. Virus moves from phloem to tuber, cause necrosis and reduces size.

Solanaceous crops (Tomato, Eggplant and Chili) are also host for the virus.

Infected tubers are secondary source.

Epidemiology:

Temperature: 15-20°C

Relative humidity: 40-65%

Management:

1. Thermotherapy of tubers (37°C for various intervals).
2. Hot water treatment (50-52°C for 17-20 mins).
3. Use of insecticide (Metasystox or Rogor @6ml/L, Aldicarb, Carbofuran).
4. Resistant varieties (FD-48-4, FD-49-62, FD-7-2, Astrix, Mirrato, Oceania, Hermes, Orla, Safreen).

Banana Bunchy Top Disease (BBTD)

Description:

Once established difficult to eradicate*. Severely infected plants produce no fruits.

*Eradication (Complete destruction of inoculum)

History and Importance:

Occur in all banana growing countries (Fiji, Indonesia, Malaysia, Australia, Sri-Lanka, Pakistan and India). Serious threat to banana industry in Pakistan. (due to quantitative and qualitative losses industry will be badly affected. Demolish of industry will affect all type of associated stake holders).

First reported in Fiji in 1989.

Etiology:

Causal organism: Banana Bunchy Top Virus (BBTV)

Genome: ssDNA

Genus: Babuvirus

Family: Nanoviridae

Symptoms:

1. Dark green streaks on petioles and veins of new leaves looking against light (Morse code streak).
2. Leaves arise in clusters.
3. Top of plant give upright and bunchy appearance.
4. The leaf lamina has thickened ridges (Green J-Hooks) and infected leaves are brittle and tear easily.

Transmission:

Black Banana Aphid (*Pentalonia nigronervosa*)

Propagative materials (Rhizomes, Suckers)

Rhizomes (also known as rootstocks) is a type of plant stem situated either at the soil surface or underground that contains nodes from which roots and shoots originate).

Sucker (Grows from the base of the root of the plant at a certain distance from the plant).

Transmitted in a persistent, circulative and non-propagative manner.

Acquisition Access Period: 17 hours

Incubation period: 20-50 days

Disease cycle:

Aphid acquire BBTV by feeding on diseased plants and alternative hosts.

Virus is inoculated into the phloem of the healthy plants during aphid feeding. After entry into the phloem virus disturbs the cells functions resulting in abnormal increase in cell size and number. Adjacent to the infected phloem cells abnormally large sized chloroplasts results in macroscopic dark green streaks. Symptomatic leaves serve as the source of further spread through aphid feeding. Suckers and rhizomes from diseased plants act as source of secondary spread.

Epidemiology:

Temperature: 18-20°C

Relative humidity: 41-84%

Management:

1. Virus free propagative material (Certified points that make sure about the virus free material).
2. Resistant variety (Gross Micheal).
3. Insecticidal soap (Prentox, Diazinon AG500).
4. Spray the plants with insecticide to kill the aphids (malathion or pyrethrin).

Tobacco Mosaic Disease (TMD)

Description:

1st reported plant virus. Interesting fact about TMV is that due to its cylindrical nature it can be incorporated into battery electrodes. It is the most stable virus with wide survival range.

History and Importance:

In 1886 Adolph Meyer described that mosaic disease can be transferred between plants.

In 1992 Ivanovsky reported about its filterable nature.

In Martinus Beijerinick named this as Tobacco mosaic virus (TMV).

It infects tobacco, tomato, cucumber and many greenhouse crops.

It is thermostable virus (can survive at high temperature).

Yield losses upto 55%.

Deteriorated quality leads to low market price.

Etiology:

Causal organism: Tobacco mosaic virus (TMV)

Genus: Tobamovirus

Genome: ssRNA

Symptoms:

1. Foliage show mosaic (alternate green and yellow patches) symptoms.
2. Leaves fern like with pointed appearance.
3. Dark green areas of the mottle appear elevated looking like blister like.
4. Leaves give distorted and cholorotic appearance.
5. Shoe string appearance on leaves.
6. Leaves show wrinkle*, crinkle* and twist*.

*wrinkle: slight line on surface. Crinkle: many lines/streaks on a particular area leading to a slight fold. Twist: a bent on leaf surface.

Transmission:

Mechanical means.

Human handling.

Disease cycle:

TMV preserved in nature in herbaceous (does not have wood) and woody plants.

Overwinters in plant stacks, plant debris, soil, seed surface, seed beds, clothes, manufactured tobacco like cigarette and Cigar.

Enters through wounded tissues. Systemically spread through plasmodesmata.

Epidemiology:

Temperature: 28-32°C

Relative humidity: 44-56%

Management:

1. Use clean and healthy seed (Because infected seeds lead to systemic movement of TMV during whole life cycle of the plant).
2. Uncontaminated soil for seed production (Soil should be properly sanitized to rule out all the hidden points of the virus).
3. Crop rotation with maize and wheat (This will help in reducing the virus inoculums by breaking its life cycle due to non-availability of the host plants).
4. Spray skimmed milk.
5. Field sanitation and Rouging.
6. Avoid contamination of hands while working in the fields.

Citrus Tristeza Disease (CTD)

Description:

Responsible for death of million of trees and as many become unproductive.

In 1930s this disease devastated the citrus orchards in Brazil and South American regions. That's why farmers refer it as "Tristeza" means sadness (in Portuguese and Spanish).

History and Importance:

Largest threat to citrus industry round the globe.

Most destructive (yield reduction, reduced quality of produce) among all virus diseases of plants.

In 1981 total world loss due to this disease was destruction of 50 million trees.

1st reported from Argentina in 1930.

Infects all type of citrus.

Prevalent (widespread in a particular area and time) in all citrus growing regions.

Shortened life span of citrus upto 10-15 years.

Etiology:

Causal organism: Citrus Tristeza Virus (CTV)

Genome: ssRNA

Genus: Closterovirus

Family: Closteroviridae

Symptoms:

1. Stem pitting-Honey combing below bud union or on branches.
2. Vein clearing
3. Seedling Yellows
4. Decline (Due to blockage of phloem at bud union).

Transmission:

Brown Citrus Aphid (*Toxoptera citricida*)

Semi-persistent manner

Acquisition access period 30-60 mins.

Retention period: 24 hours.

Grafting is also the mean of virus transmission if rootstock or scion is affected.

Disease cycle:

Acquired by the aphid from infected source and transmitted to healthy one.

Phloem limited virus, disturbs the physiology of plant.

Infected rootstock or scion are also the sources of spread.

Management:

1. Rootstocks that offer resistance to tristeza decline include the citranges (C-35, Carrizo, Troyer), citrumelos (Swingle), mandarins (Cleopatra).
2. Use of insecticides to control aphid population (Imidacloprid).
3. Neem oil with the addition of soap.

Citrus Greening Disease (CGD)

Description:

Misshapen and bitter fruits are unsuitable for sale as fresh fruit or juice.

History and Importance:

Major cause of of crop and tree loss in Asia and Africa.

Yellow shoot (Huanglongbing) in China

Dieback in India, Leaf Mottle in Philippines,

In Pakistan 60-90% citrus plantation is affected by CGD

Etiology:

Liberobacteras from Asia and Africa (*Candidatus liberobacter asiaticum*) and (*Candidatus liberobacter africanum*)

Symptoms:

1. Yellowing of veins and adjacent tissues.
2. Mottling of entire leaf.
3. Lopsided, bitter, hard fruit with small, dark aborted seeds.
4. Fruit that remains green even when ripe.
5. Asymmetrical blotchy mottling of leaves.

Transmission:

Citrus psylla

(*Diaphorina citri* resistant to heat and *Trioza erytreae* sensitive heat)

Pathogen present in haemolymph and salivary glands).

Management:

Control of vector

Healthy propagating material

Application of growth hormones (NAA)

Quarantine measures

Bacterial Blight of Cotton

History and Importance:

Angular leaf spot

Black vein

Black Arm

1st reported in Alabama USA in 1891.

In sub-continent epidemics in 1948-52.

Etiology:

Xanthomonas axonopodis pv *malvacearum*

Symptoms:

1. Bolls may become infected causing boll rot which results in rotted seed and discolored lint.
2. A white waxy crust containing the bacterium may form on old leaf spots or cankers.

3. Black cankers may girdle the stem or branches causing the portions to die above the canker.
4. Spots on infected leaves may spread along the major leaf veins. As disease progresses, leaf petioles and stems may become infected resulting in premature defoliation.
5. The angular appearance is due to restriction of the lesion by fine veins of the cotton leaf.
6. bacterial blight causes small, quarter-inch-diameter lesions that are initially dark green turning to dark brown.

Disease cycle:

In dry leaves 17 years

Fuzz or inside of seed

Infected parts (Primary source)

Secondary (Wind, Rain, Dew and Labor)

Management:

1. Seed treatment with (H_2SO_4) and Streptomycin.
2. Hot water treatment at 56°C for 10 min.
3. Mixture of Agrimycin and Blitox.

Bacterial Blight of Rice

History and Importance:

70s Epidemic in Africa

1884 in Japan

1977 in Pakistan

Severe attack results in 50% yield reduction

Etiology:

Xanthomonas oryzae pv *oryzae*

Symptoms:

1. Water soaked yellowish stripes on leaf blades with wavy margin.
2. Bacterial ooze like a milky drop on young lesions early in the morning.
3. Yellow lesion turn to white as the disease advances.
4. Panicles unfilled.

Disease cycle:

Primary source: Weeds, stubbles and ratoons (cutting most of the above-ground portion but leaving the roots and the growing shoot apices intact so as to allow the plants to recover and produce a fresh crop in the next season.) of infected plants.

Secondary source: Water, rain

Enter through hydathodes and wounds.

Epidemiology:

25-30°C

Management:

1. Seed treatment with bleaching powder @ 100ug/L
2. Zinc sulphate 2%.

Citrus Canker

History and Importance:

Occur in all citrus growing areas.

Originated in China & spread to Europe and USA in 1910.

In 1919 & 1984 all citrus destroyed in Florida, USA.

Etiology:

Xanthomonas axonopodis pv *citri*

Symptoms:

1. First raised watery spots appear on leaves.
2. Later spots become thickened, brown and corky.
3. Infection to midrib and petiole causes premature defoliation.

Disease cycle:

Primary source are old lesions on standing trees.

Wind driven rain helps in secondary infection.

Enter through stomata or wounds.

Bacteria induce surrounding cells to swell up and divide abnormally.

Tissue disruption and enzymes begin to degrade tissues, kill cells.

Plant cell contents leak out to nourish bacteria.

Epidemiology:

Leaf minor

20-30°C

Management:

1. Streptomycin 100-1000 ppm at 15 days interval.
2. Garlic extract.

Citrus Slow Decline

Description:

Prevalent (Disease present) in all citrus growing areas.

History and Importance:

1st reported from California (USA) in 1912.

5% losses overall.

Etiology:

Tylenchulus semipenetrans

Symptoms:

1. Encrusted root system.
2. Twigs dieback.
3. Yellowing of leaves, defoliation, premature shedding of fruits, reduction in number and size of fruits.

Disease cycle:

Live on alternate host (olive grapevine)

Females lay eggs in gelatinous substance, remain safer for long time.

In soil may occur as deep as 4 meters.

Planting material is secondary source of spread.

Management:

1. Hot water (45°C for 25 min)
2. Treat nursery with nematicide (nemacur).
3. Pre and post plant soil fumigation (Nemagon, D-D mixture, vapam).

Root knot diseases

Description:

Root knot of vegetables

Meloidogyne sp.

Attack more than 200 plant species.

Causes up to 75% losses.

Common in warm and hot areas.

Symptoms:

1. Few, small and pale green leaves.
2. Infected roots swell at the point of invasion giving root knot appearance.

Disease cycle:

- Host range (potato, tomato, eggplant, chili, okra, carrot, reddish etc)
- Female lays 500 eggs in gelatinous substance
- 2nd stage enters, become sedentary & feed with stylet
- Distinguish male & female at 4th stage
- Life cycle complete in 25 days at 27°C

Management:

- Soil treatment with nematicides
- Grow resistant varieties
- Cultural practices
- Crop rotation
- Biological control Bacteria: *Pasteuria penetrans,* Fungi*: Dactylella oviparasitica*

Cyst diseases

Description:

Heterodera, Globodera

- Round known golden nematodes severe on potato, eggplant & tomato (*G. rostochiensis)*
- *Hetrodera avenae* on cerials
- Yield reduces 30-75 %

Symptoms

- Soy bean on sandy soils are stunted, leaves turn yellow & fall off early
- Only few flowers & small seeds formed
- Attack on sugar beat give small to large patches of wilted, dead or stunted plants
- Smaller root system with few bacterial nodules or hair like roots
- Cysts attached on roots

Disease cycle:

Nematodes over winter as brown cysts (fully developed 2nd stage juvenile) in upper 90-100 cm of soil

Management:

- Resistant varieties
- Soil fumigation
- Several fungi (*Fusarium, Vertcillium)* parasitize on nematodes
- Early sowing when nematodes inactive
- Crop rotation with alfalfa or potato

Diseases caused by phanerogamic parasites

- Parasitic flower & seed producing plants
- More than 2500 sp are known

Dodder (Cuscuta):

- Widely distributed, Hosts (alfalfa, onions, sugar beats & several ornamentals)
- Loss slight to complete destruction
- Also transmit plant viruses

Symptoms:

- Orange or yellow strands around plant parts up to 10 feet areas
- White, pink or yellowish flowers lead to seed formation
- Infected host weekend, declined, poor yield & finally killed

Disease cycle:

- Seed over winter in infested fields or mixed with seed of crops
- In growing season, seed germinating to produce slender like shoots with haustoria
- It is a shoot parasite

Management:

- Preventing introduction
- Clean implements
- Limiting movement of domestic animals
- Spray contact herbicides
- Frequent tillage & flaming

Witch weed (Striga)

- On sugarcane, rice, cow pea, tobacco & small grains

- First time reported in 1956 in USA
- Root parasite

Symptoms

- Affected plants stunted, wilted, turn yellowish
- Flowers small, red, yellowish or white
- Single plant can produce 5000-50000 seeds
- Life cycle takes 90-120 days

Management:

- Prevent introduction
- Catch crops (stimulate germination & destroy)
- Trap crops (initiate germination but not host)

Use herbicides

Broomrapes Orobanchae

- Occur in warm & dry regions worldwide
- Cause losses up to 70 %
- Root paeasite

Symptoms

- Whitish to yellowish plant 15-50 cm tall
- Pretty, white, yellow-white or purple flowers arise singly on stem
- Over winter as seed, can survive 10 years in soil

Produce cup like appressorium

Management

- Prevent introduction
- Grow resistant crops
- Removal of broomrape before seed producing
- Fumigate soil with methyl bromide
- Flax serve as a trap crop

Mistletoes

- Mistletoes occur wherever conifers trees grow
- Height of infected plants may reduced from 50-80 %
- Some infected plants are killed by mistletoes

- Stem parasite

Symptoms

- Shoots of mistletoes occur along the twigs of host
- Infected twigs and branches develop swellings and cankers on infected areas

Management

- Physical removal of parasite is the only control

Abiotic diseases

Zn deficiency in Rice

Khaira disease of Rice

- Non availability of Zinc to rice plants
- More severe with high rates of N & P

Symptoms:

- Reduced tillering, slight stunting & chlorosis (yellowing) of lower leaves between veins
- Tips of leaf blades also develop brown spots

Management

- Dipping seedlings in Zinc oxide at transplanting
- Spray with Zinc sulphate or Zinc chloride solutions

Tirak of Cotton

- Light soil (sandy), alkaline soil, Nitrogen deficiency, seed inferior quality, crust formation in soil

Symptoms:

- Upper leaves light green & lower turn yellow, stems become shorter
- Bad opening of bolls, lint inferior quality

Management

- Use healthy seeds
- Grow in loamy soils
- Apply organic matter & balanced N,P,K
- Deep ploughing
- Green manuring