



Grow the Crop

Handout 9

Diseases in Plants

SIGNS, SYMPTOMS AND EFFECTS OF PLANT DISEASES

PLANT DISEASES

A plant disease is any abnormal condition that alters the appearance or function of a plant.

CAUSES OF PLANT DISEASES

Plant diseases are caused by both infectious (fungi, bacteria, viruses and nematodes) and non infectious agents (mineral deficiency, sun burns etc). Infectious plant diseases are caused by living organisms that attack and obtain their nutrition from the plant they infect. The parasitic organism that causes disease is referred to as a **pathogen** and the plant invaded by the pathogen and serving as its food source is referred to as a **host**. A favourable environment is critically important for disease development – even the most susceptible plants exposed to huge amounts of a pathogen inoculum will not develop disease unless environmental conditions are favourable.

For disease to occur there must be a susceptible host plant, virulent pathogen, favourable environmental conditions for the pathogen to grow, and time for the disease to develop.

The main categories of microbes that cause plant diseases which are fungi, bacteria, viruses and nematodes.

Fungi account for around 85 percent of plant diseases followed by viruses, bacteria and nematodes.

Environmental factors are important in the development of plant diseases and determine whether the diseases become epidemic. These include temperature, relative humidity, soil moisture, soil pH, soil type, and soil fertility during the crop growth.

The plant diseases caused by these factors (environmental factors) due to their deficiencies or excess in nature are classified as "abiotic," or diseases that are non-infectious.

Upon infection of a plant by a pathogen, the plant may respond to the infection leading to detectable changes in its development and these results in development of symptoms in the infected plant and signs of the pathogen will be visible.

SYMPTOMS AND SIGNS OF PLANT DISEASES

These are visible effects of disease on plants due to the interference in the development and/or function of the plant as it responds to the pathogen i.e. a result of invasion and infection by the pathogen.

Symptoms may be classified as local or systemic, primary or secondary, and microscopic or macroscopic.

Local symptoms are physiological or structural changes within a limited area of host tissue around the infection site, such as leaf spots, galls, and cankers.

Systemic symptoms are those involving the reaction of a greater part or all of the plant, such as wilting, yellowing, and dwarfing.

Primary symptoms are the direct result of pathogen activity on invaded tissues (e.g., swollen "clubs" in clubroot of cabbage and "galls" formed by feeding of the root-knot nematode). On the other hand, secondary symptoms result from the physiological effects of disease on distant tissues and uninvaded organs (e.g., wilting and drooping of bean leaves in hot weather resulting from *Fusarium* root rot or root knot nematodes).

The disease symptoms may be microscopic or macroscopic. In microscopic symptoms, the expressions of disease are in the cell structure or cell arrangements which can be seen under a microscope where as

macroscopic symptoms are the expressions of disease on the surface of plant parts that can be seen with the unaided eye in the form of symptoms on the plant.

Macroscopic (morphological) symptoms can be classified as;

- a.) Necrotic,
- b.) Hypoplastic
- c.) Hyperplastic

Necrosis is localized or the general death/degeneration of plant tissue (protoplast). It includes leaf spots, blight, rots etc.

Some of the necrotic symptoms

Wilting is loss of turgor pressure in a plant leading to temporary or permanent drooping of leaves, shoots, or entire plants from lack of water or infection by different pathogens. This is usually a secondary symptom due to plugging of xylem tissue by an organism eg. *Fusarium* wilt of tomato, Bacterial wilt of Tomatoes, root knot disease of beans



Bacterial wilt of tomatoes caused by *Ralstonia solanacearum*

Spot is a definite, localized, round to regular lesion, often with a border of a different colour, characterized as to location (leaf spot, fruit spot) and colour (brown spot, black spot); if numerous or if spots enlarge and merge, a large irregular blotch or blight may develop such as gray leaf spot of tomato; black spot of rose; Angular leaf spot of beans, Leaf spot with yellow halo, Fruit spot e.t.c.



Angular leaf spot of beans caused by *Phaesariopsis griseola*



Septoria leaf spot of tomato plant caused by *Septoria lycopersici*

Blight is the sudden or total discoloration and killing of large area of a leaf, shoots, or stems or the entire plant; usually young tissues are attacked; the disease name is often coupled with the name of the host and the part attacked—blossom blight, twig blight, tip blight



Common bacterial blight of beans caused by *Xanthomonas axanapodis* pv *phaseoli*



Bacterial blight of rice caused by *Xanthomonas campestris* p.v. *oryzae*



A healthy rice crop

Blast is sudden blighting or death of young buds, flowers, or young fruit; failure to produce fruit or seeds such as *Botrytis* blight of roses, onion, strawberry; rice blast *Magnaporthe oryzae* (*Pyricularia oryzae*)



Rice blast lesions on rice leaves



Collar-rot symptoms of rice blast



Panicle blast of rice caused by *Magnaporthe oryzae*



Rice seed infected by blast showing symptoms of brown blotches

Damping off - decay of seed in soil, rapid death of germinating seedlings before emergence, or emerged seedlings suddenly wilting, toppling over, and dying from rot at or near the soil line such as pre-emergence damping-off and post-emergence damping-off; both are common in seedbeds



Damping off in common bean due to *Pythium spp.*

Dieback progressive browning and death of shoots, branches, and roots starting at the tips to down ward e.g. die back of chilli/ citrus



Die back of citrus caused by motile bacteria, Candidatus Liberibacter spp (*Liberobacter asiaticum*, *Liberobacter africanum*)

Rots refer to the decomposition and putrefaction of cells, later of tissues and organs. The rot may be dry, watery or mushy such as bacterial soft rot

Root rot of Beans



Root rot symptoms on common bean plants caused by *Fusarium spp.*



Discolored vascular system of a root due to *Fusarium oxysporum*.

Red Rot of sugarcane caused by *Colletotrichum falcatum* (*Physalospora tucumanensis*) is a disease that manifest both in the leaf which withers away at the tips along the margins and in the internodes of a stalk by splitting it longitudinally. It includes the reddening of the internal tissues which are usually elongated at right angles to the long axis of the stalk. The diseased cane also emits acidic-sour smell. As the disease advances, the stalk becomes hollow and covered with white mycelial growth.



Red rot of sugar cane symptoms on leaves



External symptoms of Red rot on sugar cane stalks



Red rot of sugar cane caused by *Colletotrichum falcatum* (*Physalospora tucumanensis*) on stems both external

Soft rot diseases are caused by pathogens that secrete enzymes capable of decomposing cell wall structures, thereby destroying the texture of plant tissue—i.e., the plant tissue becomes macerated (soft and watery). Soft rots commonly occur on fleshy vegetables such as potato, carrot, capsicum, squash, and tomato.



Soft rot symptoms on Capsicum caused by *Erwinia carotovora* subsp. *Atroseptica*



Soft rot symptoms on Avocado caused by *Erwinia herbicola*



Soft rot symptoms on carrot caused by *Erwinia carotovora*

Black rot of crucifers caused by *Xanthomonas campestris p.v. campestris* is also a bacterial disease where the vascular system is infected and leads to necrosis of the leaves.



Symptoms of black rot on cabbage transplants



V-shaped lesions on mature cabbage



Discoloured vascular tissue in cabbage stem due to black rot caused by *Xanthomonas campestris p.v campestris*

Streak narrow, elongated, somewhat superficial necrotic lesions, with irregular margins, on stems or leaf veins such as virus streak

Stripe narrow, elongated, parallel, necrotic lesions especially in leaf diseases of cereals and grasses *Helminthosporium* stripe of barley, Red stripe of sugarcane caused by *Pseudomonas rubrilineans*



Maize streak disease on maize leaf caused by the Maize streak virus



Red stripe of sugarcane on leaves - *Pseudomonas rubrilineans*

Water-soaking (Hydrosis) is a translucent condition of tissues caused by water moving from host cells due to rupturing of cell membranes into intercellular spaces e.g. late blight lesions on potato and tomato leaves; bacterial soft rot of fleshy vegetables



Hydrosis on Irish potato leaf due to late blight caused by *Phytophthora infestans*



Symptoms of Late blight caused by *Phytophthora infestans* on tomato stems



Symptoms of Late blight caused by *Phytophthora infestans* tomato fruits

Canker a definite, dead, often sunken or swollen and cracked area on a stem, limb, trunk, tuber, or root surrounded by living tissues:



Bacterial canker of tomatoes *Clavibacter michiganensis* p.v. *michiganensis*

HYPOPLASTIC

Hypoplasia is the failure of plants or organs to develop fully i.e to obtain normal size.

Abnormal size and pale colouration is the most common hypoplastic symptom. Other symptoms include:

Dwarfing is the underdevelopment of the plant or some of its organs eg MSV or mosaic; curly top of beans;



Maize stunt due to Maize streak virus disease

Rosetting is the shortening of internodes of shoots and branches, producing a bunched growth habit example are the ground nut rosette.



Ground nut rosette caused by groundnut rosette umbravirus

Albication is the complete repression of colour caused by viruses, bacteria, fungi, and iron deficiency leading to albinism or whitening of leaf tissue.



Broad Bean Stain Virus (BBSV) symptoms on pea plants include whitening of interveinal tissue and necrosis.

Chlorosis this is the yellowing or whitening of normal green tissue due to partial or complete failure of chlorophyll to develop this symptom can developed due to different diseases such as *Fusarium* yellows of beans



Chlorosis on bean leaves due to *Fusarium oxysporum*

Mosaic is the abnormal coloration yellowing, reddening, bronzing, or purpling in localized areas of leaves where chlorophyll has been destroyed; Symptoms such as a clearing along the leaf veins (vein clearing)



Turnip Mosaic virus on cabbage leaves



cauliflower mosaic virus on Kale (below)



Veinal necrosis on common bean leaf due to Bean Common Mosaic Virus



Dark green, light green pattern/ chlorotic areas on leaves due to virus infection

HYPERPLASTIC

Hyperplasia is the overdevelopment (in size and colour) of the plant parts. Hypertrophy on the other hand is the exclusive development of a plants organ due to over hyperplasia and they include;

Leaf curls -overgrowth of tissue on one side of a leaf or petal resulting to leaves rolling.

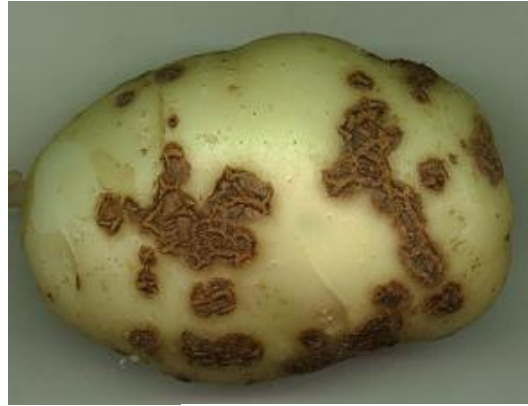


Curled tomato leaves caused by tomato leaf curl virus

Scabs roughened to crust like, more or less circular, slightly raised or sunken lesions on the surface of leaves, stems, fruit, or tubers e.g. common scab of potato, apple scab and wheat scab.



Fruit scab on Avocado due to *Sphaceloma perseae*



Potato scab caused by *Streptomyces scabies*

Tumours are symptoms that are caused by pathogens that stimulate uncontrolled multiplication of plant cells, resulting in the formation of abnormally large structures

Crown galls



Crown gall symptoms on roses caused by *Agrobacteriu tumafaciens*

Club root symptom is where the roots appear swollen, club-shaped roots



Clubroot symptom on cabbage caused by *Plasmodiophora brassicae*

Root knots are the formation of galls on the roots which is as a result of nematode infection.



Root knots (galling) on common bean roots due to nematode (*Meloidogyne spp.*) infection

SIGNS OF PLANT DISEASES

This is the physical evidence of the pathogen causing disease. Examples of signs of a pathogen include; fungal fruiting bodies, mycelia, bacterial ooze, or nematode cysts. Signs also can help with plant disease identification.

- 1.) Mycelium or Mold Growth:** under some conditions, mycelia or fungal growth is readily visible to the naked eye.



Mycelium of *Phytophthora infestans* on tomato fruits



Sunken lesions with purple coloured mycelium on bean pods –
sing of anthracnose caused by (*Colletotricum lindemuthianum*)

2.) **Conks and Mushrooms:** These are the familiar structures of some fungi that are formed by some pathogenic fungi such as *Armillaria mellea*.



Armillaria mellea mushrooms from base of infected tree

Fruiting Bodies: They are reproductive structures of some fungi that are embedded in diseased tissue, often requiring a hand lens to see e.g. sclerotia, stroma

a.) **Sclerotia** these are hard resistant structures of some fungi



Hard black sclerotia inside the stem a definitive sign of the pathogen causing this wilt, *Sclerotinia sclerotinium* commonly called white mold.



Visible fungal mycelia and sclerotia on tomato, the sclerotia (seed-like structures in the middle of the fungus mat) identify southern blight fungus *Sclerotium rolfsii*.

- b.) Cleistothecium** a speck-sized, black fruiting body completely enclosing sexual spores of many powdery mildew fungi



Powdery mildew of cucumber caused by *Sphacerotheca fuliginea*.
Chletothecia visible under high magnification

c.) **Acervulus** a shallow, saucer-shaped fungal structure that bears asexual spores (conidia); it is usually formed below the cuticle or epidermis of leaves, stems, and fruits, later rupturing the surface and exposing its spore-bearing surface anthracnose of beans, avocado, tomato e.t.c.



Anthracnose on common bean caused by *Colletotrichum lindemuthianum*.
Note the purplish colouration in the sunken lesions.

d.) Sorus (pustule) a compact mass of spores, or a cluster of sporangia (spore-bearing structures), produced in or on the host by fungi causing such diseases as white rust, smut, and true rust; before rupturing, the sorus is normally covered by host epidermis



Maize leaf with symptoms of maize leaf rust caused by *Puccinia sorghi*

3.) **Mold growth on the host plant**

- a.) **Powdery mildew** white, powdery to mealy, superficial growths of mycelia and conidiophores on surfaces of leaves, stems, flowers, and fruit powdery mildew diseases of capsicum, beans, mango etc



Powdery mildew caused by *Leveillula taurica* on capsicum plants. Note the powdery mycelium growing on the leaf.

b.) White mold on several crops caused by *Sclerotinia sclerotiorum*



Floral infection of sunflower caused by *Sclerotinia sclerotiorum*



Symptoms and signs of white mold on snap bean pod caused by *Sclerotinia sclerotiorum*.



Advanced signs of white mold of snap bean. Mature sclerotia formed on the diseased tissues.

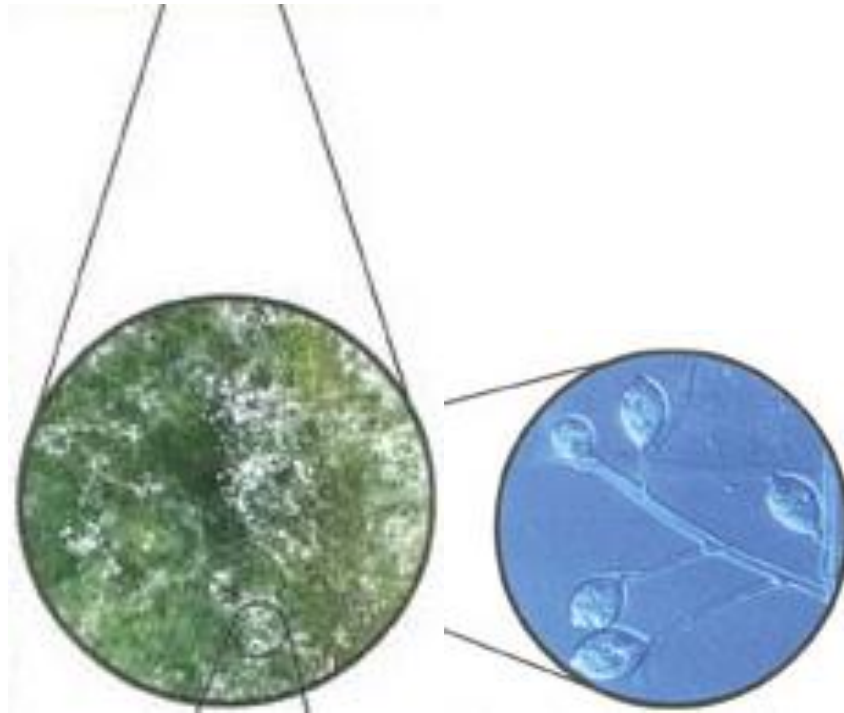


Sclerotium and apothecia of *Sclerotinia sclerotiorum*

c.) Mold of *Phytophthora infestans* on infected Potato plant



Late blight lesion on potato foliage caused by *Phytophthora infestans*



Lesion of late blight as seen through the hand lens

Micrograph of sporangia on sporangiophores

d.) Ooze and Specific Odors: associated with tissue macerations



Grey-brown discoloration of vascular tissues (vascular ring) and bacterial ooze in potato tuber infected by *Ralstonia solanacearum*

Bacterial streaming in water from a cut stem

This occurs when cut stem sections from infected plants are placed in water and threads of a viscous white slime can be observed streaming from the cut end of the stem within 15 min. These threads are bacterial ooze exuding from the infected xylem vascular bundles



Bacterial streaming in water from a cut tomato stem infected by *Ralstonia. solanacearum*