– 11 –

Common Disease Symptoms

Common names of diseases are always based on their key symptoms. These symptoms are described here.

anthracnose: A characteristic lesion, which is a circular to angular, sometimes irregular sunken spot with grayish-black center and yellow margin in leaves, stems, and fruit (e.g., grapevine anthracnose).

areolate mildew: Mildew growth in the area between veins on a leaf (e.g., cotton areolate mildew).

big vein: A condition in which veins become enlarged (e.g., *Lettuce big vein virus* disease).

black scurf: Black flaky or scaly matter adhering to the surface of a plant part (e.g., black scurf of potato).

blackening: Intensive necrosis that leads to blackening of tissues (e.g., *Potato black ringspot virus* disease).

blast: A disease that kills plants suddenly (e.g., rice blast).

blight: A plant disease characterized by withering and shriveling without rotting (e.g., late blight of potato).

blister blight: A bubblelike elevation on the surface of a diseased leaf that results in withering and shriveling of the leaf (e.g., tea blister blight).

boll rot: Decay of boll, a fruit of plants such as cotton. Boll consists of a rounded capsule containing the seeds (e.g., cotton boll rot).

brown rot: A condition in which decaying tissues turn brownish (e.g., potato brown rot).

browning: Cell death leads to necrosis, which leads to the browning of tissues (e.g., *Pea early browning virus* disease).

bud blight: Necrosis of buds (*Groundnut bud blight virus* disease).

bud rot: Decay of buds (e.g., bud rot of coconut).

bunchy top: Leaves arise in clusters, giving a rosette appearance at the top (e.g., *Banana bunchy top virus* disease).

bushy stunt: The diseased plant is severely stunted and its shoots are crowded, giving a bushy appearance (e.g., *Tomato bushy stunt virus* disease).

canker: A corky outgrowth formed on leaves, twigs, and fruit (e.g., citrus canker).

charcoal rot: Decaying tissues turn charcoal (black) in color (e.g., corn charcoal rot).

chlorosis: Yellowing or whitening may be distributed in the entire plant due to a partial failure of chlorophyll development in leaves and other plant parts, causing more or less uniform discoloration (e.g., *Tomato chlorosis virus* disease, *Lettuce chlorosis virus* disease).

club root: Roots are malformed into clublike structures due to a thick, fleshy growth of roots. The root tips are malformed, leaving the basal portions of the root mostly normal (e.g., club root of cabbage).

collar rot: Decay of the collar region of seedlings at the postemergence stage (e.g., tobacco collar rot).

crown gall: Abnormal outgrowth or swelling produced due to hyperplasia and hypertrophy of host cells (e.g., crown gall of several crops, such as apple, peach, and pear).

crown rot: Rotting of the crown that may spread to the root (e.g., oat crown rot).

curly top: Inward rolling of the leaves with puckering and blisterlike elevation (e.g., *Beet curly top virus* disease).

damping-off: Rotting and collapse of seedlings at soil level or prevention of seedling emergence (e.g., damping-off of vegetables and tobacco).

dieback: Death of diseased plant organs, especially stem or branches, from the tip backward (e.g., eutypa dieback of grape).

downy mildew: Fungal growth that appears as a coating of soft, fine hair on the surface of the host (e.g., downy mildew of grapevine).

dry rot: Putrefactive decomposition of tissues (e.g., dry root rot of citrus and peanut).

dwarf: Plant growth is stunted due to disease (e.g., rice yellow dwarf disease).

ear rot: Decay of the ear of a cereal plant that contains the seeds, grains, or kernels (e.g., corn diplodia ear rot).

enation: Small outgrowths on leaves, especially on veins and stems (e.g., *Pea enation mosaic virus* disease).

etch: Desiccation of superficial tissue (epidermal cells) (e.g., *Tobacco etch virus* disease).

false smut: Individual grains of the panicle are transformed into greenish spore balls. At first, the spore balls are smooth and yellow and are covered by a membrane. When the membrane bursts, the color of the ball becomes orange, yellowish green, or greenish black. The surface of the ball cracks subsequently. When the balls are cut open, the innermost layer is yellowish, the next layer is orange, and the outermost layer is greenish (e.g., false smut of rice).

fern-leaf: Reduced development of the leaf blade in proportion to the midrib leads to fern-leaf development (e.g., *Asparagus fern-leaf virus* disease).

fire blight: Diseased blossoms turn brown or black and exhibit a burnt appearance (e.g., fire blight of apple).

fleck: Small discolored parts are sharply bordered but circular (e.g., *Parsnip yellow fleck virus* disease).

flower color-breaking: Mosaic or variegation of petals of flowers (e.g., *Tulip color-breaking virus* disease).

foot rot: Decay of the basal portion of a plant (e.g., rice foot rot).

freckle: A small brownish spot or small area of discoloration; a freckle is smaller than a spot (e.g., banana freckle).

fruit rot: Decay of fruit (e.g., strawberry alternaria fruit rot).

gray mold: A condition in which infected blossoms and fruit become coated with the fine gray fruiting stalks and spores of the fungal pathogen (e.g., gray mold *[Botrytis cinerea]* of strawberry).

green ear: The floral parts of the ear of a cereal plant are transformed into a green leafy structure; in the spikelet, the glumes, lemmae, paleae, stamens, and pistil are all transformed into green leafy structures (e.g., green ear of pearl millet).

gummosis: Secretion of gum as a symptom of the disease (e.g., citrus gummosis).

head rot: Decay of the head of plants such as sunflowers, which consists of fertilized inflorescence with developed seeds and grains (e.g., sunflower head rot).

kernel rot: Decay of kernels (e.g., corn fusarium kernel rot).

leaf blight: The entire leaf may be blighted (e.g., northern corn leaf blight).

leaf blotch: Irregular, large, discolored, usually black spots (e.g., leaf blotch of barley).

leaf crinkle: Wrinkles form in the infected leaf (e.g., *Turnip crinkle virus* disease).

leaf crumple: The infected leaf appears crushed, forming wrinkles or creases (similar to marks produced by folding) (e.g., cotton leaf crumple).

leaf curl: Leaf margins turn downward and come together at the bottom, exposing the middle upper surface of the leaf blade; the disease results in the downward curling of leaves; the distortion, puffing, and crinkling of a leaf resulting from the unequal growth of its two sides (e.g., *Tobacco leaf curl* virus disease).

leaf roll: A condition in which the leaf tends to roll (e.g., *Potato leafroll virus* disease).

leaf spots: Several types of spots are seen in infected leaves. Water-soaked spots are common in bacteria-infected leaves; circular, cylindrical, irregular, or angular spots are common in fungus and bacteria-infected leaves (e.g., sigatoka leaf spot of banana).

line pattern: Infected leaves show an arrangement of repeated lines (e.g., *Pelargonium line pattern virus* disease).

little leaf: In diseased plants, the leaves are malformed into tiny chlorotic structures (e.g., little leaf of eggplant).

mosaic: Infected leaves show various shades of green and yellow areas that are usually irregularly angular, but sharply delimited. Mosaic is characterized by a patchy variation of normal green color (e.g., *Tobacco mosaic virus* disease).

mottle: Diffusely bordered variegation (differently colored spots), i.e., a pattern of white patches in leaves and other plant parts, that results from the failure of chlorophyll to develop in certain cells. Mottle is an arrangement of spots or confluent blotches of different shades, as of the surface of marble (e.g., *Tomato mottle virus* disease, *Bean pod mottle virus* disease).

necrosis: A symptom in which cells die in patches (e.g., *Rice necrosis virus* disease).

phyllody: The floral parts are transformed into green leafy structures (e.g., phyllody of sesamum).

powdery mildew: Fungal growth seen as a powdery growth on the host's surface (e.g., wheat powdery mildew).

Pox: Infected leaves show various types of mottling, which consist of light green to yellowish-green blotches. The fruits are poxed (i.e., pustules form on the skin) (e.g., *Plum pox virus* disease).

red rot: Decaying tissues appear reddish in color (e.g., sugarcane red rot).

reddening: Red pigments predominate (e.g., *Carrot red leaf virus* disease).

rhizome rot: Decay of rhizome (e.g., turmeric rhizome rot).

ringspot: Infected leaves show ringlike circular spots (e.g., *Groundnut ringspot virus* disease, *Carnation ringspot virus* disease, *Citrus ringspot virus* disease).

root rot: Root decay leads to wilting in plants. In the field, a sudden and complete wilting of the plants is seen. The major difference between wilt and root rot is the discoloration of the stem. When the bark of plants is removed, black streaks can be seen extending upward to the branches and downward to the lateral roots. Root rot, which also leads to wilting, is characterized by root decay (e.g., corn pythium root rot, cotton black root rot).

rosette: Rosetting (decoration resembling a rose) is formed due to impeded internodal expansion at the stem tips; crowding of the foliage excessively in the form of a rosette (e.g., *Groundnut rosette virus* disease).

rot diseases: Decay of tissues. Several types of rot symptoms are seen in crops.

rugose: The growth of veinal tissue is retarded (e.g., *Bean rugose mosaic virus* disease).

rust: Rustlike pustules (small elevated spots resembling pimples). Several types of rust diseases are known and they are referred to by the color of their pustules: **Brown rust** (brown [leaf] rust of wheat), **black rust** (black [stem] rust of wheat), **yellow rust** (yellow [stripe] rust of wheat), and **white rust** (white rust of crucifers). When pustules are arranged in linear rows between

the veins of the leaf, the rust is called **stripe rust** (stripe rust of wheat). In the case of leaf rust, rust pustules are seen mostly on leaves (leaf rust of wheat). In the case of **stem rust,** rust pustules are seen mostly on stems (stem rust of wheat).

scab: The surface of affected tissues becomes rough and the affected surface is raised due to an abnormal proliferation of cells in the epidermis. The surface has a rusty appearance that is deeply pitted with corky wounds (e.g., apple scab).

scald: Affected plants show lesions, which appear to be similar to the scalding caused by hot water. Such lesions are mainly bleached and may be partly translucent (e.g., barley scald).

shot hole: Leaf spots in which the necrotic (spot) regions drop out, leaving holes in the affected leaves (e.g., peach *Stigmina* shot hole).

silver leaf: A condition in which infected leaves show a metallic luster (e.g., plum silver leaf).

smut: Black sooty masses of fungal spores that cover the affected plant parts. Several types of smuts are seen, including **covered kernel smut:** smut sori replacing grains of plants (e.g., covered kernel smut of sorghum); **long smut:** smut sori are covered by a fairly thick membrane and are much longer than the other smuts; they are cylindrical in shape (e.g., long smut of pearl millet); **loose smut:** smut sori are covered with a fragile membrane, which breaks easily at the time of spike emergence from the host, exposing a powdery mass of spores (e.g., loose smut of wheat); **covered smut:** smut sori are covered with a thick membrane, which resists easy rupturing (covered smut of oats); **flag smut:** smut sori occur on the leaf blade, leaf sheath, and culm (flag smut of wheat); **head smut:** the entire earhead is converted into smut sori (head smut of corn); **kernel smut:** symptoms appear only on mature grains; minute black pustules or streaks bursting through the glumes are seen; sometimes the entire grain is replaced by a powdery, black mass of smut spores (e.g., kernel smut of rice); and **leaf smut:** smut sori are formed in infected leaves (leaf smut of rice).

soft rot: Soft, water-soaked, irregular lesions appear on tubers, rhizomes, fruits, vegetables, and other storage organs. These lesions are more or less superficial, but soon spread and cover the inner tissues. Lesions lead to rotting of storage organs (e.g., soft rot of potato).

sooty mold: Masses of fungal black spores that stick to the leaf surface, making the foliage appear black and ugly (e.g., sooty mold of citrus, mango, sapota, and guava).

spindle tuber: A condition in which the tubers of affected plants are elongated (spindle shaped) (e.g., *Potato spindle tuber viroid* disease).

spotted wilt: Bronze markings appear on the upper surface of young leaves, and the markings extend from the leaf blade down to the petiole and stem, resulting in wilting of the stem (e.g., tomato spotted wilt).

stalk rot: Decay of plant stalks (e.g., corn bacterial stalk rot).

stem bleeding: Exudation of sap or resin from an infected stem (e.g., coconut stem bleeding).

stem gall: Abnormal outgrowth in the stem (coriander Protomyces stem gall).

stem rot: Decay of stem tissues (e.g., rice stem rot, crucifers sclerotinia stem rot).

stenosis: In diseased plants, the leaves are highly reduced in size and clustered along the stem (e.g., cotton stenosis).

sterility: Suppression of development of reproductive structures. Diseased plants do not produce seeds, fruit, stamens, or pistils (e.g., pigeonpea sterility mosaic disease).

storage rot: Decay of storage organs (e.g., corn aspergillus ear and storage rot).

streak: Mosaic in leaves along veins, which looks like a streak (e.g., *Tobacco streak virus* disease).

stripe: A long band of mosaic pattern along the parallel veins of a leaf (e.g., *Peanut stripe virus* disease).

stunt: Retardation of plant growth due to disease (e.g., *Peanut stunt virus* disease).

tumors: Swellings on stems or roots (e.g., *Sweet clover root tumor virus* disease).

vein band: A broad dark-green band along the veins. The rest of the lamina surface shows chlorosis (e.g., *Strawberry vein banding virus* disease).

vein chlorosis: Chlorosis is restricted to tissues adjoining the veins in leaves (e.g., *Raspberry vein chlorosis virus* disease).

vein clearing: A clearing or chlorosis of the tissue in or immediately adjacent to the vein (e.g., *Petunia vein-clearing virus* disease).

wilt: In the early stages of wilting, yellowing of leaves is seen. A flaccid or drooping condition of the plant due to disease, wilting may be due to a shortage of water, an impeded supply of nutrients, or excessive transpiration (e.g., cotton fusarium wilt, banana fusarium wilt, crucifers verticillium wilt).

witches'-broom: Abnormal proliferation (mass outgrowths) of the branches of woody plants due to disease (e.g., witches'-broom of potato).

yellows: Uniform yellow to almost-white discoloration of leaves; yellowing will be the conspicuous symptom in the diseased plant. Yellow pigments may predominate in infected plants (e.g., crucifers aster yellows, *Beet yellows virus* disease).

– 12 –

Crop Disease Assessment

Crop disease assessment is otherwise called phytopathometry. It involves the measurement and quantification of crop diseases. Accurate disease assessment will help in predicting the development of epidemics and in developing a decision support system for timing the application of fungicides to control diseases. Diseases are assessed by different methods, based on the type of disease symptoms and their relationship with yield loss. Remote sensing and image analysis are important tools in disease assessment.

DISEASE INCIDENCE ASSESSMENT

A disease is assessed either as a percentage of disease incidence or as disease severity. Disease incidence is calculated as follows:

Percentage disease incidence =
(number of infected plants/total number of plants assessed) × 100

Assessment of disease incidence will be useful for measuring systemic infections, which may result in total plant loss. Virus diseases such as rice tungro, barley yellow dwarf, and banana bunchy top, and fungal diseases such as loose smut of wheat and barley and sugarcane smut are assessed by estimating disease incidence. Some fungal pathogens may not cause systemic infection, but may cause total crop loss. Wilt diseases such as Fusarium wilt of tomato, Panama wilt of banana, and Fusarium wilt of chickpea cause total losses and these diseases are assessed as percentage of disease incidence. Monosporascus wilt of melons is assessed as percentage of wilt incidence (Cohen et al., 2000).

Percentage of disease incidence is calculated also for some leaf spot and fruit spot/rot diseases. Brown spot of pear, which is caused by *Stemphylium vesicatarium,* is assessed by recording the number of leaves that show leaf spots out of ten leaves of four shoots per tree (Llorente et al., 2000). The