Lesson 24

Title of the Experiment: Identification of disease symptoms using live specimens
(Activity number of the GCE Advanced Level Practical Guide - 37)

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Introduction:
A doctor diagnoses illness in a patient by looking for visible or measurable indications that the body is not functioning normally. These indications are known as **disease symptoms**. They might occur singly or in characteristic combinations and sequences. Such a group of symptoms occurring together regularly is known as a **disease syndrome.**

Similar considerations are common to plant diseases as well. For the diagnosis of plant diseases, plant pathologists must be aware of the range of symptoms that can occur under various disease conditions. In some instances, the occurrence of a particular combination of symptoms is sufficient to arrive at a tentative diagnosis. However, if symptoms are common to a wide variety of diseases, detailed microbiological, biochemical, immunological or nucleic acid or protein based analyses will be necessary for accurate diagnosis of disease.

Plant diseases can be infectious or non-infectious. Non-infectious plant diseases are caused by abiotic factors whereas infectious diseases are caused by biotic factors such as fungi, bacteria, viruses, viroids, phytoplasma, Mycoplasma Like Organisms (MLOs), nematodes, and parasitic plants and plant diseases caused by these factors can cause heavy economic losses worldwide. Accurate plant disease diagnosis is essential for effective disease management as knowing the specific disease and its cause is necessary to decide which control measures will be effective and economically viable. For example, application of a fungicide to control a disease caused by a virus would not only be ineffective, but also cause loss of revenue (loss of productivity from uncontrolled disease and cost of ineffective disease control).

The first step of plant disease diagnosis is close observation of symptoms and signs present on the diseased sample as they are indications of a deleterious interaction between the causative agent(s) of disease and the plant.

Signs of plant disease are any portion of the pathogen or its products visible on a plant or a plant part. These can be vegetative structures such as mycelium of a fungus, reproductive structures such as the spores or spore-bearing structures, the eggs of a nematode, or the seed of a parasitic seed plant. A sign may also be the product of a pathogen such as a bacterial ooze or odor which indicates a pathogen's presence.

A **symptom** is a visible change in a host plant due to pathogen activity. Symptoms can occur as a direct result of pathogen activity, such as decay due to the release of an extracellular enzyme, or as an indirect result, such as nutrient deficiency symptoms resulting from roots that are unable to absorb nutrients. Signs and symptoms can indicate not only that a disease is present, but also the type of pathogen that is present. In some instances, the occurrence of a particular combination of symptoms is sufficient to arrive at a tentative diagnosis. However, as symptoms are common to a wide variety of diseases, detailed microbiological, biochemical and DNA based analyses will be necessary for accurate disease diagnosis.

Since symptom identification is important for plant disease diagnosis, the following section will describe different types of more frequently encountered symptoms caused by different groups of organisms; fungi, bacteria, virus and nematodes.

Some of the common symptoms of plant diseases (Figure 1)

i. Colour Changes

- **a. Chlorosis:** A normally green tissue becomes yellowish. This is one of the most common symptoms of plant disease.
- **b. Albinism:** A normally green tissue loses chlorophyll and becomes white.
- **c. Anthocyanescence:** Plant tissues become purple or red in color due to the build-up of anthocyanins.
- **d. Silvering/Bronzing:** Plant tissues have a silver- or bronze-colored metallic luster due to a slight separation of the upper epidermis.
- **e. Interveinal chlorosis:** Leaf veins remain green while the area between veins is chlorotic.
- **f. Vein clearing:** Leaf veins become clear or whitish while the rest of the leaf is green.
- **g. Mosaic:** A variegated pattern consisting of light green, dark green, and yellow colored plant tissue. Mosaics are characteristic of some virus diseases.
- **h. Mottle:** Similar to a mosaic but the demarcation between adjacent colors is less distinct. Mottle is also a characteristic of some virus disease.
- **i. Virescence:** Development of chlorophyll in tissues or organs in which it is normally absent.

ii. Necrosis:

The term necrosis is used to indicate the condition in which the death of cells, tissues and organs has occurred as a result of infection. Following are the different necrotic symptoms:

- **a. Spots**: The death of cells or tissues (necrosis) occur in definitely limited areas. The shape of the lesions (necrotic spots) may be round, angular, or irregular. The dead areas are often surrounded by a purple, red, yellow or brown margin. Fruiting bodies may also develop in the dead areas. Leaf necrosis may lead to a dead leaf tissue falling away, causing a shot hole effect.
- **b. Streaks or stripes**: They are prominent symptoms consisting of elongated but relatively narrow lesions. These streaks or stripes usually have some shade of brown color.
- **c. Blight:** This term means a burnt appearance. Extensive death of tissues associated with browning of leaves and flowers is known as blight. It also refers to a sudden death of a plant or its conspicuous parts, such as leaves, blossoms, or twigs. The dead organ usually turns brown or black and may soon disintegrate. Early and late blights of potatoes are good examples for blight disease caused by fungi.
- **d. Rot:** In most cases this condition is brought about by fungi and bacteria, which dissolve the cell walls more or less completely by means of enzymes. According to the plant organ attacked the rot may be called root rot, leaf or stem rot, bud rot, and fruit rot. Depending upon the type of dissolution brought about by the pathogen the rots may be grouped as soft rot, wet rot, or dry rot. Brown rot and white rot of woods caused by fungal species is another common example.
- **e. Canker:** A canker is a dead area in the bark or cortex of the stem, especially in woody plants. It is a localized, sunken, dead area on the trunk, stems, or twigs of woody plants with well-defined margins. In many cases, the dead bark splits and finally peels away leaving the wood naked. Fungi and bacteria often cause cankers on hard woody stems. Bacterial canker is one of the most destructive and difficult-to-manage diseases of tomatoes.
- **f. Blast:** Flowers on infected plants that is sterile as a result of disease.
- **g. Mummification:** Transformation of fleshy fruits into dry, shriveled, hard structures that is highly resistant to decay.

h. **Damping-off:** Death of a plant before (pre-emergence damping-off) or after emergence (post-emergence damping-off) of the seedling. It is a condition in which the stem is attacked near the soil surface. Damping-off of vegetable and ornamental seedlings is common examples.

iii. Abnormal Growth increase:

This is the abnormal increase in size of plant organs or the entire plant as a result of stimulation of the host tissues. This may be brought about either or both of the two processes, *hyperplasia* and *hypertrophy*. Hyperplasia is the abnormal increase in the size of a plant organ due to increase in number of cells of which the organ is composed. In hypertrophy, the increased size of the organ is due to increase in size of the cells.

a. **Galls**: Localized swellings or overgrowths on a plant. These are malformations of more or less globose, elongated, or irregular shape. They may be fleshy or woody. Crown gall, club root and root knot are few examples caused by bacteria, slime molds and nematodes
b. **Curl**: Leaves are arched, puckered, twisted, curled, and distorted due to growth in tissues in localized area of the leaf. Papaya leaf curl caused by the infection of viruses is a good example.
c. **Fasciculation:** Excessive branching around a common point. Also known as witch's broom numerous slender branches arise from a limited region in rather close clusters appearing like a broom.
d. **Hairy root**: Numerous fine fibrous roots are produced which are abnormal.
e. **Phyllody:** Development of leaves at sites from which ovules normally develop. This can caused by phytoplasmas, or due to environmental imbalances, which trigger plant hormonal balance.

iv. Abnormal growth decrease:

a. **Stunting, Dwarfing**: A general reduction in the size of an infected plant.
b. **Rosette:** A short, bunchy growth around a common point due to a failure of internodes to elongate.

v. Wilting:

Loss of turgidity such that plants becomes flaccid.

vi. Defoliation and/Fruit drop:

Leaves or fruits drop prematurely due to the formation of abscission layers following infection by a pathogen. Leaf defoliation caused by the fungal pathogen, which causes coffee rust is a good example.

vii. Disruption of mobilization of stored food: Seedling blights.

viii. Disruption of absorption of water minerals: root and foot rots.

ix. Disruption of water transport: Vascular wilts.

x. Dieback: A common symptom of woody plants, characterized by progressive death of twigs, branches, shoots, or roots, starting at the tips of the plant.

xi. Gummosis: Excessive gum formation from small cracks in the infected bark, giving the tree a bleeding appearance.

xii. Rusts: These are diseases with rusty symptoms. The rusts appear as relatively small pustules of the fungal spores, usually through the host epidermis. The pustules may be either dusty or

compact, and red, brown, yellow, or black in colour. Fungal plant pathogens causing coffee rust and plumeria rust are good examples.

xiii. **Smuts**: The word smut means a sooty or charcoal-like powder. The affected parts of the plant show a black or purplish-black dusty mass. These symptoms usually appear on floral organs, particularly the ovary but they can also be found on stems, leaves and roots.

Learning outcomes:

At the end of this laboratory exercise, students should be able to,

1. Identify and describe symptoms/signs on infected plant specimens,
2. Determine the group of causative agents based on symptoms present on specimens,
3. Carryout microscopic observations on disease specimens and causative agents.

Materials:

You are provided with:

Infected plant specimens with numbered tags
Hand lens
Blades
Slides and coverslips
Microscopes

Methodology:

Observe the signs and symptoms of the diseased plants/specimens provided, with the naked eye as well as with a hand lens and fill the Table 1.
Make appropriate drawings of the disease specimens.
List/Note the symptoms that occur frequently in many of the specimens.
Scrape the diseased areas showing symptoms with a scalpel. Prepare slides and observe under the light microscope and note mycelia, sporangia, bacteria cells etc. indicative of the presence of a pathogen.

Table 1: Fill the following table when possible describing the symptoms and indicating possible causative agents.

Specimen number	Symptoms	Causative agent

Figure 1a: A- leaf necrosis, note the yellow halo surrounding the necrotic centre (pic. by. Dr N. Deshappriya), B-mummification on blueberry (pic. by Dr D. Bambino, WSU), C- fruit rot of apple (pic. by C.G. Aguilar, WSU, USA), D- late blight on potato (Pic. by Dr R.N. Attanayake), E- cabbage rot (pic. by Dr R.N. Attanayake), F- necrotic spots on strawberry leaves (http://www.fruit.cornell.edu/berrytool/strawberry), G- vein clearing (pic. by Dr R.N. Attanayake), H- chlorosis (www.toptropicals.com), I- anthocyanescence on grapes (pic by Dr S. Bag, OSU, OR, USA), J- albinism (http://pixshark.com/albinism-plants.htm), K- mosaic pattern on tulips petals-break (http://mrbrownthumb.blogspot.com/2010/05/tulip-viruses.html), L- leaf streak on sugarcane, M-mosaic on bean leaves (Pic. by Dr D.S. Paudyal, OSU), N- goals on cinnamon leaves (pic. by Dr R.N. Attanayake), O-root knots on okra (pic. by Dr R.N. Attanayake)

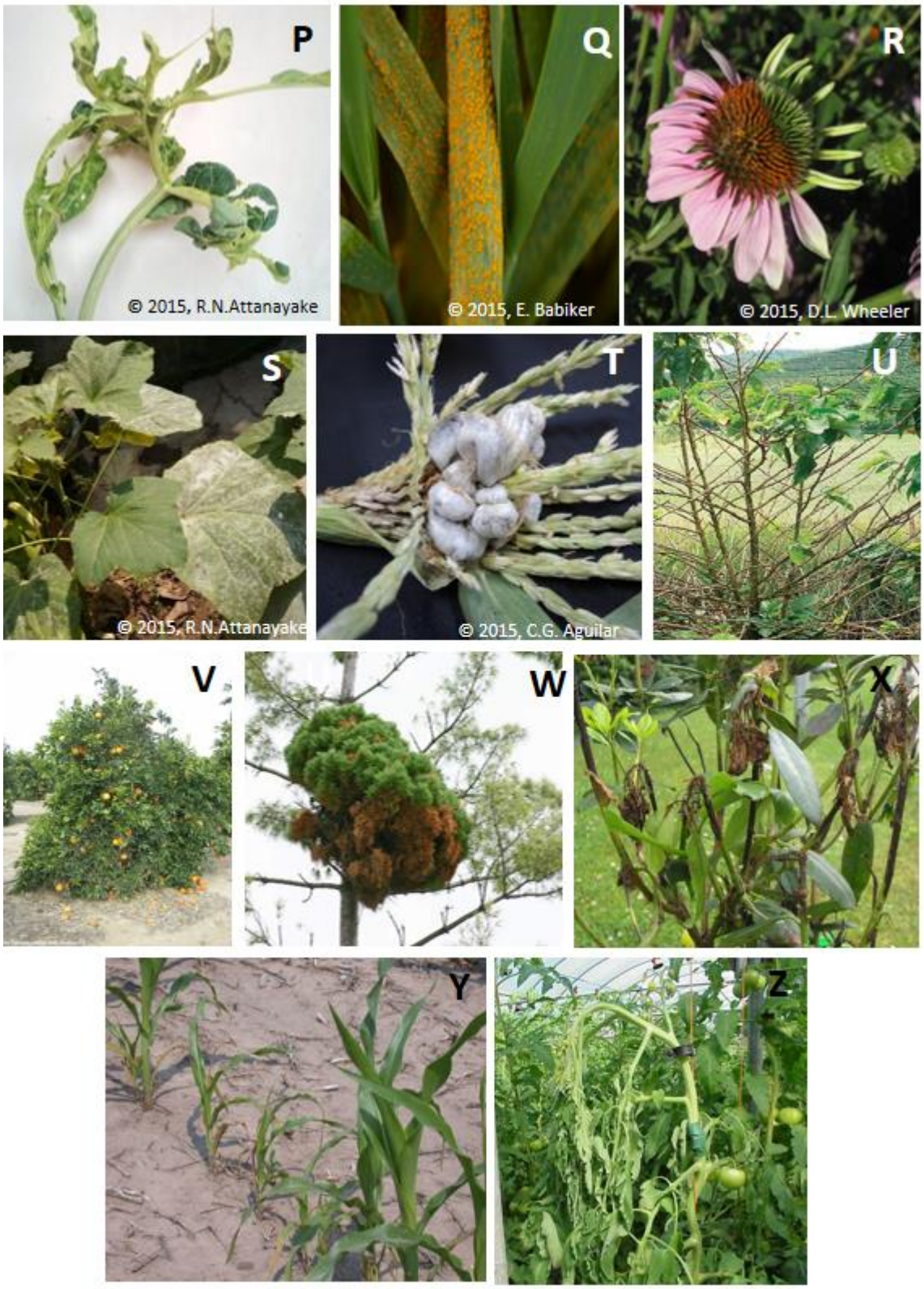

Figure 1b: P- leaf curl on papaya (pic. by Dr R.N. Attanayake), Q- wheat rust (pic. by Dr E.M. Babiker, WSU, USA), R- phyllody (pic. by D.L. Wheeler, WSU, USA), S- powdery mildew on okra (pic. by Dr R. N Attanayake), T- smut on corn (pic. by C.G. Aguilar, WSU, USA), U- leaf fall of coffee (http://schmidling.com/), V- fruit drop of citrus (http://idtools.org/id/citrus/diseases/), W- witch's broom (http://schmidling.com/wbroom.htm) X- dieback (http://agrifish.dk/plants/harmful-pests/fungi), Y- stunting of corn (www.greatlakeshybrids.com) Z- wilting of tomato (www.msucares.com/crops/comhort/tomatodisease/)