PRINCIPLES OF CROP PROTECTION
(CRP 312)
(Phytopathology section)

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OUTLINE

• Introduction to Crop Protection
• Concept of Plant Diseases
• Effective Management of Plant Diseases
• Terminologies used in Plant Pathology
• Methods of Plant Disease Management
• Crop Loss Assessment
• Disease Assessment Parameters
OUTLINE CONT’D

• Weed Management
• Diseases of Selected Crops
  ❖ Bacterial Diseases
  ❖ Fungal Diseases
  ❖ Viral Diseases
  ❖ Nematode Diseases
INTRODUCTION TO CROP PROTECTION

• Food shortage is a crucial issue especially in Africa where food production is seriously challenged.

• World’s population is currently put at 6 billion and still growing.

• The question of food production becomes an important concern.

• Directly related to food production issue are losses caused by pests and diseases that pose even much more challenges.

• Global estimation of crop losses due to diseases, insects and weeds are 11.9%, 12.3% and 9.8% respectively. An additional 15% food loss is added due to post harvest pests and diseases (FAO report).

• Effective management of pests, diseases and other factors of production would result in tremendous increase in productivity and availability of food crops.
Plant pathology therefore entails the study of:

• The biotic and the abiotic factors (environmental conditions) that cause diseases in plants.

• The mechanism by which these factors produce diseases in plants.

• The interaction between the disease causing agents and the diseased plant.

• The methods of preventing diseases, alleviating the effects of damage or controlling a disease before or after it develops in a plant.
Concept of Plant Diseases

Definition of Plant Disease

• Plant disease may be defined as any disturbance that prevents the normal functioning or development of a plant and thereby reducing its development, economic or aesthetic value.

• A disease interferes with the normal functioning of whole or some parts of the plant, resulting in lower yields or reduced quality. For the farmer, plant disease leads to a decrease in income; for the consumer, reduced food supply of lower quality at a higher price and to a pathologist, a riddle that must be solved.

What is a Disease Symptom

• The visible reactions of a plant to a disease are called symptoms.

• A diseased plant is recognized by comparing it to a healthy one.
What is a Disease Symptom Cont’d

- Disease symptoms may include:
  - Wilting.
  - Yellowing.
  - Stunting.
  - Death of plant.
  - Abnormal growth of parts of the plant.

Causes of Plant Diseases

- There can be no disease in the absence of the primary agent. The primary agent could be biotic or abiotic.

Biotic agents include:
- Fungi.
- Bacteria.
- Viruses/Viroids.
- Nematodes.
- Mycoplasmas.
- Parasitic higher plants, e.g. dodder, witch weed, protozoa.
Abiotic agents include:
- Deficiencies or excesses of mineral nutrients.
- Lack or excess soil moisture.
- Lack or excess light.
- Unfavourable soil pH.
- Air pollutants e.g. industrial gas wastes.
- Soil compaction.
- Unfavourable temperatures (extremes of heat or cold).

**Sterilization techniques in plant pathology**
   a. Dry heat.
   b. Moist heat.
   c. Flame.
2. Chemical methods.
3. Ultra filtration.
4. Ultra violet rays.
Effective management of plant diseases

Management of a disease depends on its accurate diagnosis and an accurate diagnosis of a disease depends on the identification of the causal pathogen or agent.

Microscopic examination or isolation of the causal pathogen is always necessary for diseases caused by micro-organisms. The identification of the causal organism of a new disease must meet four criteria called KOCH’s postulates for establishment of pathogenicity. It states thus:

1. The pathogen or abiotic agent must be consistently associated with the disease.
2. The pathogen must be isolated in pure culture or an abiotic agent identified and its characteristics described.
3. The pathogen from pure culture must be inoculated onto healthy plants of the same species or variety on which the disease appear and it must produce the same disease symptoms.
4. The pathogen must be re-isolated into pure culture and its characteristics must be exactly like those observed in Step 2.

Step 2 should be modified for viral diseases.
Terminologies used in Plant Pathology

1. **Pathogens**: They are micro-organisms which cause plant diseases.

2. **Pathogenicity**: This is the ability of a pathogen to become a part of a causal complex.

3. **Pathogenensis**: It is the chain of events involved in disease development and this include inoculation, penetration, incubation, infection and reproduction of the pathogen.

4. **Parasite**: This is the organism that lives in or on other organisms and derives its food from the organism without conferring any benefit.

5. **Host plant**: This is a plant that supports the activities of micro-organism.

   Types of hosts include:

   i. **Immune host**: A host that is free from infection even under the most suitable environmental condition is said to be **immuned**.

   ii. **Resistant host**: A host in which the pathogen develops slowly or incompletely is said to be **resistant**.

   iii. **Susceptible host**: A host that easily succumbs to infection is said to be **susceptible host**.
Terminologies used in Plant Pathology Cont’d

6. **Signs of disease**: These are the presence of causal organisms or any of their parts (e.g. hyphal filaments, spores, eggs) or products which include toxins and enzymes.

7. **Symptoms of disease**: These are evidence of disease expressed by the plant itself. Types of symptoms include:
   i. **Localized symptoms**.
   ii. **Systemic symptoms**.

8. **Pure culture**: A pure culture is one which contains one and only one micro-organism e.g. a culture plate containing a culture of *Fusarium oxysporum* alone.

9. **Biotroph** is a pathogen which survives and derives nourishment from living cells of the host.

10. **Saprophyte (Saprobe)** is an organism which survives on dead organic matter e.g. *Mucor*
Methods of Plant Disease Management

1. Regulatory methods:
   • This method involves plant quarantine and inspection. Plant materials such as seeds and other vegetative parts are observed at borders for the presence of disease pathogens.
   • They may observe these plants in green houses and or laboratories.
   • Plant quarantine regulations restrict or prohibit the introduction of foreign pathogens.
   • The materials are released if found to be disease free and a phytosanitary certificate is issued to accompany these materials to the importing country while those containing disease pathogens are destroyed.
   • This is a major method that controls disease transfer across geographical boundaries.
2. Cultural control methods:
   i. Crop rotation.
   ii. Conventional tillage.
   iii. Farm sanitation.
   iv. Selection of cultivars to be grown.
   v. Adjustment of Planting time.
   vi. Improvement of growing condition.
   vii. Use of healthy plant stock.

3. Physical control methods:
      i. Sterilization of soil using steam.
   iii. Hot water treatment of yam tubers.
   b. Refrigeration.
   c. Radiation.
   d. Grading and sorting of produce.
4. Chemical control methods
   (a) Foliar sprays/dusts
   (b) Seed treatment
   (c) Soil treatment
   (d) Post-harvest treatments
   (e) Disinfestation of storage facilities
   (f) Control of vectors

5. Biological control methods
   (a) Use of resistant plant varieties
   (b) Cross protection
   (c) Hyperparasitism

     I. Bacteriophage (Viruses infecting bacteria)
     II. Mycoparasite (Non-pathogenic fungi parasitizing on other pathogenic fungi)
     III. Nematophagus fungi (These parasitize nematodes)

   (d) Use of trap crops
6. Integrated pest/disease management (IPM)
   • Integrated pest management is a process by which farmers carefully combine a range of pest control options in order to achieve pest and disease control in an effective, economical and sustainable manner for a particular local situation.
   
   • The goal of IPM is to increase yield both in quantity and quality by effective combination of all available disease control methods in acceptable and justifiable proportions.
   
   • IPM is most effective when all relevant and pertinent information about the host and the pathogen are well understood.

   The following should be given consideration in an IPM programme
   • The methods applied must be compatible
   • The methods must be cost effective and sociologically acceptable.
   • IPM does not exclude the use of chemicals in pest and disease management but should be used as a healthy combination.
Commandments of IPM

Commandments of IPM
• Pest/disease monitoring
• Threshold levels
• Prevention is better than cure
• Record keeping
• Use least toxic chemicals
• Management of resistance

Main Partners in IPM
• Farmers
• Researchers
• Extension agents
Crop Loss Assessment

Crop loss assessment is necessary for following reasons.

1. To justify research because it influences the decision to initiate or terminate a research programme.

2. It helps to guide governmental Agricultural decision.

3. It helps to influence economic decisions on the farm and agro-allied industries

4. It helps to influence environmental impact decision by governmental and non-governmental groups.

**Crop loss assessment methods**

- Field surveys
- Personal testimonies
- Controlled experiments
- Use of Questionnaires
- Expert advice
- Remote sensing
Disease assessment parameters

To assess the direct contribution or effects of pests and pathogens on crop, two parameters are used

• Disease / incidence (Abundance)
This is the proportion of pest infested to pest free plants in a sample or the proportion of diseased to healthy. It is usually expressed in percentage.

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\text{Disease Incidence (DI)} = \frac{\text{No. of plants showing disease symptoms}}{\text{Total No. of plants assessed}} \times 100
\]

• Disease severity:
This is the measure of the extent of damage. It is usually measured as the proportion of a plant or plant organ which shows disease symptom.

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\text{Disease Severity (DS)} = \frac{\text{Area of Disease infestation}}{\text{Total Area of Plant}} \times 100
\]

The percentages are also interpreted in scales
1 = No disease
2 = 1-25% infection (Low infection)
3 = 26-50% infection (Mild/moderate)
4 = 51-75% infection (Severe)
5 = >75% infection (Death)
WEED MANAGEMENT

- Weeds are unwanted plants that grow with crops and compete with these crops for space and nutrients thus, inhibiting their growth.
- Two factors have influenced the success of weeds over the years;
  1. Their ability to reproduce readily (by seed production and by vegetable methods)
  2. Spread of weeds through various agents of dispersal
- Agents of weed dispersal
  - Man
  - Wind
  - Water
  - Animals

Principles and methods of weed control
1. Non-chemical control methods
   - Cultural methods
   - Physical methods
   - Biological methods
2. Chemical control methods
DISEASES OF SELECTED CROPS

• **Bacterial Diseases**
  – Bacterial blight of cowpea (CBB) caused by *Xanthomonas campestris pv vignicola*
  – Bacterial blight of rice caused by *Xanthomonas campestris pv oryza*

• **Fungal Diseases**
  - Sigatoka disease of banana – Banana leaf spot caused by *Mycosphearella musicola* (Perfect state) and *Cercospora musae* (Imperfect state)
  - Citrus scab caused by *Elsinoe fawcetti* (perfect state) and *Sphaceloma fawcetti* (Conidial or imperfect state)

• **Viral Diseases**
  - Cassava African Mosaic disease caused by Cassava mosaic virus
  - Rosette disease of groundnut caused by Groundnut rosette virus

• **Nematode Diseases**
  - Tuber dry rot of yam caused by *Scutellonema bradys* (Yam nematodes)
  - Root rot toppling disease of banana caused by *Rodophilus similis* (Nematode)