COURSE TITLE ; PLANT PROTECTION

COURSE CODE ; CRP 514

Plant Protection

1. Scope

Plant protection measures are carried out to limit harmful organisms performance and yield losses in crop production during the growing season and afterwards (storage protection) as well as for quarantine purposes. They serve primarily to safeguard yields, although in combination with other cultivation measures they can also help to raise yields. A wide variety of individual measures - with varying ecological, economic and socio-economic impacts - are available for keeping harmful organisms (diseases, pests, weeds) below the economic threshold.

To reduce the probability of damage, preventive measures are taken in the areas listed below. Some of these can be regarded as belonging to the field of plant production (cf. environmental brief Plant Production), which reflects the close links between the two sectors: Measures in these areas are backed up by the following direct forms of plant protection:

- physical methods

- chemical methods
- biotechnical methods
- biological methods
- integrated methods

Physical methods directly destroy harmful organisms, aim to retard their development or prevent them from spreading. They can be divided into mechanical and thermal measures. The former include tillage to control weeds and pests (hoeing, removal of affected parts of plants and intermediate hosts), flooding of fields to combat soil-borne harmful organisms (e.g. Fusarium oxysporum, which causes banana wilt), laying of sticky belts to trap flightless insect pests and other measures for catching pests or keeping them away from crops, such as fences, trenches (locust control), traps and picking-off of pests. Thermal methods utilise the harmful organisms' sensitivity to high or low temperatures. They include hot-water treatment of seed and planting stock (e.g. to combat viruses and bacteria in sugar cane cuttings), solarisation (covering the surface of the ground with plastic sheeting produces phytosanitary effects by virtue of the greenhouse effect resulting from insolation, e.g. for controlling parasitic seed plants, soil-borne harmful organisms etc.), burning-over to control weeds and burning of crop residues. Low temperatures inhibit the spread of certain storage pests. Eradicative, protective and curative methods are used in chemical

plant protection to destroy harmful organisms or keep them away from plants, to protect plants against attack and penetration by harmful organisms and to cure plants (or parts of plants) that have already become infested or diseased. Although chemical methods can be subdivided in this way on the basis of their effects, the boundaries between the individual categories are somewhat fluid, as many pesticides have more than one type of effect. Pesticides generally kill the harmful organism by influencing vital metabolic processes or disrupting the conduction system. Selectivity can be varied through appropriate selection of the active ingredient, formulation, application technique and time of application.
Biotechnical methods utilize the natural reactions of the (almost exclusively motile) harmful organisms to physical and chemical stimuli in order to bring about changes in their behavior for the purpose of plant protection (e.g. light and color traps, chemical attractants, antibodies, pheromones, hormones,growth regulators]

Biotechnical and biological methods of plant protection have gained in significance, among other things because the risks and limits of chemical measures are today assessed more realistically.
The emphasis is on measures which aim not to directly kill the harmful organisms, but rather to permit population monitoring for the purpose of forecasting, defensive action and deterrence. The

harmful organisms can be killed by combining biotechnical methods with chemical measures. Biological plant protection involves using organisms and their activity to protect plants and enhance their resistance to biotic (harmful organisms) and abiotic limiting factors. For the purpose of pest and disease control, beneficial organisms are specifically preserved and fostered, released in large numbers or introduced into habitats where they have not been found hitherto. Biological control of weeds has to date primarily involved introducing beneficial organisms into new habitats. Another biological method is that of inducing resistance to disease. This can be done, for example, by infecting plants with pathogens having low virulence.

Integrated plant protection is a concept which involves coordinated use of all ecologically and economically justifiable methods in order to keep harmful organisms below the economic threshold. The emphasis is on utilizing natural limiting factors. The main aim is to preserve the balance of nature as far as possible; this is to be achieved by reducing use of chemical plant protection methods and simultaneously employing a variety of measures from the other categories. It is here that the links with the plant production sector are particularly close. Use of pesticides is to be reduced to the essential minimum by abandoning the practice of routine or calendar-based spraying, gearing pesticide dosage to actual

conditions, refraining from the use of broad-spectrum persistent agents (liable to harm beneficial organisms) and selecting the time of application such that beneficial organisms suffer no adverse effects.

CAUSATIVE AGENTS OF PLANT DISEASES

Nematode

Fungi

Bacteria

Virus

DISEASE SYMPTOMPS

NEMATODE DISEASE

Plant parasitic nematode are often regarded as pathogens in their own right, capable of producing recognizable diseases, however there is a decreasing amount of evidence that they may also facilitate the entry and establishment of plant pathogen, fungi, bacteria and virus

SYMPTOMS ASSOCIATED WITH NEMATODE

Above ground symptoms:-

1) ***Injury to the growing point:-*** Nematode that feeds on the aerial part of plants do cause injury on leaves and growing point e.g.; a white tip disease of rice caused by Aphelenchoides bassay , Anguila tritici. A. tritici is a nematode of wheat. The symptoms are the black wheat seed in the given quantity of food grain.
2) ***Dry rot***:- The nematode that got into the buds in which they multiply rapidly destroying the external portion of the bud e.g. S. dispaci
3) ***Leaf blight***:- Caused by nematode that feeds on blades of leaves causing blight effect. Example of such nematode is Aphelenchoides ritzmabozi
4) ***Seed gall***:- Caused by effect of nematode that multiply in the seed e.g. Anguina tritici
5) ***Necrosis***:- These are nematode lesion caused by feeding on leaves and stem e.g. A. bassay
6) ***Root knot***:- These are result of hyperplasia on hypertrophy on the host of nematode e.g. Meloidogyne spp.
7) ***Root lession***:- These are wounds created by feeding habit of nematode on the root or entry point into the leaves e.g. Practylenchus on maize.
8) ***Stubby root***:- Swelling of the terminal point of the root e.g. Trichodorus spp.

FUNGI

Most pathogenic fungi spent part of their life in the host and later part in the soil as saprophyte. Some live their active life entirely on the plant and spore produced returns to the soil and remains inactive until it is packed up by some other host. Some live part of their lives on the host and the later part on the plant debris or in deed host as saprophytes. Survival and performance of the saprophyte fungi depends on the varying environmental condition.

SYMPTOMS OF FUNGI DISEASES

Fungi generally cause local lession in their host hence killing their host tissue. They also cause hypoplasia and hyperplasia. The main symptoms are

- ***Cankers, anthracnose***: Necrotic and sunken ulcer-like lessions on leaf or stem or flower of a part).
- ***Leaf spot***: Local lession on leaves considering of dead and collapse cells. Leaf spot may be angular, circular amorphous in nature.
- ***Scab***: they are localized lesions on host, fruits, leaves or tuber usually raised or sunken and track leafy or scabby appearance.
- ***Blight***: general and extremely rapid browning of the leaf branches and trees or floral parts resulting from them

- ***Dry and soft rot***: this is the disintegration of fruits, tubers. Stem and succulent leaf while dry rot occur in the absence of excess moisture
- ***Hypertrophy*** : this is the enlargement of roots appearing as a spindle or club.
- ***Gall***: enlarge portion of the plant usually filled with fungi mycelium.
- ***Witches broom***: produced upward branching and curling of leaves.
- ***Wilts***: usually a generalized secondary symptoms in which the leaves or the shoot loose their turgidity and dry up because of the disturbance of vascular system or the root.
- ***Leaf curl***: distortion or thickening and curling of leaf.
- ***Rust***: many small lession on the leaves usually rusty in appearance
- ***Mildew***: Chlorotic lesion on the necrotic area on the leaves stem or fruit usually with the mycelia of the fungi and fructification

BACTERIA

Pathogenic bacteria enters the plant through wounds and natural opening inside the plants. Bacteria multiplies the intracellular space by enzymatic actions, cell walls and the middle lamella are broken

down. This result in damage of the parenchyma. Cell first collapse and remains loosed inside the plant and eventually the plant dies.

SYMPTOMS OF BACTERIA DISEASES

Bacteria diseases are manifested via the following symptoms

- Leaf blight
- Leaf spot
- Soft spot
- Wilt
- Cankers
- Scabs
- Necrosis

VIRUS

SYMPTOMS OF VIRUS DISEASES

There are external and internal symptoms of virus diseases. This is due to the expression of the disease externally on the crop and at external levels.

- ***Distortion or inhibition of chlorophyll***
  - ***Chlorosis:*** this is a general pale green coloration of the parts of the leaves. Chlorosis results from the destruction or inhibition of the formation of chlorophyll subsequent to virus infection.

- ***Mosaic:*** it may be irregular intermingling of normal green and yellow patches on a diseased plant.
- ***Mottle:*** applies to intermingling of the different shape of green coloration of leaves
- ***Vein Chlorosis:*** This is a condition where only the veins are discolored (chlorotic)
- ***Vein clearing:*** veins turns translucent. Some part of the plant looks green and you can also see through the veins
- ***Vein banding:*** this is irregular green yellow patches along the vein of leaves. Monocot, because of their parallel venation tends to have elongate chlorotic patches which is called streak.

- ***Necrotic lession:*** it refers to regular localized spots scattered among the normal green leaves. When such lession appear in concentric plains, they are called leaf spot.
- ***Mosaic symptoms:*** it develops because both infected and non-infected parts multiplied. The mosaic pattern is likely due to escape by the uninfected cell or due to resistance.
- ***Necrosis:*** it is the death of tissue in localized regions. It may be the primary symptom of many virus or a secondary symptom of mosaic yellow group of viruses.

DAMAGES CAUSED BY VERTEBRATE PESTS

These are represented by rats, mice and other animals like bats and brown rats (Rattus rattus and R. novegicus). They damage arable and plantation crops such as rice, sugar cane, cocoa etc.

The mouse is a pest of stored and does damage to crop products and food. The large rodents e.g. rabbit and squirrels damage rice, leaven fruits or whole plant.

The cane rat and giant rats extensively damage such crops like maize, rice, sugar cane, cutting them at ground level and destroying more than they can eat.

Birds include Quella spps which fed on grains in the sahelian part of Africa. Some birds are fruit eaters e.g. Eidon helvrum in Indonesia, parrots' are serious pest of cocoa plantation.

Control method

- Setting of traps
- Exclusion
- Poison application
- Scarring
- Use of rodenticide.
- Proofing all storage structure.

sLOSSES AND DAMAGES CAUSED BY POST HARVEST PATHOGENS

MICRO-ORGANISMS:- They are too small to be clearly perceived by the unaided human eye. Organisms with a diameter of less than 1mm or any microscopic or ultramicroscopic animal or plant are micro-organism.

When present in food stuff, they can cause loss and spoilage. The food values and palatability are altered. Sometime they are contaminated by toxins which affect animal and man. Deterioration of packaging and sealing materials occur due to moulds. Also damp, mouldy and cakes food commodities often occur in storage due to micro-organism. In dry foods, the spore and mycelia of micro-organism are in dormant state, Inactive until conditions become favorable for their growth. Favorable conditions are provided by increase humidity of the environment or increase moisture content of the commodity, the micro-flora is activated, start growing and accompanied by active respiration and from this point deterioration increases at an exponential rate. The factors that affect the growth and development of micro-organism are:

- **Physical Factors**, such as temperature, water availability, oxygen, light and moisture content.
- **Chemical Factors** such as acidity of the food or pH, sugar content, inhibitory substances, nutrient type and quantity

EXAMPLES OF MICRO-ORGANISMS

BACTERIA:- This are typically one celled organism which have no chlorophyll. They multiply by simple rapid cell division and are the smallest of the micro-organism

associated with food spoilage. Examples are staphylococci, bacilli, streptococci.

MOULDS:- These belongs to a microscopic group of plant known as fungi that have no green colour (chlorophyll). They occur as a downy or furry growth on surface of organic matter. Sexual and asexual spores are produced according to the species. The spores are of extreme importance for their survival in harsh environmental conditions. In Aspergillus Spp. Conidia chains are borne on swollen vesicles.

YEAST: - These are microscopic yellow frothy substances consisting of a mass of minute fungi which germinates and multiply in the presence of starch or sugar. They produce Alcohol and carbon dioxide during fermentation process induced by enzyme. Multiplication of cell is by budding.

ACTINOMYCES: - They are microscopic organism often group with bacteria but has elongated and branched cells. Inhalation of their spores can cause lung disease in man. They have been identified in dried fish products.

DAMAGES CAUSED BY PHYSIOLOGICAL DISORDER

NUTRIENT DEFICIENCIES: -

The deficiency of major elements as nitrogen, potassium, phosphorus and sulphur is generally characterized by yellowing of leaves and poor plant growth magnesium deficiency is characterized by mottling or Chlorosis, as well as cupping of leaves and necrotic spotting. Calcium

deficiency results in irregular, distorted, brown scorched leaves and necrotic spotting.

INSUFFICIENT LIGHT: -This slows down chlorophyll formation and leads to condition known as **Etiolation** (lean growth with long internodes), pale green leaves and premature abscission of leaves and flowers.

TOO HIGH TEMPERATURE: - The side of the fruit facing the north (sun scald disease) below the skin and becomes discolored and water-soaked.

LOW SOIL MOISTURE: - The symptom is generally poor growth in maize, the leaf turns brown and the crop hardly flowers. When severe, the plant wilts and dies.

AIR POLLUTION:-Dust settling on leaves could lead to Chlorosis and poor growth. Phytotoxicity may result when some dissolve in water**.**

HIGH MOISTURE LEVEL:- Water logging of soil causes root decay due to reduced oxygen. The situation, if prolonged could lead to the collapse of the root cell and death of the plant

PESTICIDE TOXICITY:- Leaf-burn may result from pesticide spraying that is too highly concentrated.

EXAMPLES OF DISEASES ASSOCIATED WITH CROPS AND CAUSATIVE PATHOGENS

FUNGUS DISEASES

Fusarium wilts of tomato (Fusarium oxysporum)

This disease is caused by fungus spore. Fusarium enters roots of tomato through natural openings, cracks, entry points of nematode and wounds caused by farm practices.

Fusarium grows and produces spores and moving on into the vascular system. Inside the vascular system, there is proliferation of hyphea and production of fruiting bodies. There is production also of polysaccharides. The total effect of this is clogging of the vascular system thereby preventing uptake of water and nutrients as well as supply of metabolites from the leaves to the other part of the plant, cells in the leaves, branches and stems. Culminating in sudden wilt of the plant.

Sudden collapse of leaves and branches is generalized through out the whole plant. This is very sudden and rapid. It is secondary symptoms. The primary symptoms will be collapse roots, browning of vascular system and eventual death. The only control in a field infected by Fusarium wilt is roughing of infected plant and complete removal from the field. By the time symptoms are observed on the field, no control measure can be effective.

Black Pod Disease of Cocoa.

This is caused by Phytophthora palmivora and occurs in most cocoa growing areas of the world. Pod infection is characterized by a fast expanding dark brown or almost black rot, may occur at anytime during the development of the pod. The fungi develops extensively in the wall of fruits before damaging the seeds.

This disease is spread in cocoa by wind, insect, animal and most frequently by dipping and splashing of water from the surface of spore bearing cocoa disease.

A considerable amount of humidity is required for the development of the fungus. This disease produces crop losses of 30%-60%. Some neglected farms have recorded over 80% in very wet season.

Control:

- Spray fungicides e.g Perenox, carbide Bordeaux, lime Bordeaux or cocobre Sandoz.
- Infected pods should be removed at early stage of infection.

BACTERIA DISEASES

Bacteria blight of cassava.

(Xanthomonas manihotis**)** This is the bacteria responsible for this disease.

Symptoms: it is characterized by leaf wilt, defoliation and tip die-back accompanied by cream exudation from infected plant.

Control: use clean planting materials i.e. cuttings from infected plant should not be used. Two peak infections have been observed. Since the first peak of infection coincides with the first phase of heavy rains, planting should be carried out early in the season, march to April and late in seasons towards the end of September or early October. The planting date should depend on the rainfall distribution of the areas.

BACTERIAL SCAB (Xanthomonas campestri) of tomato.

Distribution: - It is widely distributed in many countries in Europe, Africa, Asia and Latin American countries.

Symptoms: - The first symptoms of bacteria scab is the appearance of small water soaked spots on leaves and stems. This spots become drier looking, sunken and grayish-brown in colour. They are about 2-5mm in diameter. The leaves may dry up. Bacterial ooze may form and dry to a cream coloured film. The stem lesion are grayish, long and scab-like. The green fruit of an infected plant develops dark water soaked spots which later form corky scabs on the surface. Flowers and young fruits of infected plants are often shed. Variation in symptom may occur under different climatic conditions.

Development and spread: - The wide spread and development is favored by prolonged condition of heavy rainfall, high relative humidity and temperature around 24°c when it can cause severe damage. The pathogen is able to survive in dead stalks of diseased plants and can also survive from one season to the next on solanaceous weeds and wheat's roots. It is seed-borne and also spread on wind driven rain and by insect. It enters the leaves through stomata and fruits through wounds. Fruits

symptoms are reported to be associated with punctures caused by insect.

Control: -

- Use of disease free seed
- Practice of crop rotation
- Solanaceous weeds should be destroyed
- Overhead sprinkling irrigation should be avoided
- Tomato plants should be stalked in row parallel to direction of the wind.

VIRAL DISEASES

Swollen shoot disease of coco

The name swollen shoot was given because the swellings were the first symptoms by which the disease was recognized in cocoa.

Swollen shoot covers a complex virus of which the symptoms vary considerably. Some virus isolates do not cause swellings and leave mosaic pattern are more diagnostic and serve to distinguish different isolates. Two viruses have been found:-

- Strain A produces vein clearing and red mottling.
- Strain B, producing yellow vein banding, swelling of shoot have also been observed. These virus may cause leaf fall, delay flushing and in severe cases die- back and death of trees. Yield are reduced by up 20%.

Epidemiology

The viruses are generally transmitted by mealy bugs Pseudococcus njalensis and plannococcus citri which are common in Nigeria and Ghana. Ants have been found to assist in the dispersal of the mealy bugs.

Control:

Numerous insectidal spray and dust have been tested for the control of mealy bugs. Nicotin, Parathion and Gamalin 20 kill some mealy bugs but sufficient vectors survive the treatment

- Control of ants attendant upon mealy bugs with Dieldrin
- Breeding of varieties of cocoa that are resistant to virus diseases.

GENERAL CONTROL METHOD OF PLANT DISEASES

Crop diseases can be controlled using cultural, biological and chemical methods

1) Cultural method: - This is the application of normal cultural practices to combat and prevent incidence of some diseases. This is especially very important for virus diseases for which there are no known cures, for crops that are harvested early and eaten raw and where options of pesticide use have been ruled out, this method is very important.

   Cultural method includes

   - ✓ Isolation
   - ✓ Cover crops and other barriers
   - ✓ Roughing and field sanitation
   - ✓ Crop rotation
   - ✓ improve growing condition
   - ✓ non-host
   - ✓ addition of soil amendments

2) Physi cal control methods: - The physical agents used in plant disease control are temperature and radiation. Heat treatments can be used for soil sterilization, disinfection of propagules etc. these physical treatments includes

   - ✓ Soil sterilization
   - ✓ Propagules treatment
   - ✓ Virus elimination by heat
   - ✓ Hot air treatment of storage organs
   - ✓ Refrigeration

- ✓ Radiation, comprising of various electro-magnetic radiations such as ultra-violet lights, x-rays, gamma rays as well as particle radiation

3) Biological control: - This involves the use of natural enemies to control diseases. With this techniques, microorganism, known to be antagonistic or parasite of disease pathogen are utilized. This method includes;
   - ✓ Hyperparasitism: - This is the control of pathogen with other microorganism or viruses which parasitise or antagonize the pathogens. The best known cases includes;
     - Bacteriophages (bacteria destroying virus)
     - Mycoparasites – Some fungi and bacteria are antagonistic or are parasite of pathogenic fungi
     - Parasites of Nematode – Many plant parasitic nematodes are parasitized by soil fungi
   - ✓ Tissue Culture: - control of vascular diseases can be achieved by meristem tissue culture. Pathogen free seedlings are generated this way for virus, bacteria and fungal diseases.
   - ✓ Cross protection: - This is the protection of a crop by a mild strain of virus from a more virulent strain.
   - ✓ Breeding for resistance: - this is the cheapest and most reliable control measures.

4) Chemical control method: - this is the most effective method of crop disease control. Although certain side effects are associated with this method. It remains the most effective means of reducing plant pathogen. The type of chemical used depends on the prevailing pathogen on the crop. As a result, the following are used to control plant diseases

- ✓ Fungicide – for the control of fungus disease e.g. copper, Bordeaux mixture, lime, captan etc.
- ✓ For virus disease, the vector transmitting such disease are controlled using insecticide.
- ✓ Bacterial disease are controlled with antibiotics like Cuprous oxide, Agrosan etc.
- ✓ Nematicides are used to control nematodes. Examples includes Nemagon, Vapan D.D and Methyl bromide.