PHYSICAL AND LEGISLATIVE METHODS OF PLANT DISEASE MANAGEMENT

Aim: To acquaint the students with physical and legislative methods of plant disease management

Physical Agents Used for Disease Control

The physical agents used most commonly in controlling plant diseases are:

i) Temperature (high or low)

ii) Dry air

iii) Unfavourable light wavelengths

iv) Various types of radiations

v) Cultivation in glass or plastic green houses

vi) Plastic or net covering

Soil sterilization by heat

- Soil sterilization is completed when the temperature in the coldest part of the soil has remained for at least 30 minutes at 82^{o}C or above, at which temperature almost all plant pathogens in the soil are killed.
- Soil can be sterilized in greenhouses, and sometimes in seed beds and cold frames, by the heat carried in live or aerated steam or hot water.
- The soil is steam sterilized either in special containers (soil sterilizers), into which steam is supplied under pressure, or on the greenhouse benches, in which case steam is piped into and is allowed to diffuse through the soil.
- At about 50^{o}C, nematodes, some oomycetes, and other water moulds are killed, whereas most plant pathogenic fungi and bacteria along with some worms, slugs, centipedes, are usually killed at temperatures between 60 and 72^{o}C.
- Most weeds, rest of plant pathogenic bacteria, most plant viruses in plant debris, and most insects are killed at about 82^{o}C.
- Heat tolerant weed seeds and some plant viruses, such as *Tobacco mosaic virus* (TMV)are killed at or near the boiling point that is between 95 and 100^{o}C.
- Excessively high or prolonged high temperatures should be avoided during soil sterilization.

- High temperatures destroy all normal saprophytic microflora in the soil and result in release of toxic levels of some (e.g., Manganese) salts.
- High temperatures also result in the accumulation of toxic levels of ammonia (by killing the nitrifying bacteria before they kill the more heat resistant ammonifying bacteria), which may damage or kill plants planted afterward.

Soil solarization

- When clear polythene film is placed over moist soil during sunny summer days, the temperature at the top 5 cm of soil may reach as high as 52^oC compared to a maximum of 37^oC in unmulched soil.
- If sunny weather continues for several days or weeks, the increased soil temperature from solar heat, known as solarization inactivates (or kills) many soil borne pathogens, viz., fungi, nematodes, and bacteria near soil surface, thereby reducing the inoculum and its potential for causing disease.

Hot water treatment of propagating organs

- Hot water treatment of certain seeds, bulbs, and nursery stock is used to kill pathogens with which they are infected or which may be present in seed coats, bulbs, scales, and so on, or which may be present in external surfaces or wounds.
- Seed treatment with hot water was the only means of control in some diseases for many years, as in the loose smut of cereals, in which the fungus overwinters as mycelium inside the seed where it could not be reached by chemicals.
- Treatment of bulbs and nursery stock with hot water frees them from nematodes that may be present within them, such as *Ditylenchus dipsaci* in the bulbs of various ornamentals and *Radopholus similis* in citrus rootstocks.
- The effectiveness of this method is based on the fact that the dormant plant organs can withstand higher temperatures than those of their respective pathogens can do for a given time.
- The temperature of the hot water used and the duration of the treatment vary with the different host pathogen combinations.
- In case of loose smut of wheat, seed is kept in hot water at 50^oC for 11 minutes, whereas bulbs treated for the control of *Ditylenchus dipsaci* are kept at 43^oC for 3 hours.
- A short (15 seconds) treatment of melon fruit with hot (59 $\pm$ 1^oC) water rinse and brushes result in a significant reduction of fruit decay while maintaining fruit quality after prolonged storage.
- Treated fruit had less soil, dust, and fungal spores at its surface while many of its natural openings in the epidermis were partially or entirely sealed.

Hot air treatment of storage organs

- Treatment of certain storage organs with warm air (curing) removes excess moisture from their surfaces and hasten the healing of wounds, thus preventing their infection by certain weak pathogens.
- Keeping sweet potato at 28 to 32^0C for 2 weeks helps the wounds to heal and prevents the infection of *Rhizopus* and by soft rotting bacteria.
- Hot air curing of harvested ears of corn, tobacco leaves, and so on removes most moisture from them and protects them from attack by fungal and bacterial saprophytes.
- Dry heat treatment of barley seed at 72^oC for 7 to 10 days eliminates the leaf streak and black chaff- causing bacterium *Xanthomonas campestris* pv. *transluscens* from the seed with negligible reduction of seed germination.

Control by eliminating certain light wavelengths

- *Alternaria*, *Botrytis* and *Stemphylium* are examples of plant pathogenic fungi that sporulate only when they receive light in the ultraviolet range (below 360 nm).
- Diseases can be controlled on greenhouse vegetables caused by several species of these fungi by covering or constructing the greenhouse with a special ultraviolet absorbing vinyl film that blocks the transmission of light wave lengths below 390 nm.

Drying stored grains and fruits

- All grains, legumes, and nuts carry with them a variety and number of fungi and bacteria that can cause decay of these organs in the presence of sufficient moisture.
- Such decay, however, can be avoided if seeds and nuts are harvested when properly mature and then are allowed to dry in the air or treated with heated air until the moisture content is reduced sufficiently (to about 12% moisture) before storage.
- Subsequently, they are stored under conditions of ventillation that do not allow build up of moisture to levels (about 12%) that would allow storage fungi to become activated.
- Fleshy fruits, such as peaches and strawberries, should be harvested later in the day, after dew is gone, to ensure that the fruit does not carry surface moisture with it during transit, which could result in decay of the fruit by fungi and bacteria.
- Many fruits can also be stored dry for a long time and can be kept free of disease if they are dried sufficiently before storage and if moisture is kept below a certain level during storage.
- Grapes, plums, dates and figs can be dried in the sun or through warm air treatment to produce raisins, prunes, and dried dates and figs, respectively, that are generally unaffected by bacteria and fungi as long as they are kept dry.

- Even slices of fleshy fruit such as apple, peaches, apricots can be protected from infection and decay by fungi and bacteria if they are dried sufficiently by exposure to the sun or to warm air currents.

Disease control by refrigeration

- Refrigeration is the most widely used and the most effective method of controlling post harvest diseases of fleshy plant products.
- Although low temperature at or slightly above the freezing point does not kill any of the pathogen that may be on or in the plant tissues, they do inhibit or greatly retard the growth and activities of all such pathogens, thereby reducing the spread of existing infection and the initiation of new ones.
- Most perishable fruits and vegetables should be refrigerated as soon as possible after harvest, transported in refrigerated vehicles, and kept refrigerated until used by the consumer.
- Regular refrigeration of especially succulent fruits and vegetables is sometimes preceded by quick hydrocooling or air cooling of these products, aimed at removing the excess heat carried in them from the field as quickly as possible to prevent the development of any new and latent infections.
- The magnitude of disease control through refrigeration and its value to growers and consumers is immense.

Disease control by irradiation

In this method, various electromagnetic radiations are used for controlling postharvest diseases of fruits and vegetables by killing the pathogens present on them, such as:

- UV light
- X-rays
- Gamma rays
- Particulate radiations, such as α-particles and β-particles

Legislative Methods

Quarantine regulation

Quarantine can be defined as a legal restriction on the movement of agricultural commodities for the purpose of exclusion, prevention or delay in the spread of plant pests and diseases in uninfected areas.

- Plant quarantine legislation has been placed on the statute book in most agriculturally advanced countries to restrict the movement of diseased plant material or of fungi, bacteria or viruses that can cause diseases in plants.

  Quarantine measures are of three types:

  i) domestic
  ii) internal
  iii) total embargoes

- The quarantine law was first enacted in USA in 1912, and was known as Federal Quarantine Act.
- In India, the Destructive Insect and Pest Act (DIPA) was passed in 1914 and subsequently supplemented by other provisions.
- Such quarantine laws were first enacted in France in 1660, and in Denmark in 1903.
- They aimed at the rapid destruction or eradication of barberry which has been known since early times to harbour black rust pathogen.

International Plant Protection Convention

The problem of plant diseases is global. Hence, European Plant Protection Organization (EPPO) was formed prior to the treaty in Rome. In 1951 in Rome, an International Plant Protection Convention was drawn up which at present has about 50 signatory nations. Briefly, each contracting government agrees to make provisions for:

i) An official protection organization with the specific basis of inspecting, rowing crops and the produced derived from them and issuing phytosanitary certificates.
ii) The distribution of information regarding pests and diseases both within the country and to other countries through FAO, so that a world reporting service is established.
iii) Research and investigation in the field of plant protection on a cooperative basis for diseases which have international effects. Within the framework of the international cooperation, there are six regional groups.