

PRINCIPLES OF PLANT DISEASE MANAGEMENT

Aim: To acquaint the students with general principles of plant disease management

Fundamental principles of disease management

- i) Avoidance: Geographical area, selection of a proper field, planting time and disease escaping varieties, avoidance of insect vectors and weed hosts
- ii) Exclusion: Quarantine, inspection & certification, seed treatment
- iii) Eradication: Crop rotation, sanitation, roguing, soil treatment, heat and chemical treatment to diseased plant material, use of antagonists
- iv) Protection: Chemical treatment
- v) Immunization: Resistant varieties, induced systemic resistance
- vi) Therapy: Chemotherapy, thermotherapy

Avoidance

- It involves tactics that prevent contact between the host and the pathogen.
- The selection of geographic area, selection of a proper field, planting time and disease escaping varieties play an important role in avoiding the disease.
- For example bean anthracnose is common in wet areas. Similarly smut and ergot of pearl-millet are serious in areas where rainfall occurs for long durations during flowering of the crop.
- Successful cultivation of a crop depends to a great extent on the selection of a proper field especially in soil borne diseases, e.g., root knot nematode disease, wilt of pigeon-pea etc.
- In many diseases the incidence or disease severity depends upon the coincidence of susceptible stage of the host and favourable conditions for the pathogen.
- This can be achieved by alteration in the date of planting/sowing.

- Certain insects especially aphids, beetles and leafhoppers are known to transmit viruses and mollicutes from infected plants to healthy plants.
- Perennial weeds including pokeweed, milkweed, Johnson grass and horse nettle serve as over-wintering reservoirs of some viruses.
- Curly top in sugar-beet is a leaf hopper-transmissible viral disease and weeds play a significant role in its spread.
- Some of the important weeds involved in the spread of curly top disease are certain species of *Chenopodium*, Russian thistle, *Amaranthus*, deadly night shade, shepherd's purse and knotweed.
- In some cases, aphids feed on some of the early-appearing weeds and then move to new crop plantings, thus introducing viruses which are then spread in secondary cycles within the planting.
- Bean yellow mosaic virus (BYMV) is a common problem in bean growing areas.
- Forage legumes (red clovers) are found to be the source of primary inoculum for aphids to carry BYMV into bean fields.
- For lettuce mosaic virus, only 10 to 15 seconds of feeding is needed by an aphid to acquire the virus and another 10 to 20 seconds on another plant suffices for the aphid to transmit the virus.

Exclusion

- It means preventing the entrance and establishment of pathogens in uninfected crops in a particular area.
- It can be achieved using certified seed or plants, sorting bulbs before planting, discarding any that are doubtful, possibly treating seeds, tubers or corms before they are planted and most importantly refusing obviously diseased specimens from dealers.
- In order to prevent the import and spread of plant pathogens into the country or individual states, certain federal and state laws regulate the conditions under which certain crops may be grown and distributed between states and countries.

- Such regulatory control is applied by means of quarantine, inspection of plants in the field or warehouse and occasionally by voluntary or compulsory eradication of certain host plants.
- Plant quarantines are carried out by experienced inspectors, stationed in all points of entry into the country, to stop persons or produce likely to introduce new pathogens.
- Similar quarantine regulations govern the interstate and even intrastate sale of nursery stock, tubers, bulbs, seeds and other propagative organs, especially of certain crops such as potatoes and fruit trees.
- For example, the outbreak of citrus canker in USA in 1910 through planting material imported from Southeast Asian countries.
- Due to heavy destruction, strict quarantine was imposed against entry of citrus planting material.
- However in 1981, 1984 and 1991, fresh outbreaks were reported due to illegal importation of citrus planting material. In India, interstate quarantine is in place for the movement of potato from Darjeeling area of West Bengal to prevent the spread of potato wart which is restricted to that area only.

Eradication

It involves elimination of a pathogen once it has become established on a plant or in a field.

It can be accomplished by:

- Removal of diseased plants or parts as in roguing to control virus diseases or cutting off a cankered tree limb.
- Cultivating to keep down weed hosts and deep ploughing or spading to bury diseased plant debris.
- Rotation of susceptible with non-susceptible crops to starve out the pathogen.
- Disinfection usually by chemicals, sometimes by heat treatment.
- Spraying or dusting with sulphur to kill the mildew mycelium.
- Treating the soil with chloropicrin to kill nematodes and fungi.
- Soil treatment with various nematicides (Telone II, Temik 15G, Counter 15 and 20G) is useful to control sugar-beet nematodes.

Protection

- It is the use of some protective barrier between the susceptible part of the susceptible host and the pathogen.
- In most cases, a protective spray or dust applied to the plant in advance of the arrival of the fungus spores.
- Sometimes, it is achieved by killing insects or other inoculating agents.
- Sometimes it is achieved by erection of a wind-break or other mechanical barrier.
- Fungicidal sprays that act as protectants are used to control Cercospora leaf spot of sugar-beet, especially in those fields where inoculum has carried over from the previous year.
- The principle of protective fungicides is to disrupt the natural sequence of infection.
- These fungicides act on the leaf surface to kill the newly germinated spores.
- Sulphur is used as a protectant fungicide to control powdery mildew of sugar-beet.
- There is a long list of chemicals available in the literature that can be used in protective spraying and dusting, along with eradicant chemicals.
- The commercially sold chemicals are provided with instructions or notes on compatibility and possibilities of injury.
- Improvement of aeration under crop canopy reduces the humidity on aerial parts of the plant and thus checks the growth of fungi which flourish in humid atmosphere.

Immunization/Disease resistance

- Disease resistant and tolerant varieties are the cheapest, easiest and most efficient way to reduce disease losses.
- Varieties should be selected that possess resistance or tolerance to one or more disease organisms.
- For some diseases, such as the soil-borne vascular wilts and the viruses, the use of resistant varieties is the only means of ensuring control.
- Certified seed of resistant varieties is available and sold commercially.

- The use of varieties of plants resistant to particular diseases has proved to be very effective against stem rust of wheat, rust of dry bean and Rhizoctonia root rot of sugar beet.
- Most plant breeding is done for the development of varieties that produce greater yields of better quality.
- When such varieties become available, they are then tested for resistance against some of the most important pathogens present in the area where the variety is developed and where it is expected to be cultivated.
- If the variety is resistant to these pathogens for that area, it may be released to the growers for immediate production.
- There are degrees of resistance to certain diseases, some varieties being completely immune, others partially susceptible.
- Resistant varieties may become susceptible to new races of a pathogen, as happens with cereal rusts, powdery mildews, downy mildews and *P. infestans*.
- Modern DNA technology has made it possible to engineer transgenic plants that are transformed with genes for resistance against specific disease, for tolerance of adverse environmental factors or with nucleic acid sequence that lead to gene silencing of the pathogen.
- Use of microorganisms and chemicals to induce systemic acquired resistance and activations of plants' defense system could also be used for the management of plant diseases.

Therapy

- It is used on individual plants and can not be used on a large scale.
- It is achieved by inoculating or treating the plant with something that will inactivate the pathogen.
- Chemotherapy is the use of chemicals to inactivate the pathogen, whereas heat is sometimes used to inactivate or inhibit virus development in infected plant tissues so that newly developing tissue may be obtained which is free of pathogen.

- Thermotherapy involves the exposure of diseased plants or parts of them to hot water or high air temperature for different periods of time.
- Loose smut of wheat is controlled by treating the seeds with hot water, but growing resistant varieties is a simpler method of control.
- Hot water treatment has been used to kill nematodes in bulbs, corms, tubers and fleshy roots while they are in a dormant condition.
- Dormant chrysanthemum stools can get rid of foliar nematodes by submerging in water at 112°F (44°C) for 30 minutes.