PLANT DISEASE MANAGEMENT AND CONTROL

Disease management is the selection and use of appropriate techniques to suppress disease to a tolerable level. The appropriateness of a technique depends on several types of information: the pathogen involvement, epidemiological characteristics of the agro-ecosystem, and efficacy of the specific technique.

Disease management means; to reduce the economic and aesthetic damage caused by plant diseases. On the contrary, control means; measures taken to prevent the incidence of a disease, reduce the amount of inoculum that initiates the spreads of disease and finally minimizes the loss caused by the disease.

Principles of plant disease management

1) Avoidance
2) Exclusion
3) Eradication
4) Protection
5) Resistant varieties
6) Therapy

Avoidance: Avoiding disease by altering planting time, or planting in areas where inoculum is ineffective due to an environmental condition or rare or absent.
Avoidance can be carried out by

- Choice of geographical areas
- Selection of field
- Selection of seed and planting material
- Choice of time of sowing
- Disease escaping varieties
- Modification of cultural practices.

Exclusion: Preventing the inoculum from entering or establishing in the field or area where it does not exist. It can be done by

- Seed treatment
- Inspection
- Certification
- Quarantine
- Cleaning farm equipment

Eradication: This principle aims at eliminating a pathogen after it is introduced into an area but before it has become well established or widely spread. It can be applied to individual plants, seed lots and fields or regions. It is generally not effective over large geographic areas. Eradiation can be done by

 Destroying weeds that are reservoirs of various pathogens or insect vectors of disease
 Biological control of plant pathogen
 Crop rotation
 Soil treatment
 Heat and chemical treatment
 Elimination of potato cull piles etc.

Protection: Preventing infection by creating a chemical toxic barrier between the plant surface and pathogens. It can be done by
 Chemical treatment
 Chemical control of insect vector
 Modification of environment or environment condition
 Modification of host nutrition

Resistant Varieties: Preventing infection or reducing the effect of infection by managing the host through improvement of resistance in it by genetic manipulation or by chemotherapy. It can be done by
 Selection and hybridization of disease resistance
 Mutation for disease resistance

Therapy of disease plant: Reducing severity of disease in an infected individual by chemicals. It can be done by
 Chemotherapy
 Tree Surgery
 Heat Therapy

Plant disease management and control methods

1. Cultural method
2. Mechanical and Physical method
3. Chemical method
4. Biological method
5. Host plant resistance method

CULTURAL METHOD

The term cultural control describes the activities of humans aimed at controlling disease through the cultural manipulation of plants. Cultural control practices could be considered a form of biological control and tend to be preventative and indirect in their actions against pathogens. The success of cultural control practices ultimately depends on understanding the biology of the pathogen and the response of the host to infection. Such knowledge facilitates management decisions which 'attack' by pathogens at vulnerable stages of their life cycles.

Cultural control practices maybe eradication of alternate and collateral hosts, Rouging, crop rotation, manure and fertilizer management, mixed cropping, sanitation, hot weather ploughing, soil amendments, time of sowing, seed rate and plant density, irrigation and drainage etc.

Eradication: Eradication is the elimination of pathogen after it has become established in the area where host is growing. The following are the important methods followed to prevent the spread of the diseases:

Eradication of alternate hosts

Removal of alternate hosts helps to prevent and check the spread of the disease caused by heteroecious rust pathogens in the primary hosts. Barberry bush is the alternate host for stem rust pathogen *Puccinia graminis tritici* on wheat where the pathogen survives in the offseason. The eradication of barberry had two benefits i.e., it elimination of early spring primary inoculum and prevention of the formation of new physiologic races of the pathogens.

Eradication of collateral and self-sown overwintering hosts

There are many weed hosts or wild species of cultivated plants act as collateral hosts or volunteer plants of an economic crop which act as reservoirs of pathogens of annual crop. Reservoir hosts help the pathogen to continue the infection chain. The primary inoculum is produced on and dispersed from these hosts to the cultivated crop hosts. If these wild or uneconomic host plants of the pathogen are destroyed, the sources of primary inoculum are eliminated and chances of initiation of the disease in the crop hosts are reduced. Destruction of these hosts breaks the life cycle of the pathogen and the infection chain. Reservoir hosts or indigenous plant species which are not actually involved with the life cycle of the pathogen but provide additional sites for its persistence and multiplication. *Xanthomonas oryzae* pv. *oryzae* causes bacterial leaf blight disease in rice and when the host is absent then the pathogen can survive in collateral host such as *Cyanodon dactylon, Cyperus rotundus* etc.

Eradication of affected plants or trees

In some threatening plant diseases, it is essential to eradicate the host and the pathogen from an area. Citrus, canker (*Xanthomonas axonopodis* pv. *citri)* is an example of success of an eradication programme. This disease was first noticed in Florida citrus trees in 1913. An eradication campaign was started in 1915. All the citrus nurseries and orchards were inspected

and the infected trees were cut and burnt. The eradication programme continued till 1927 and no citrus canker was present in that area.

Eradication of pathogens from infected plant parts by surgery

Eradication of affected plant parts (tree surgery) are also practiced in certain cases which reduces the source of primary inoculum. Lesions caused by fire blight bacterium *(Erwinia amylovora)* on pear and apple trees are removed during winter months. This not only prevents further spread in the affected trees but also reduces the amount of inoculum that can spread to other branches and trees.

Crop rotation

Crop rotation is essentially a preventive measure and has its effect mainly on the succeeding crop. Crop rotation is the oldest and cheapest method adopted in agriculture for eradication of certain types of pathogens from infested soil. Continuous cropping or mono culturing provides the opportunity for perpetuation of pathogenic organisms in the soil when the same crop is raised year after year in the same field. The soil-borne pathogens of that crop easily perennate in the soil and increase in their population. After sometime, the soil becomes so heavily infested that it becomes unfit for cultivation of the particular crop. Virus diseases of crop plants and their vectors are found to increase after every crop if a crop is cultivated continuously in a field. On the other hand, when immune, resistant or non-host crops are grown for a definite duration after a susceptible crop in the field it is expected that in the absence of nutrition, the pathogen will be starved off and the population of such pathogens consequently decreases. It is also possible that different crops release some biochemical substances in their root exudates which either directly kill the pathogen or encourage development of antagonistic microorganisms in the soil. In this way, crop rotation is one of the most effective methods of root disease control. Crop rotation with sugarcane or paddy is effective in the control of 'Panama wilt' of banana (*Fusarium oxysporum* f. sp. *cubense*) and crop rotation with paddy or green manures is effective in the control of red rot of sugarcane (*Colletotrichum falcatum*).

Fallowing

Fallowing starves the pathogen and helps in reduction of the inoculum by elimination of the host. Diseases like *Macrophomina* root rot on different crop plants is controlled by following this method. Flood fallowing is to a depth of 0.6 to 1.5 m for 4 to 6 months markedly reduced the Panama wilt pathogen *Fusarium oxysporum* f. sp. *cubense* inoculum in banana.

Application of organic manures

Addition of organic manures like farm yard manure or green manures or oil cakes to the soil increases the antagonistic microorganisms in the soil. Buildup of antagonistic microorganisms reduces the population of soil-borne plant pathogens and the diseases caused by them. Application of farm yard manure at the rate of 12.5 t/ha reduced the incidence of *Macrophomina* root rot of cotton.

Soil amendment

It has been proved that the organic amendments rich in carbon and deficient in nitrogen control the take-all disease (O*phiobolus graminis*) of wheat. There is considerable liberation of CO_2 by soil saprophytes which suppresses the pathogenic activity of this fungus. In the process of survival also,

low nitrogen content in the soil reduces the longevity of the fungus. *Phytophthora* root rot of avocado is controlled by amending the soils with alfalfa meal- a material of low C/N ratio.

Summer ploughing

Deep ploughing during summer periods buries the inocula of fungi of soil-borne nature. Fungal propagules, sclerotia and different types of spores, conidia on plant refuses die when exposed to sunlight due to the higher temperature prevailing during the summer. Further infected self-sown plants, volunteer hosts plants, weed hosts, regrowth from the plant roots, alternate hosts and alternative hosts are also destroyed.

Altering the soil pH

In certain soil borne diseases adjustment of soil reaction helps in the reduction of inoculum level of the pathogens. The altered pH of the environment forms a barrier against the pathogen. A very low pH less than 5.2 is unfavourable to common scab bacterium on potato (*Streptomyces scabies*). Thus, use of acid forming fertilizers (like sulphur) and avoiding lime and calcium ammonium nitrate application are effective in controlling the common scab disease. On the other hand the club root pathogen of cabbage (*Plasmodiophora brassicae*) cannot live and infect when the soil pH is 7.0 or more. Hence liming which increases the soil pH gives satisfactory control of club root disease.

Selection of seeds and seed materials

Seeds and seed materials carry many fungi, bacteria, viruses and phytoplasmas and may introduce these pathogens into the field, i.e., seeds and seed materials form the primary source of infection. Seed and seed materials like cuttings, tubers, grafts, setts etc., should be well matured, disease free, uninjured and have a high germinating capacity. The absence of an initial inoculum in seeds is definitely helpful in delaying or suppressing the incidence of the disease. It is a preventive method. The diseases like foot rot, brown spot, short smut of sorghum, loose smut of wheat, bacterial blight of rice, bacterial blight of cotton, leaf crinkle of blackgram etc., are transmitted through seeds.

Burning of stubbles and crop residues

Burning of plant wastes, crop residues, stubbles, etc., in the areas selected for raising nurseries for vegetable crops, tobacco, chillies and forest trees etc. heats the soil and kills the inoculum of the pathogens present in the top layer of the soil. When nurseries are raised in these areas incidence of damping off disease is highly reduced. Burning of rice crop residues avoid carryover of sheath blight (*Rhizoctonia solani*); stem rot (*Sclerotium oryzae*) of rice and bacterial blight of cotton.

Intercropping

Intercropping is also a device in the control of some soil borne diseases. Intercrops should be properly chosen so that they should not have any common pathogen. As for e.g., *Macrophomina phaseolina* has got wide host range and hence common host should not be grown as intercrops. Intercropping with moth bean (*Phaseolus aconitifolius*) in a cotton field reduced the root rot (*M. phaseolina*) incidence.

Barrier cropping

Taller crops can be grown to protect a crop of lesser height from virus vectors. The insects may land at the taller crops (barrier crops) and the dwarf crop may escape from virus diseases by those

insects. Barrier cropping with 3 rows of maize or sorghum or pearlmillet around the main crop namely blackgram or greengram is effective in reducing the vector population and incidence of yellow mosaic.

Decoy crop and trap crop

Decoy crops (hostile crops) are non-host crops sown with the purpose of making soil-borne pathogens waste their infection potential. This is effected by activating dormant propagules of fungi, seeds of parasitic plants, etc. in absence of the host. Trap crops are host crops of the pathogen, sown to attract pathogens but destined to be harvested or destroyed before they complete their life cycle. Fodder sorghum can be raised as a trap crop to reduce downy mildew of sorghum.

Roguing

Roguing consists of completely removing or uprooting the diseased plants to prevent further spread of the disease. This method is widely adopted in the control of virus diseases spread by insects (yellow mosaic of blackgram and greengram, citrus tristeza, bunchy top of banana) and basal stem rot of coconut, green ear of pearlmillet and broomrape (*Orobanche*) in tobacco.

Management of plant nutrients

The plant nutrients in general when applied in excess may increase or reduce the resistance in plants to diseases. Increased application of nitrogenous fertilizers increases the incidence of many diseases. Crops fed with heavy doses of nitrogenous was fertilizers grow robust with foliage and succulent tissue but become highly susceptible to the attack of diseases. High dosage of nitrogen fertilizer enhance the blast disease of rice and low dosage of nitrogen fertilizer increase the brown spot disease of rice.

Repeated application of phosphatic fertilizers delays the onset and lessens the severity of take-all disease of barley (*Gaeumannomyces graminis*). Potassium application reduces the disease incidence in many crop diseases probably by increasing phenolics synthesis in plants. Application of potash induces resistance in groundnut against root rot caused by *Macrophomina phaseolina*. Calcium application suppresses the lesions due to the *R. solani* on bean roots. It is due to formation of calcium pectate, which is less available to action by polygalacturanase (PG) enzyme than is pectic acid. Calcium has also been shown to affect *Sclerotium rolfsii* by neutralizing the oxalic acid which is produced by the fungus. Application of molybdenum reduces infection of potato tubers by *Phytophthora infestans* and also diminishes incidence of *Ascochyta* blight on beans and peas. Manganese reduces late blight of potato, ferric chloride controls rice brown spot and silicon application reduced rice blast.

Crop growing seasons

Adjustment of sowing time

In many diseases the incidence is more severe when the susceptible stage of the plant growth and favourable conditions for the pathogens coincides. While choosing the time of sowing it should be taken into consideration that susceptible stage of the crop growth and soil conditions and other environments favourable for maximum activity of the pathogen does not fall at the same time. Properly adjusting the sowing dates can give good dividends. Late planted wheat crops contract less infection than wheat planted on normal dates.

Adjustment of harvesting time

Harvesting of groundnut should not coincide with the rainy days and it helps to avoid infection by *Aspergillus flavus*.

Field and plant sanitation

Field and plant sanitation is an important method of disease control through cultural practices. The inoculum present on field plants in the field may multiply on the plant or in the soil and in due course of time may be sufficient to nullify or reduce the effect of control practices. Many pathogens overwinter or oversummer on plant debris during the off-seasons and become active when the crop is again grown in the field. Hence plants bearing pathogens or plant debris introducing inoculum into the soil should be removed as early as possible. In most of the soil-borne diseases like wilt and root rot, it has been reported that as long as the dead roots and other roots and other affected parts are present in the soil, the fungus continue its growth. When such diseased plant materials are removed, there is quick decline in the population of pathogens in the soil.

In this manner *Fusarium* wilt of cotton, pigeonpea and banana, *Verticillium* wilt of cotton, root rot of beans, downy mildew of pearlmillet, sorghum, maize and peas, foot rot of betelvine, bacterial blight of cotton, white rust of crucifers, black spot of rose, powdery mildew of pea and cereals are reduced. In certain areas the linseed rust fungus (*Melampsora lini*), the rice blast and brown spot fungi and the fungus causing early blight of potato also perennate through dormant stages in diseased crop debris. Destruction of crop debris by burning immediately after harvest reduces the amount of inocula which survive through debris.

Cultural control can be an effective and sustainable approach to the management of plant disease. Indeed, continuing problems with fungicide resistance and breakdown of host plant resistance, together with increasing concern for the environment means that there is renewed interest in cultural practices for the management of crop diseases. However, the choice and use of cultural practice with depend on the crop and the pathogen, although it might be possible to integrate the management of more than one disease by combining several appropriate cultural practices.