EFFECT OF ENVIRONMENTAL FACTORS ON DISEASE DEVELOPMENT

Aim: To acquaint the students with effect of environmental factors on disease development

Effect of Environmental Factors on Disease Development

- Plant diseases are ubiquitous throughout the world wherever plants grow, but of more common occurrence in humid to wet area with cool, warm or tropical temperatures.
- Diseases most commonly occur during wet, warm days and night and on plants heavily fertilized with nitrogenous fertilizers.
- So, environmental conditions frequently determine whether a particular disease will occur or not.
- Most common environmental factors that have considerable influence on development of plant disease are temperature and moisture.
- Other factors include wind, light, soil pH, soil structure etc.

Effect of temperature

- Each pathogen has an optimum temperature for its growth.
- Different growth stages of fungus, such as the production of spores, their germination and the growth of the mycelium may have slightly different optimum temperature.
- Storage temperatures for certain fruits, vegetables and nursery stock are manipulated to control fungi and bacteria that causes storage decay, provided the temperature does not change quality of products.
- In temperate regions, low temperature during late fall, winter or early spring are not congenial for the development of pathogen, but as the temperature rises, these pathogens become active and when other conditions are favourable they can cause infection and thus disease.
- Pathogen differs in their preference for higher or lower temperature. For example, the fungi namely *Typhula* and *Fusarium* causing snow mould of cereals and turf grasses, late

blight pathogen *Phytophthora infestans* are more serious in cold regions whereas fungus like *Colletotrichum, Ralstonia* are favoured by higher temperature.

- Rapid disease development occurs when temperature is optimum for pathogen development and is below or above the optimum for host development.
- For stem rust of wheat (*Puccinia graminis tritici*) completion of infection cycle is 22 days at 5°C, 15 days at 10°C and 5-6 days at 23°C.
- The minimum, optimum and maximum temperature for the pathogen, host and disease are same, the effect of temperatures in disease development is apparently through its influence on pathogen.
- Effects of temperature may mask symptoms of certain viral and mycoplasmal diseases and making them more difficult to detect.

Effect of moisture

- Moisture influences the initiation and development of infectious plant diseases in many interrelated ways.
- It may exist as rain or irrigation water on plant surface or around the roots, as relative humidity in the air and as dew.
- Moisture is indispensable for the germination of fungal spores and penetration of the host by germ tube.
- It is also indispensable for the activation of bacterial, fungal and nematode pathogens before they can infect the plant.
- Moisture in the form of splashing rain and running water also plats an important role in the distribution and spread of many of the pathogens on the same plant and on other plants.
- Moisture also increases the succulence of host plants and thus their susceptibility to certain pathogens, which affects the extent and severity of disease.

Effect of rainfall

- The occurrence of many diseases in a particular region is closely correlated with the amount and distribution of rainfall within year.
- Late blight of potato, apple scab, downy mildew of grapes and fire blight are found or are severe only in areas with high rainfall or high relative humidity during the growing season.
- In apple scab, continuous wetting of the leaves, fruits etc. for at least 9 hours is required for primary infection to take place even at optimum range (18 to 23°C) of temperature.
- At lower temperature the minimum wetting period required is higher.
- In powdery mildews, spore germination and infection are actually lower in the presence of free moisture on the plant surface than they are in its absence.

Effect of Relative humidity

- Relative humidity is very critical in fungal spore germination and the development of storage rots.
- Rhizopus soft rot of sweet potato (*Rhizopus stolonifer*) is an example of storage disease that does not develop if relative humidity is maintained at 85-90 %, even if the storage temperature is optimum for the growth of the pathogen. Under these conditions, the sweet potato root produces corky tissues that wall off the *Rhizopus* fungus.
- Moisture is generally needed for fungal spore germination, the multiplication and penetration of bacteria and the initiation of infection e.g., germination of powdery mildew spores occurs at 90-95 % relative humidity.

Effect of soil moisture

- Soil moisture influences the initiation and development of infectious plant diseases.
- High or low soil moisture may be a limiting factor in the development of certain root rot diseases.
- High soil moisture levels favours development of destructive water mould fungi, such as species of *Aphanomyces, Pythium* and *Phytophthora.*

- Overwintering by decreasing oxygen and raising carbon-dioxide levels in the soil makes roots more susceptible to root rotting organisms.
- Diseases such as take all of cereals (*Gaeumannomyces graminis*), charcoal rot of corn, sorghum and soyabean (*Macrophomina phaseolina*), common scab of potato (*Streptomyces scabies*) and onion white rot (*Sclerotium cepivorum*) are most severe under low moisture levels.

Effect of wind

- Most plant diseases that occurs in epidemic portions and spread in large areas are caused by fungi, bacteria and viruses that are spread either directly by wind or indirectly by insects which can travel long distances with the wind.
- Uredospores and many conidia are transported to many kilometers by wind.
- Wind becomes more important when it is accompanied by rain.
- Wind blown rain splashes can help in spread of bacteria from the infected tissues.

Effect of light

- Light intensity and duration may either increase or decrease the susceptibility of plants to infection and also the severity of disease.
- Light mainly cause production of etiolated plants due to reduced light intensity which in turn increases the susceptibility of plants to non-obligate parasites but decreases the susceptibility of plants to obligate parasites.
- It also enhances the plants' susceptibility to viral infections.

Effect of soil pH

- Soil pH is a measure of acidity or alkalinity and it markedly influences occurrence of soil borne pathogens.
- Growth of potato scab (*Streptomyces scabies*) pathogen is suppressed at a pH of 5.2 or slightly below but is more severe at a pH 5.2 to 8.0 or above.
- Club root of crucifers caused by *Plasmodiophora brassicae* is most severe at a pH of 5.7, whereas its development drops sharply between 5.7 and 6.2 and is completely checked at pH 7.8.

Effect of soil type

- Certain pathogens are favored by loam soils and others by clay soils.
- Fusarium wilt disease which attacks a wide range of cultivated plants causes more damage in lighter and higher soils.
- Nematodes are also most damaging in lighter soils that warm up quickly.

Effect of host-plant nutrition

- Nutrition affects the rate of growth and the state of readiness of plants to defend them against pathogenic attack.
- Nitrogen abundance results in the production of young, succulent growth, a prolonged vegetative period and delayed maturity of the plants.
- These effects make the plant more susceptible to pathogens that normally attack such tissues and for longer periods.
- In contrast, plants suffering from a lack of nitrogen are weaker, slow growing and faster aging.
- Such plants are susceptible to pathogens that are best able to attack weak, slow-growing plants.
- Large amounts of nitrogen increases the susceptibility of pear to fire blight (*Erwinia amylovora*), wheat rust (*Puccinia*) and powdery mildew (*Erysiphe*).
- Reduced availability of nitrogen may increase the susceptibility of tomato to Fusarium wilt and *Alternaria solani*, of sugar-beets to *Sclerotium rolfsii* and of most seedlings to Pythium damping-off.
- Severity of the disease caused by *Fusarium* spp., *Plasmodiophora brassicae* and *Sclerotium rolfsii* increases when an ammonium fertilizer is applied whereas the severity of diseases caused by *Streptomyces scabies* and *Gaeumannomyces graminis* increase when nitrate form of fertilizers are applied.
- Phosphorus has been shown to reduce the severity of potato scab but to increase the severity of cucumber mosaic virus on spinach and *Septoria* infection of wheat leaves and glumes.

- Phosphorus seems to increase resistance either by improving the balance of nutrients in the plant or by accelerating the maturity of the crop and allowing it to escape infection by pathogens that prefer younger tissues.
- Potassium has also been shown to reduce the severity of numerous diseases including stem rust of wheat and early blight of tomato, whereas high amounts of potassium increase the severity of rice blast and root knot.
- Potassium seems to have a direct effect on the various stages of pathogen establishment and development in the host and an indirect effect on infection by promoting wound healing.
- Calcium reduces the severity of several diseases caused by root and stem pathogens such as *Rhizoctonia, Sclerotium, Botrytis* and *Fusarium oxysporum,* but it increases the severity of common scab of potato (*Streptomyces scabies).*
- The effect of calcium on disease resistance seems to result from its effect on the composition of cell walls and their resistance to penetration by pathogens.
- In general, plants receiving a balanced nutrition, in which all required elements are supplied in appropriate amounts, are more capable of protecting them from new infections and of limiting existing infections than plants to which one or more nutrients are supplied in excessive or deficient amounts.

Effect of pollutants

- Air pollutants cause various types of direct symptoms on plants exposed to their high levels.
- Ozone may affect a pathogen and sometimes the disease it causes. For example in wheat rust fungus, ozone reduces the growth of uredia and of hyphal growth and also the number of uredospores produced on ozone injured leaves. Ozone increases the infection of potato leaves