

DISSEMINATION OF PLANT PATHOGENS

Aim: To acquaint the students with the dissemination or dispersal of plant pathogens

Dissemination is the spread of plant pathogens within the general area in which it is established is termed as their dissemination or dispersal or transmission.

Methods of dissemination

- Different methods of dissemination of the plant pathogens within a crop season as well as to the next season after its survival are:
 - i) Direct methods
 - ii) Indirect methods.
- In direct transmission, the dispersal takes place along with the seeds and vegetative plant parts used for propagation.
- Indirect transmission may be active/autonomous or brought about passively by different agencies like wind, water, animals or human beings.

Direct transmission

It is further divided into:

- Adherent transmission
- Germinative transmission
- Vegetative transmission
- In **adherent** type, the pathogen propagules are carried over the surfaces of seed or other propagative materials. Bunt of wheat caused by *Tilletia foetida* and *T. caries* is carried through the seed externally. Similarly, spores of *Synchytrium endobioticum* which causes potato wart and *Rhizoctonia solani* (the black scurf pathogen) sclerotia are adherent to potato tubers used as seeds.
- In **germinative** type, the plant pathogens are carried through the seed or other propagules internally as in case of loose smut of wheat and barley. Similarly, bean mosaic is transmitted through pollen grains and is carried in the seeds.

- In **vegetative** transmission, a large number of fungal, bacterial, viral and phytoplasmal plant pathogens are carried in the vegetative plant parts used as seeds such as tubers, cuttings, runners, grafts etc.
- For example, ring rot of potato caused by *Clavibacter sepidonicum* and *Ralstonia solanacearum* causing brown rot is carried through infected potato tubers to new ones.
- Similarly, dormant mycelium of *Phytophthora infestans* is carried through potato tubers. A large number of viruses, e.g., potato virus X, potato virus Y, citrus tristeza and apple mosaic virus, etc. are transmitted through their propagative parts apart from red rot and whip tail of sugarcane.

Indirect transmission

It can be:

- a. Autonomous/Active transmission
- b. Wind dispersal of pathogens (Anemochory)
- c. Water dispersal of pathogens (Hydrochory)
- d. Animal dispersal (Zoochory)
- e. Insect dispersal (Entomochory)
- f. Human dispersal (Anthropochory)

Autonomous transmission

- By this method, the plant pathogens are spread to short distances.
- It takes place by active growth of the hyphae or hyphal strands.
- It is characteristic of wood rotting fungi like *Armillariella*, *Fomes*, *Ganoderma*, etc. which migrate independently through the soil from plant to plant or even from field to field by active growth of their strands.
- Zoospores of *Phytophthora* and *Pythium* can swim through the water film in soil although to limited distances, likewise nematodes.
- Spores of some fungi are expelled forcibly from the sporophores or sporocarps by puffing action.
- The seeds of some parasitic plants are also expelled forcibly and may reach over distances of several meters.

Dissemination by wind/air

- Many fungal spores and seeds of most parasitic plants are disseminated by wind or air currents that carry them as particles to various distances.
- Air current pickup spores and seeds of sporophores and carry them upward or horizontally.
- While air borne some of the spores may reach the wet surfaces and get trapped; and when air movement stops or it rains the rest of the spores land or may be brought down by rain drops on to the susceptible host surfaces.
- The spores of many fungi are too delicate to survive a long trip through air and are, therefore, successfully disseminated to a few hundred to a few thousand meters only.
- The spores of other fungi, particularly those of cereal rusts are very hardy and can be successfully transported over distances of several kilometers for causing widespread epidemics.
- Bacteria and nematodes present in the soil may be blown away along with soil particles on the dust storm.
- Wind also helps in the dissemination of bacteria, fungal spores and nematodes by blowing away rain splash droplets carrying them and wind also carries away insects that may contain or smeared with viruses, bacteria or fungal spores.

Disseminations by water

- Water is an important agency for disseminating pathogens in three ways:
- Bacteria, nematodes and spores, sclerotia and mycelial fragments of fungi present in soil are disseminated by rain or irrigation water that moves on the surface or through the soil.
- All bacteria and spores of many fungi are exuded in a sticky liquid and depend for the dissemination on rain or over-head irrigation water which either washes them downward or splashes them in all directions.
- Rain drops or drops from over-head irrigation pickup the fungal spores and any bacterial propagules from the air and wash them downward where some of them may land on susceptible plants.

Dissemination by insects

- Insects, particularly aphids and leaf hoppers are by far the most important vectors of viruses, phytoplasmas and fastidious bacteria.

- Each one of these pathogens is transmitted internally by only one or a few species by insects during feeding and movements of insect vectors from plant to plant.
- More than 50 species of aphids are known to transmit the viruses of plants. Some can transmit only a few kinds or other transmits many.
- *Myzus persicae*, the green peach aphid alone is the vector of fifty different viruses. Some of the diseases transmitted by aphids are Katte or Marble disease of cardamom, bunchy top of banana, cowpea mosaic, papaya mosaic, potato leaf roll.
- Most of the yellows and witches' broom type of diseases are transmitted by leaf hoppers including rice tungro.
- Other insects like white flies transmit some important diseases like leaf curl of cotton, tobacco etc. Bottle gourd mosaic is transmitted by red pumpkin beetle.
- Thrips transmit the spotted wilt virus; whereas squash mosaic, cowpea mosaic and turnip yellow mosaic viruses are transmitted by beetles while the turnip yellow mosaic virus (TYMV) is also transmitted by grass hoppers and ear wigs.
- In general, the viruses that require no incubation period in the insect vectors are called **non persistent or stylet borne viruses**; and those which enter into the system of the insects and require incubation period are called **persistent or circulative viruses**.
- Insects are also important in the dissemination of certain bacterial and fungal plant pathogens. *Erwinia tracheiphila*, the cucurbit wilt organism is completely dependent on cucumber beetle for its spread. *Xanthomonas stewartii*, the corn wilt pathogen overwinters inside the corn flea beetle. Insects are also important agent of dissemination and inoculation of *Erwinia carotovora* causing black leg of potato. *Erwinia amylovora* causing fire blight of pear and apple is known to be transmitted by ants, whereas *Xanthomonas citri* causing citrus canker is carried by leaf mite from diseased to healthy plants. The conidia of *Claviceps* are spread from malformed to healthy flowers by insects feeding on honey dew. The spores of *Ceratocystis fagacearum* (oak wilt) and *Ceratocystis ulmi* (Dutch elm disease) are carried by beetles.

Dissemination by Nematodes

- About 20 viruses are known to be transmitted by the members of 4 genera of soil borne ectoparasitic nematodes, viz., *Longidorus*, *Xiphinema*, *Trichodorus* and *Paratrichodorus*. *Longidorus* and *Xiphinema* spp. transmit polyhedral-shaped viruses (NEPO) such as tobacco and tomato ring spots, cherry roll, grape vine fan leaf and others. *Xiphinema index* transmits fan leaf disease of grapevine. Whereas, *Trichodorus* and *Paratrichodorus* spp. transmit tubular (NETU) viruses like and tobacco rattle and pea early browning.
- Some fungal and bacterial plant pathogens are also transmitted by nematodes, e.g., *Corynebacterium fasciens* causing leaf gall disease is transmitted by ectoparasitic nematodes *Aphelenchoides*. *Anguinia tritici* is believed to transmit fungal pathogen *Dilophospora alopecuri* causing leaf spotting and twist of grains and cereals.

Dissemination by mites

- Mites transmit both stylet-borne and circulative viruses, e.g., wheat streak mosaic virus, peach mosaic virus, sterility disease of pigeon pea.

Dissemination by animals

- Almost all animals small and large that move among plants and touch them along the way can disseminate pathogens such as fungal spores, bacteria, seeds of parasitic plants, nematodes and some viruses and viroids.
- Most of these pathogens adhere to the feet or the body of the animals, but some may be carried in contaminated mouth parts.

Dissemination by fungi and dodder

- Some plant pathogens, like the zoospores of some fungi (e.g. *Olpidium brassicae*) and certain parasitic plants (e.g. dodder) can transmit viruses as they move from one plant to the others (zoospores) or they grow and form a bridge between two plants.
- *Olpidium brassicae* can transmit lettuce big vein virus, tobacco necrosis and tobacco stunt viruses.
- *Synchytrium endobioticum* can transmit PVX and potato mottle virus whereas dodder can transmit many viruses including aster yellows.

Dissemination by human beings

- Humans are known to disseminate all kinds of pathogens over short and long distances in a variety of ways.
- Humans disseminate some pathogens such as tobacco mosaic virus by successively handling of diseased and healthy plants.
- Other pathogens are disseminated through farm tools such as pruning shears (pear fire blight), ploughs etc. by contaminating the healthy plants or plant parts after their contamination with spores and other pathogen structures.
- Humans also transport pathogens by contaminated soil on their feet or equipment and by using infected transplants, seed, nursery stock and bud wood.
- Humans disseminate plant pathogens by importing new varieties in to an area that may carry pathogens that have gone undetected by travelling throughout the world and by importing food or other items which may carry harmful plant pathogens.
- For examples, introduction of Dutch elm disease (caused by *Ophiostoma ulmi*) or citrus canker in USA or powdery mildew of grapes in Europe; and more recently rapid spread of ergot of sorghum through out the world.
- Similarly, deadly diseases like late blight of potato (1883), downy mildew of grapes (1910) and bacterial blight of rice (1959) were introduced in England, Europe and Philippines, respectively by human activity only.