**TRANSMISSION OF PLANT PATHOGENS**

Course IMB (Voc) III

 Transmission of disease is the most recent topic, now well known to the world population with present reference to the spread of COVID 19.Every body knows how this deadly disease spreads from person to person. Let us discuss this with reference to plants. Transmission is the spread of pathogen from one host to the other or from one area to the other geographical region either directly or indirectly by means of any agency.

 Knowledge of disease transmission is important in order to control any disease. To control any disease, it is essential to know the life cycle and the mode of transmission of that particular pathogen. Until and unless we know the transmission, we cannot know the control measures of any disease. Different scientists have many important researches on this aspect. Based on their studies there are two types of transmission of disease:

1**. Direct transmission**. 2. **Indirect transmission**

**Direct transmission** is the transmission of disease inoculum directly by the plant parts such as seeds, vegetative parts, where as **Indirect transmission** takes place through any agency, such as wind, water, soil, animals, insects, flies or even human beings. They are called as vectors. Vectors carry the inoculum of the pathogen and transfer them to the other host/s, for example most of the viral diseases are transmitted through a large number of insects.

 **Direct transmission** is of following types-

**1. Germinative transmission.**

**2. Vegetative transmission.**

**3. Adherent transmission.**

**Germinative transmission**- This takes place through seeds or propagules. Bean mosaic is transmitted through pollens and carried in seeds .Best example is case of transmission in Loose smut of wheat, and barley caused by *Ustilago tritici* and *U. nuda* respectively. The seeds carry the dormant mycelium but look healthy externally. The mycelium remains throughout the storage period and the mycelium germinates along with the germinating seed. This makes the new crop infected with fungal mycelium inside, which spreads to the developing inflorescence. Similarly *Alternaria leaf* blight of wheat is carried through seeds both externally and internally. *Helminthosporium* blight of wheat is also seed borne. The fungus can survive up to seven years in the seeds in storage.

**Vegetative transmission-** This is the most common type of transmission which takes place in vegetatively propagated plants, such as potato, sugarcane, Sweet potato. This takes place through tubers, runners cuttings grafts etc. Ring rot of potato caused by *Corynebacterium sepidonicum* and brown rot of potato caused by *Pseudomonas solanacearum* are vegetatively transmitted bacterial rots. Late blight of potato caused by *Phytophthora infestans* is transmitted through diseased potato tubers in the next season after sowing the diseased tuber.

Whip smut of sugar cane caused *by Ustilago scitaminea* and red rot of sugar cane caused by *Colletotrichum falcatum* are vegetatively transmitted to the next crop through diseased cutting used as seed sets.

**Adherent transmission**- in this case disease inoculum is adhered on the surface of the seeds or vegetatively propagated plant parts. Bunt of wheat caused by *Tilletia foetida* and *T. Caries* is carried through seeds externally. Covered smut of barley caused by *Ustilago hordei* is transmitted through the seeds where the inoculum remains adhered.

There are many examples of this type of dissemination such as Wart disease of potato caused by *Synchytrium endobioticum* and species of *Helminthosporium, Rhizoctonia* solani*.*

**Indirect transmission-**

**(a) Autonomous transmission** – When the dissemination of pathogen or its propagules are transmitted by their body parts, it is called as autonomous transmission. This is characteristics of wood rotting fungi which transmit their hyphae or hyphal mats to short distances in the soil. *Armillaria mellea* rhizomorphs spread from one root to the other in forest trees. Many pathogen propagules are disseminated through their active hyphae, such as wood rotting fungi are disseminated through their hyphae carried through soil. The wood rotting fungi include *Ganoderma, Fomes* and *polypores* etc. Hyphal mats grow out to short distances in the soil from the sclerotia of *Rhizoctonia solani* and *Sclerotium rolfsii.*

**(b) Wind dispersal (Anemochory**):-

 Wind is one of the important agencies through which a large number of pathogens are carried to long distances. Aeciospores of *Puccinia graminis tritici* travel from hills to plains through air. Almost all fungi which produce conidia, spores are transmitted through wind. Downy mildews, powdery mildews rusts, smuts causing fungi are disseminated through wind. Fungi of this type of transmission produce large number of spores or conidia for their successful landing on susceptible hosts. Millions of spores are produced by smut fungi. About 70,000 millions of aeciospores of *Puccinia* are produced from the secondary host *Berberis* plant. A cloud of rust spores appear in the heavily rust infected wheat crop field .Long distance transmission of rust spores has been well established by many mycologists namely, Mehta, 1940; Nagarajan & Singh, 1974, 1975.The uredospores of *P.graminis tritici* get transported by the upper winds from the Nilgiri & Palney hills and are washed down over plains of central India by rain even up to 600 kilo metres. Fungal spores are generally denser in the air near the earth surface than the high altitudes, several investigators have found clouds of spores, bacteria and other propagules even several thousand feet the earth. Uredospores of *Puccinia graminis tritici* were caught as high as 14000 feet above the ground (Mehta, 1940).Long distance travel of air borne rust spores has been well established by many scientists from south and central India. It has been established that uredospores of *Puccinia graminis tritici* get transported by wind from Nilgiri and Palney hills at an altitude of above 3000 metres to plains travelling about 600 Kms.

Apart from spores, bits of mycelia and nematode cysts are also transmitted sometimes by winds. Dissemination of spores by wind depend on varied factors such as spore size, spore / conidia producing structures, climatic conditions, wind velocity and wind direction etc. .

**(c) Water dissemination (Hydrochory)**:- Water is next to wind as disseminating agent. Almost all soil borne fungi infect new hosts through water. They produce motile spores (zoospores) which swim in the water to reach their new host. Zoospores may be uniflagellate or biflagllateSoil borne lower fungi are generally spread by soil water, irrigational or rain water. Damping off disease caused by *Pythium* debaryanumspreads through water. Some fungi are transmitted both by wind and water such as late blight of potato caused by *Phytophthora infestans* and downy mildew by *Peronospora*. Rain and irrigational water carry a large number of pathogens such as red rot of sugar cane caused by *Colletotrichum* *falcatum*, *Plasmodiophora brassicae* causing club root disease. Many bacterial diseases are also transmitted through water. Fire blight of apple disease caused by *Erwinia amylovora*; black rot of cabbage caused by *Xanthomonas campestris* and black rot of cereals by *X. translucens*; bacterial wilt of tomato caused by *Corynebacterium michiganense* are some examples of water borne transmission.

**(d) Insects, mites and nematode transmission**: - Insects are important vectors of many bacterial and viral diseases. Waite (1891) discovered that bees and wasps can transmit bacteria causing fire blight of apple and pear, *Erwinia amylovora*. *Erwinia tricheiphila*, the cucurbit wilt organism is completely dependent on cucumber beetles for its transmission. Insects are not only vectors but they are also agents of inoculation. This happens so, due to multiplication of many pathogens within insect body. The cucumber beetles chew the leaves infected with *Erwinia tracheiphila* and carry bacteria inside the body, where they over winter, passing on the host in the next season. Great many plant pathologists have worked on insect transmission of diseases namely Leach (1940), Carter (1962), Bowden (1964) and many more.

Insects are well equipped with mouth parts for injecting and sucking the sap of host. They inject the diseased host, suck the pathogen loaded sap and transfer the pathogen to other healthy host. Most vector Insects belong to Homoptera. Largest number of species known to transmit viruses mainly belong to two families Aphididae (aphids) and Cicadellidae (leaf hoppers) . More than fifty species of aphids are known to transmit viruses. The green peach *aphid Myzus persicae,* alone transmit fifty types of viruses. Some aphid transmitted viral diseases are marble disease of cardamom, mosaic and grassy shoot of sugar cane, mosaic streak of wheat, mosaic of maize, bean, barley and cowpea ,bunchy top and mosaic of banana. Some of the white fly transmitted viral diseases are tobacco leaf curl, yellow mosaic of mung, Tungro disease of rice is transmitted by leaf hopper vectors.

Fire blight of apple, pear and other members of Family Rosaceae caused by bacteria, is transmitted by flies and ants. *Xanthomonas citri*, the causal organism of citrus canker, is transmitted by leaf miners.

It is estimated that about sixty fungal pathogens are transmitted by hundred species of insects.

Conidia of *Claviceps purpurea,* causing ergot of rye, are transmitted by flies.

Nematodes, which are soil borne microscopic worms, are responsible to transmit many bacterial and fungal diseases. They are only plant parasites belonging to animal kingdom. Numerous species of nematodes infect a variety of plant species. Yellow ear rot of wheat caused by *Corynebacterium tritici* is spread by ear cockle nematode *Anguina tritic*i. There is ample evidence that many soil borne fungi are able to enter host roots through the wounds caused by nematodes. Cotton wilt caused by *Fusarium oxysporum f.sp*. *vas-infectum* is associated by root knot nematodes***.***

 Nematodes affect the host physiology which makes them susceptible to other pathogens too.

**Human Transmission (Anthropochory):--** Human beings are also responsible to transmit many plant pathogens mainly viruses and bacteria. Generally the disease spreads through the pathogen contaminated hands during cutting, pruning and other agricultural practices. Some important diseases, bacterial canker of tomato caused by *Corynebacterium michiganense*, angular leaf spot of cucumber caused by *Pseudomonas lachrymans*, are disseminated by man. Viruses those are spread by animals can also spread by man. Tobacco mosaic virus is well known to be transmitted by workers who handle tobacco plants. Long distance travel of pathogens can take place by transport of infected plant produces, such as fruits, seeds, nursery stocks or timber products.

Examples of Plant diseases introduced in India from other countries

Disease Introduced from Year

**Late blight of potato**

**C.O*. Phytophthora infestans***England1883

**Downy mildew of grapes** Europe 1910

**C.O*. Plasmopara viticola***

**Downy mildew of cucurbits** Sri Lanka 1910

**C.O. *Erysiphe cichoracearum***

**Bunchy top of banana (Viral)** Sri Lanka 1940

**Bacterial blight of paddy** Philippines 1959

**C.O. *Xanthomonas oryzae***

**Onion smut** Europe 1958

**C.O*.Urocystis cepulae***

**ABSTRACT-** Transmission of disease is the transfer of pathogen from diseased host to new susceptible host/s. Pathogens are transmitted either directly by the host and its parts such as tubers, cuttings, seeds ,or it may be transmitted indirectly by means of non living or living agents. Propagules include spores, zoospores, conidia, fungal hyphae, bacterial cells etc. Transfer of such units of pathogens takes place through different agencies. These agents may be natural such as air and water (irrigational, rain or soil moisture) or living organisms known as vectors. Insects, flies, mites, nematodes, earthworm, snails and human beings .They act as carriers of pathogen/s from the diseased host to the healthy ones. Knowledge of mode of transmission of pathogens is very important aspect in plant pathology because without this knowledge, we cannot devise the measures of disease control. Transmission of pathogens is also related with the climatic condition of the geographical area. Production of spores or other propagules is also related with the kind of transmission agency. Wind disseminated fungi produce very large number of spores to ensure successful transmission. There is more chance of futile dispersal in case of wind disseminated pathogens. Aeciospores of rust causing fungus *Puccinia graminis tritici* are produced in millions in number on the secondary host Berberisplants, growing on hills. These spores travel a long distance to plains in order to complete its cycle on wheat (Mehta, 1940; Nagarajan and Singh, 1974, 1975).

Water is also one of the important agents for transmission of soil borne fungi and many bacteria. Majority of lower fungi belonging to class Phycomycetes produce flagellated spores (zoospores). Transmission is facilitated by rain splashes and irrigational water.

Insects, bees, mites, nematodes are most common vectors. They play principal role in transmission of viral and some bacterial pathogens. Insects belonging to two families namely Aphididae (Aphids) and Cicadellidae (Leaf hoppers) are well adapted to transmit viruses from one host to the other.