# Transmission of Plant Diseases

Rational and most effective control of parasitic plant diseases is possible only if –

1. The disease is correctly diagnosed,
2. The nature of transmission of the disease is known and
3. Life cycle stages of the involved parasite i.e its mode of reproduction active structures produced under the favourable condition for repaid and wide dispersal and the structures produced to overcome adverse condition are known.

The detail study of life cycles of different parasites being beyond the scope of this article it would be quite sufficient to understand and remember from article\chapter. one of the general modes of reproduction of different plant parasites viz. fungi, bacteria, viruses (not true parasites) and nematodes and the structures which enable these parasites to survive under most unfavorable condition like the off season of suitable host crop(s) and / or exceptional high temperature and dry weather conditions prevailing in the summer months in a tropical country like India.

All parasitic as well as viral diseases are transmissible, the parasites or issues being infectious to suitable host plants with ability to spread from host to host and from one area to another. The microscopic parasites or sub-microscopic infectious agents viz. Viruses causing plant diseases are technically termed as **‘pathogens’**.

 Wherever a disease is established in a particular area or country, **transmission of the pathogen from host to host or from one place to another is termed as ‘dissemination’ or ‘dispersal’ of the pathogen.** Dissemination of plant diseases is recognized in relation to different phases of diseases as under:

1. **Primary infection:** Contact of a pathogen with a suitable host plant and initiation of the disease first time in the season of a crop is called ‘primary infection’. Often a few or several plants in the crop are likely to get primarily infected.
2. **Secondary spread**: When a plant or few plants are primarily infected, rapid multiplication of the pathogen sets in under favorable climatic conditions, which helps ‘secondary spread’ of the disease.

In case of fungal diseases the primary infections are usually caused by the resting or dormant structures of the fungal pathogen while the secondary spread occurs through the asexually produced, countless and short-lived spores

Although in majority of plant diseases the above two phases occur sequentially, primary infections occurring only once in the season and secondary spread often repeating several times in the same season thus causing rapid. Transmission over wide areas, this type of cycle is not observed in many other disease. In such cases there is no secondary spread in the same season i.e. the pathogen multiplies only once during the crop period and the spread of disease is observed only during the following crop season by way of increased primary infection. Mildews, leafspots, blasts, blights etc are the common examples of former type while some smut disease of cereal or grain crops where black powder is formed in place of grains or inflorescence fall in the latter type. Control measures, therefore, in the former type need to be directed to avoid the primary infection and also to check the secondary spread.

**Modes of primary infections:**

According to the general mode of primary infection plant diseases are recognized as:-

1. **Soil borne**
2. **Seed borne, including diseases carried with planting material.**
3. **Air / Wind borne**
4. **Insect borne etc.**

This knowledge is helpful in adopting suitable control measures.

**Continuous and discontinuous transmission:** -

Transmission of disease is termed as ‘continuous’ when it occurs naturally by way of growth, multiplication and spread of the pathogen in an area or country where the disease is established. At times, however, in an area or country where a particular disease has never occurred, it may get introduced through the agency of man carrying diseased material to a new locality or to a distant country for the purpose of introduction of new plants, crops, varieties etc. such transmission, of course, is unnatural and regarded as ‘discontinuous’ transmission. Altogether different control measures viz. Quarantine Regulations are enforced to check such discontinuous transmission.

**Direct and indirect transmission:-**

For classifying the methods of disease transmission in relation to the methods of suitable control measures, the following two groups can be conveniently recognized.

1. **Direct transmission:** - Disease transmission where the pathogen is carried externally or internally on the seed or planting material like cuttings, sets, tubers, bulbs etc.
2. **Indirect transmission:-** The pathogen spreading itself by way of its persistent growth or certain structures of the pathogen carried independently by natural agencies like wind, water, animals, insects, mites, nematodes, birds etc. are the different methods of indirect transmissions.

**Direct transmission:** -

1. **Internal transmission through seed or planting material:-** False smut disease as well as Helminthosporin Blight disease of wheat are the common examples of fungal diseases carried internally through apparently healthy seed. Ring rot and Brown rot of potato caused by bacteria are carried internally through the tubers. The well known whip smut and red rot of sugarcane are fungal diseases carried internally in the planting sets. Mosaic and leaf roll of potato which are viral diseases are also carried inside the infected tubers.
2. **External transmission through seed or planting material:-** In this mode of transmission the pathogen is carried externally over the surface of seed or vegetatively propagated plant parts like sets, tubers, bulbs etc. or may even be carried as a physical mixture of fungal structures with the seed. The common grain smut of Jowar is an example of the former type while the fungal structures called ‘sclerotia’ having the size of a grain or slightly bigger in case of the Ergot disease of Bajra are often likely to be transmitted in the form of physical mixture with the seed.

**Indirect transmission:** -

1. **Autonomous transmission:-** It takes place by continuous and persistent growth of the threads or ‘hyphae’ of the causal fungi in soil, characteristic of several wood rotting fungi attacking forest trees and some fruit plants. Some root rotting fungi infecting certain seasonal crops also are transmitted by this method. The autonomous dispersal of such soil fungi may range from few cm. To several (8 to 10) meters in a single season. Some plant parasitic nematodes also exhibit active but limited mobility in the soil.
2. **Wind/ Air dispersal: -** Fungal spores produced externally on host surfaces are most easily carried by wind currents and this is the most dangerous mode of transmission of plant pathogenic fungi like those causing powdery and downy mildews, leaf spots, blasts, blights and rust diseases. The black stem rust disease of wheat in India perpetuates on wild grasses in the Nilgiri hills in the south India from where the rust spores are carried to south, central & then to north India by wind currents every year. Spores may be carried from low to very high altitudes of 12,000 to 14,000 feet and from short distances to very long distances of several hundred kilometers.

Extensive and severe epidemics of plant diseases are mostly the results of wind transmission of the pathogens. Wind dissemination involves four stages relating to the spores viz. Production of countless spores, their liberation in the wind currents, dispersal alongwith the wind and deposition on new susceptible host surfaces where they cause infection under favourable climatic conditions. Apart from spores, bits of fungal threads and nematode cysts are also amenable to wind transmission in certain cases.

1. **Water dissemination:** Disease transmission through the agency of water in different ways is comparatively less important as compared to the wind transmission. Splashing rain drops mostly transmit the foliar diseases from leaf to leaf, from shoot to shoot and even from plant to plant in case of closely spaced crops. Such transmission is usually accompanied by wind dispersal as well. Plant pathogens requiring high humidity conditions like the fungi causing downy mildew diseases or bacteria causing canker of citrus are well adapted to this kind of short distance water dispersal.

Certain soil inhabiting pathogenic fungi and bacteria causing root and collar rots, wilts, foot, rots, etc are likely to be transmitted to much longer distances through the agencies like irrigation water, streams and rivers, etc. It is also an important agency in transmission of seeds of higher flowering parasites like dodder and striga.

1. **Animals:** Farm animals serve as disease transmitting agents in some cases. They are likely to carry the pathogen externally on their body surface, particularly on legs and hoofs, etc. or internally through their intestinal tract. Commonly, the soil inhabiting fungi causing rots and wilts are carried externally while certain smut fungi causing diseases to grain crops are transmitted through the intestinal tract.
2. **Birds:** Although birds play a very minor role in disease transmission, in cases of dispersal of seeds of higher flowering parasite. Loranthus sp. Parasitising certain trees like mango, etc. their role is of great significance. They transmit loranthus both externally and internally.
3. **Implements and Tools:** Farm implements used for cultivation of soil are often likely to transmit plant pathogens from one place to another. The pathogens in this case are usually carried in the form of bits of plant disease debris lying in the soil. Similarly tools used for carrying out operations like cutting, pruning, budding, grafting, thinning,etc. also help in the transmission of certain diseases from plant to plant. Several viral diseases are disseminated through the budding and grafting operations.
4. **Insects:** Most of the viral diseases of plants are transmitted through the agency of different insects. Both types of insects viz. sucking and chewing or/biting are capable of transmitting viral diseases. The transmission may be simply `mechanical’ or it may be `biological’. In the latter case the specific insect and the specific viral pathogen have some kind of association or relationship between the two. Insects in such cases are called the `vectors’ for the particular viral pathogen. In case of mechanical transmission the pathogen is simply carried externally or internally by the insect.

Viruses carried `biologically’ by the insect vectors are of two types:

1. Non-persistent-viral pathogen requiring no latent or incubation period in the insect body.
2. Persistent: viral pathogens requiring certain incubation period inside the vector body before they are inoculated or transmitted to healthy host.The insects responsible for transmission of viral diseases belong to the species of aphids, jassids (leaf hoppers), white flies, mealy bugs, etc. Certain bacterial and several fungal pathogens are also known to be carried by insects.
3. **Mites:** Mites in contrast to insects are wingless anthropods resembling ticks and having four pairs of legs and no antennae. It is suspected that some viral diseases of chillies, tomato, brinjal, etc. have vector relationship with mites.
4. **Nematodes:** Nematodes have been observed to transmit viral, bacterial and fungal plant diseases. Nematodes feeding externally on host plant roots cause injuries to roots which become the avenues for entrance of fungal and bacterial pathogens infecting plant roots. The Fan-leaf virus of grapevine is a well known example of transmission through a species of nematodes.
5. **Biological transmission**: Dodder which is higher flowering parasite is known to transmit certain viral diseases which remain `persistent’ in the dodder plant. The flowering parasite after acquiring the virus from infected plant does not show any symptom itself but remains capable of transmitting the virus to healthy hosts.
6. **Human dispersal**: Man is often responsible for transmission of plant diseases in two ways viz.
7. Workers handling seedlings, other planting material or fruits are likely to get personally in contact with plant pathogens like fungi or bacteria. While handling the diseased material and unknowingly and indirectly transmit the pathogens to healthy seedlings or plant parts through his contaminated hands. This is a kind of `continuous’ mode of transmission.
8. The other or`discontinous’ mode of transmission for which only man is responsible is the most efficient and equally dangerous phenomenon of transmission of plant diseases between distant geographical areas often separated by physical barriers like oceans, mountains or deserts, etc. Such long distances transmission of a disease to an area or country hitherto free from the disease is usually accomplished by the transport of infected seed, nursery stock or timber, etc. Thus it is a kind of direct transmission through propagating material.

In the history of plant pathology this mode of transmission has often resulted in to some of the worst plant disease epidemics in new areas, the local host plant stock being not adapted to the pathogen and consequently remaining highly susceptible. Fungal diseases viz. Late blight of potato and downy mildew of grapes, Bunchy top of banana, which is a viral disease and Bacterial blight of paddy are the examples of some severe and important diseases introducing in India from other countries.

Practically all the countries of the world have suffered from such introduction of new plant diseases through the agency of man. Concerned international authorities, therefore, are engaged in promoting studies in this respect and designing regulations to reduce the danger.

## Transmission

**Fungi** are spread primarily by [spores](https://www.britannica.com/science/spore-biology), which are produced in abundance. The spores can be carried and [disseminated](https://www.merriam-webster.com/dictionary/disseminated) by **wind** currents, water (splashing and rain), soil (dust), insects, birds, and the remains of plants that once were infected. Vegetative fungal cells that exist in dead plant material also can be transmitted when they come in contact with a susceptible host. The survival of vegetative cells of plant pathogenic fungi in nature depends on climatic conditions, particularly [temperature](https://www.britannica.com/science/temperature) and moisture. Vegetative cells can survive temperatures from −5° to 45° C (23° to 113° F); fungal spores are considerably more resistant. The germination of spores, however, is favoured by mild temperatures and high humidity.

In order for a **bacterium** to produce a [disease](https://www.britannica.com/science/disease) in a plant, the bacterium must first invade the plant tissue and multiply. Bacterial pathogens enter plants through [wounds](https://www.britannica.com/science/wound), principally produced by adverse weather conditions, humans, tools and machinery, insects, and nematodes, or through natural openings such as stomates, lenticels, hydathodes, nectar-producing glands, and leaf scars.

Most foliage invaders are spread from plant to plant by windblown rain or dust. Humans[disseminate](https://www.merriam-webster.com/dictionary/disseminate) bacteria through cultivation, grafting, pruning, and transporting diseased plant material. Animals, including insects and mites, are other common transmission agents. Some bacteria, such as the causal agent of Stewart’s, or bacterial, wilt of corn (Erwinia stewartii), not only are spread by a [flea beetle](https://www.britannica.com/animal/flea-beetle) but also survive over winter in this insect.

When conditions are unfavourable for growth and multiplication, bacteria remain dormant on or inside plant tissue. Some, such as the [crown gall](https://www.britannica.com/science/crown-gall) bacterium, may survive for months or years in the soil.

Bacterial diseases are influenced greatly by temperature and moisture. Often, a difference of only a few degrees in temperature determines whether a bacterial disease will develop. In most cases, moisture as a water film on plant surfaces is essential for establishing an infection.

 With the exception of tobacco mosaic **virus**, relatively few viruses or viroids are spread extensively in the field by contact between diseased and healthy leaves.

All viruses that spread within their host tissues (systemically) can be transmitted by [grafting](https://www.britannica.com/topic/graft) branches or buds from diseased plants on healthy plants. Natural grafting and transmission are possible by root grafts and with dodder (Cuscuta species). Vegetative [propagation](https://www.merriam-webster.com/dictionary/propagation)often spreads [plant](https://www.britannica.com/plant/plant) viruses. Fifty to 60 viruses are transmitted in seed, and a few seed-borne viruses, such as sour-cherry [yellows](https://www.britannica.com/science/fusarium-wilt), are carried in pollen and transmitted by [insects](https://www.britannica.com/animal/insect).

Most disease-causing viruses are carried and transmitted naturally by insects and mites, which are called [vectors](https://www.britannica.com/science/carrier-of-disease) of the virus. The principal virus-carrying insects are about 200 species of [aphids](https://www.britannica.com/animal/aphid), which transmit mostly [mosaic](https://www.britannica.com/science/mosaic-plant-disease) viruses, and more than 100 species of[leafhoppers](https://www.britannica.com/animal/leafhopper), which carry [yellows-type](https://www.britannica.com/science/fusarium-wilt) viruses. Whiteflies, thrips, mealybugs, plant hoppers, grasshoppers, scales, and a few beetles also serve as vectors for certain viruses. Some viruses may persist for weeks or months and even duplicate themselves in their insect vectors; others are carried for less than an hour. Slugs, snails, birds, rabbits, and dogs also transmit a few viruses, but this is not common.

A small number of plant viruses are soilborne. Viruses causing grape fanleaf, tobacco rattle, and tobacco and tomato ring spots, as well as several strawberry viruses, are spread by nematodes feeding externally (i.e., ectoparasitic) on plant roots. A few soilborne viruses may be spread by the swimming spores of primitive, soil-inhabiting pathogenic fungi, such as those causing big vein of lettuce, soilborne wheat mosaic, and tobacco [necrosis](https://www.britannica.com/science/necrosis).

**Viruses** often [overwinter](https://www.britannica.com/science/overwintering) in biennial and [perennial](https://www.merriam-webster.com/dictionary/perennial) crops and weeds (plants that overwinter by means of roots and produce seed in their second year or during several years, respectively), in plant debris, and in insect vectors. Plants, once infected, normally remain so for life.