Unit-II :- Plant Disease Development

PAGE No.
DATE

Modes of Entry of plant pathogens :-

Infection by a plant pathogen involves stages i.e. entry of plant pathogen into the host, establishment of a stable relationship with the host tissue. There are various modes of entry of the plant pathogens into the host. The viruses and bacteria do not produce any special structure to penetrate the host. In some fungi, the hypha itself is capable of entering the host. In most fungi, germ tubes or some special morphological features are formed, which help for them enter into the host tissue.

Different modes of entry of plant pathogens are discussed below.

(1) Direct penetration :-

This is the most common method of entry of fungi and nematodes. Many powdery mildew fungi and smut fungi are able to penetrate directly. The flower infection in loose smut of wheat takes place by direct penetration through stigma. The secretion of stigma is favorable substrate for germination of conidia in case of pathogen like Ustilago tritici (loose smut of wheat). The fungi such as Alternaria, Colletotrichum, Peronospora enter the host by direct penetration & they prefer young developing tissues.

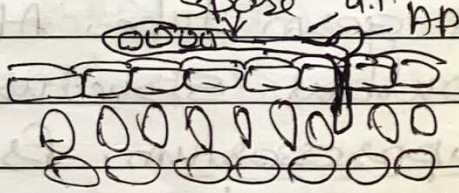


Fig. Infection peg penetration through epidermis

The plant surface (epidermis) is covered by a layer of cuticle. When a fungal spore

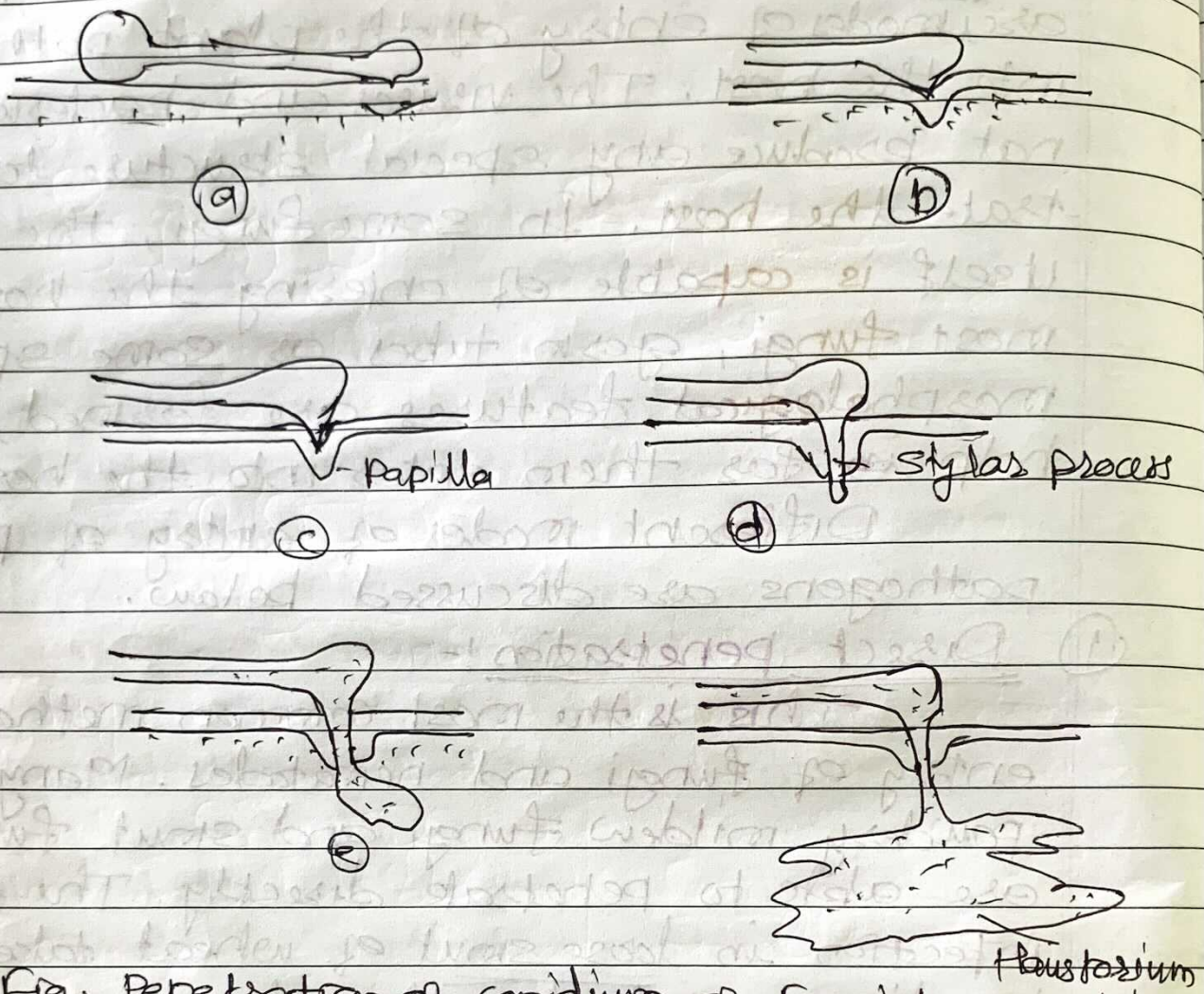


Fig. Penetration of conidium of Erysiphe graminis into wheat.

land over the surface of the plant, under favorable conditions. It germinates and produces a germ tube. At the end of germ tube, a bulbous structure is produced, called as appressorium. From the flat surface of appressorium a thin hypha is produced, which is called penetration peg/ infection peg or infection hypha. The diameter of infection hypha is smaller than normal hypha. It grows towards the host & pierces the cuticle

and cell wall. After entering the cell, it gains its normal diameter.

The penetration of cuticle has been regarded as purely mechanical. Some scientists regard it to be chemical degradation (as chemical degradation) due to production of pectolytic and cellulolytic enzymes by the pathogens.

As a result of the penetration, the epidermal cell wall produces a papilla, which projects inside the cell. The tip of hypha lacks cell wall and the epidermis dissolves in the region of the tip. Hence, the infection hypha enters within the cell. It is thought that, a mechanical force pushes the infection hypha through the host cell wall and papilla. It is considered as chemical degradation by some scientists.

In case of infection of wheat due to Erysiphae graminis the germ tube produces a stylar process which ~~pise~~ pierces the cutick and reaches to the epidermis. The epidermal cell wall produces a small papilla into the cell. The stylar process penetrates the papilla, enters inside the host cell and produces a branched haustorium.

(2) Entry through natural openings :-

@ ~~Entry through stomata :-~~ The process of entry of fungi through stomata can be well understood by studying the wheat rust fungus Puccinia graminis tritici. Uredospores germinates in water on the

→

leaf surface under optimum conditions and produces a germ tube which grows over the leaf and approaches the stoma. The protoplasm of germ tube accumulates at the tip of tube.

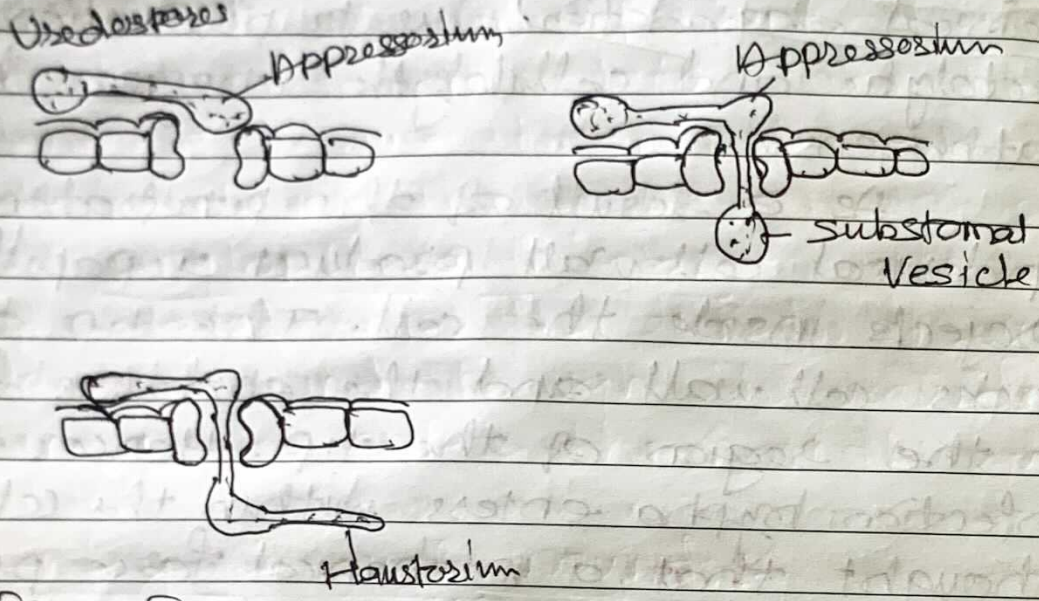
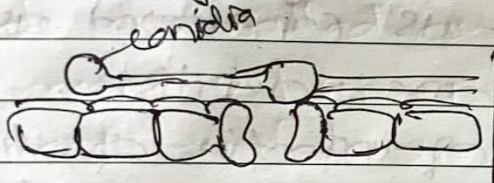
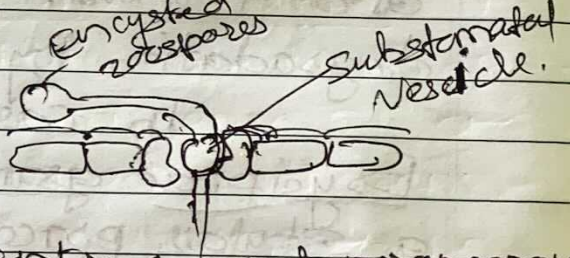


Fig - Entry of Puccinia graminis tritici in wheat



Entry of peronospora destructor in onion



Entry of pseudoperonospora cubensis into cucurbit

~~Entry of Perono~~

on reaching stoma, the end of germ tube swells to form a bulbous structure called appressorium in the stomatal aperture. The empty germ tube is cut off by formation of a cross wall. From the appressorium, thin hyphae called infection peg is developed which grows through the stomatal aperture and reaches to substomatal cavity and produce

a swollen structure called sub-stomatal vesicle. The contents of the appressorium then pass into the sub-stomatal vesicle. One or more hyphae are developed from the substomatal vesicle towards the host cell and penetrate the cell-wall. After penetration it produces a haustorium in the cell. The haustorium absorbs food material from the host cell. The haustoria are the main source of metabolic exchange bet^n the host and parasite.

In case of peronospora destructor infecting onion leaves, the germ tube continues to grow after the formation of first appressorium

In many leaf infecting fungi (imperfecti from Deuteromycetina generally enter through stomata. Some of the examples are Cladosporium fulvum, infecting tomato, Cladosporium cucumerianum infecting cucumber etc. Some other fungi entering through stomata are phoma trifolii infecting Trifolium patens, phoma herbarum infecting medicago sativa etc (These fungi can also enter by direct penetration under certain conditions.

Stomata are the only pathways for entry of many parasitic bacteria such as Pseudomonas tabaci infecting tobacco, Xanthomonas malvacearum infecting cotton, Bacteria enter the stomata through the film of water present on host surface.

b) Entry through Lenticels :-

In many plants after secondary growth

a protective zone called peridesm is developed. ~~It peri~~ The peridesm is has cracks at certain points, which are filled with loosely arranged cells to form the lenticells. The entry of plant pathogens through lenticels is also important. Streptomyces scabies (common potato scab) enters through lenticels, because it can not break the ~~the~~ peridesm. The germ tubes of zoospores of phytophthora infestans (late blight of potato) enter the tubers through the lenticels and through the wounds. Botrytis cinerea also enters the host through lenticels.

③ Entry through wounds :-

The infections which take place through wounds are called as wound infections. The pathogens which are not able to penetrate the host surface in the absence of a wound are called low-grade pathogens.

The wounds or injuries may be caused by the activity of man or other agencies like insect bites, nematodes, farm operations, etc. Many fruits and vegetables are quite succulent when they are ripe. In this condition, they are most susceptible to wounds. Fungi like Rhizopus, Aspergillus, Colletotrichum, Fusarium and many species of bacteria enter through such wounds.

Wounds caused by insects are easily penetrated by various plant pathogens. The brown rot fungus Ptomopsis vexsoniana

enters the fruit of pomegranate through the path made by fruit borer. In Red rot of sugarcane caused by Colletotrichum falcatum, the secondary infection takes place through the borer injury to the stem & leaves.

Many important forest pathogens also enter through wounds. A destructive pathogen of conifers ~~Fomes~~ Fomes annosus naturally colonizes the wounds caused by high winds, snow or other natural agencies.

Among the disease caused by bacteria, Vascular wilt of cucurbits (Erwinia species) enters the host through wound caused by cucumber beetles.

(4) Entry through Buds –

Some rust fungi, including Uromyces pisi enter through unfolding buds. The peach leaf curl fungus, Taphrina deformans enter its host through the unfolding leaf buds. Venturia inaequalis causing scab of apples enter through young buds. Wart disease of potato (Synchytrium endobioticum) also results from bud infection.

(5) Entry through root hair –

The root hair are not covered with cuticle and therefore allow the parasite to enter which can not penetrate the cuticle. Plasmodiophora brassicae causing club root of cabbage enters through root hair. This entry is also

Characteristic of fusarium wilt, the fungus causing hollow stem of sorghum (Rhizoctonia bataticola) etc. Entrance of pathogen through root hair is of common occurance in many root rotting fungi & soil borne bacteria like Rhizobium.

The mode of entry of Plasmodiophora brassicae is unique. Zoospore of pathogen encysts on the wall of a root hair. A bullet shaped structure is produced from the zoospore, which suddenly forces its way from within the cyst into the interior of the root hair cell. This process takes place within a few seconds.

PAGE No.
DATE

Factors Affecting Disease Development :-

[Temp, humidity, pH, wind]

(1) Temperature :-

Temperature is the most important factor, which enfluences the occurance and development of many plant diseases. Certain plant diseases occur during winter, others during summer and many others during rainy season. This seasonal occurance of the diseases may be due to both host as well as pathogen. Hosts are available only in the particular season and therefore, the diseases also occur in that season. The ~~term~~ temperature of the season is generally favorable for growth of the pathogen. It is possible that, the temperature before or after the particular season may not be favorable for the pathogens.

Some pathogens are able to grow only at low temperature. Peach leaf curl caused by Taphrina deformans occurs only in cool areas. This plant is grown in India both on hills as well as in plains, but fungal leaf curl is found only on the hills. Similarly late blight of potato (Phytophthora infestans) develops better in areas where temperature is low. High temperature is harmful to the fungus and unfavorable for disease development. A pathogen surviving at low temperature can occur (in sub-tropical climate) only at the places at high ~~altitudes~~ altitudes (7000 to 8000 ft), where temperature is low.

Some pathogens are favored by high temperature. Pseudomonas solanacearum causes wilt and brown rot of potato in warm regions. It does not affect the potato crop (in plains of India) which is raised during winter. (but may occur when the crop is planted in January to February) best development of disease in potato and other solanaceous crop occurs at 37°C. The soft rot of potato (Erwinia) is also common in warm seasons. (The fungus Sclerotium rolfsii causes severe rot in variety of crop plants at 25°C or above.

Stages in the process of infection are also affected by temperature. The incubation period can increase or decrease according to temperature. (The incubation period determine the no of life cycles the pathogen can complete during the season and the no of crops of spores the fungus will produce for spread of the disease). If the incubation period is long, the no. of life cycles of the fungus will be reduced and therefore spread of the disease will be slow. When the incubation period is short, the crops of spores will be produced quickly and disease will spread fast. Temperature determines incubation period of various pathogens and the spread of the disease. The relationship between temperature and incubation period in puccinia graminis tritici (Black/stem rust of wheat) is as follows.

Temp (°c)	4·5	10·0	19·0	24·0
Incubation period (days.	22	15	9	5

Thus at 24°c, the no.s of days required for production of uredospores after infection is reduced and disease is rapidly spread. The incubation period in Fusarium oxysporum, fu. sp. vasinfectum (wilt of cotton) is only 12 days at 27°c, but at 16°c, it is 58 days. The powdery mildews have an optimum temperature of 21°c for germination and growth. Many viruses are more virulent bet^n the temperatures 20°c. to 25°c. These viral pathogens include tobacco mosaic virus, potato mosaic virus etc.

The rhizosphere (environment in root zone) affect many root pathogens. Rhizosphere has root exudates. Temperature affect root exudation pattern. This leads to changes in the microflora in rhizosphere.

Effect of temperature on viral diseases of plants is variable. Temperature not only determines the ease of infection, but also affects multiplication and symptom Expression. Many plants get easily infected by viruses if they are kept at 36°c for 1-2 days. At low temperature incubation period is increased and the rate of appearance of symptoms is decreased. The nature of symptoms is also changed. Masking of symptoms is known as at high temp.

PAGE No.
DATE

(2) Moisture / Relative humidity :-

The moisture content of the air is referred to as relative humidity. This is defined as "the ratio of actual amount of moisture in the air to the amount of moisture the air could hold"

Atmospheric humidity and precipitation in the form of rain, fog, dew etc. determine disease incidence to a great extent. Similarly, the amount of soil moisture determines the severity. The speed of spore germination, its entry into host, and period of incubation are very much affected by the amount of moisture available.

The moisture activates pathogenic bacteria, fungi and nematodes, so that they can cause infection. In the form of rain drops or flowing water, moisture helps in dispersal of many plant pathogens. By making the plant surface soft, moisture predispose the surface to attack.

The geographical distribution of many plant diseases is determined by moisture. → late blight of potato (Phytophthora infestan -s) is of rare occurence in dry areas. It may occur in dry areas due to heavy irrigation and fertilizer application, which causes excessive vegetative growth of the plants. As a result of luxurient foliar canopy, there is retention of moisture conditions favourable for the pathogen. Cereal rust and downy mildew of grapes are

more serious in wet than in dry areas. Heavy irrigation is known to predispose the crop to rust attack. Heavy rainfall favours the germination of spores of the pathogen and infections in diseases such as downy mildew and rusts.

Diseases such as root rot of peas (Aphanomyces euteiches), damping off (Pythium debaryanum), etc. are greatly influenced by an increase in moisture content of the soil. On the other hand, diseases like white rot of onion (Sclerotium cepivorum) usually spread under dry conditions. Moderate soil moisture is favorable for head smut of jowar (Sphacelotheca reiliana) and pea foot rot due to Fusarium solani.

Colocasia blight (Phytophthora colocasiae) occurs only in rainy season, when there is continuous spell of moisture and cloudy weather.

Lack of atmospheric humidity is also the reason for (relative) absence of certain foliage diseases (in certain geographical areas). These diseases include anthracnose of bean (Colletotrichum sp.), bacterial blight of bean (Xanthomonas phaseoli), etc.

Most of the diseases of foliage depend on humidity for infection and development in the crop. In the same season and (in the) same field, the spread depends on number of disease cycles completed which is determined by humidity in the atmosphere

and on the host surface. Downy mildew of grapes spreads rapidly in wet weathers. Dry weather has an opposite effect. Either the disease will not appear or if initiated its spread will check. In case of late blight of potato, (i.e. infestanced size of leaf spots is restricted in dry weather. In wet weather, the blight is so rapid that entire foliage is destroyed in 2-3 days. A humid period is necessary for sporulation, a drier period is desirable for dissemination and a wet period is necessary for germination and penetration. In presence of film of water on leaf surface, the sporangia germinate by producing zoospores which swim in water present and increase the no. of infection sites on the same leaf. On the hills, the fungus has better conditions for survival and dispersal occurs throughout growing season of the crop. However, its great development takes place in June and July when rains occur (In the valleys, due to higher temperature low humidity, the disease is not so severe).

Q24- Powdery mildews are reported to be favored by dry conditions. Film of water (free moisture) is inhibitory to these diseases. Immersion of conidia in water for 1-3 hrs is reported to cause their death in Erysiphe graminis, E. cichoracearum, etc.

The favorable and unfavourable effects of water on root diseases have been known

PAGE No.
DATE

Root rots and damping off diseases have close relationship with soil moisture. Aphanomyces and pythium are most active in high soil moisture. Only a few root diseases are favoured by dry soils and most are favored by wet soil.

Bacteria

Many bacterial diseases are favoured by high soil moisture eg. Wilt of tomato & potato caused by Pseudomonas solanacearum.

Viruses

In case of viral diseases, maximum multiplication of viruses occurs in young growing parts of the plant. In presence of high humidity concentration of virus particles is high in plants growing in wet soil. However, some viruses are favoured by hot and dry weather and do not express any symptom in wet conditions.

The reproduction and flight of insect vectors is also determined by humidity in the air. Therefore incidence of insect-transmitted viruses is affected by relative humidity of the atmosphere.

(3) Role of Soil pH :-

The alkalinity and acidity of the soil is very important factor which influences incidence and distribution of many diseases. The effect of soil pH is mostly on the development of the pathogen. Most fungi, bacteria and nematodes can tolerate pH range in which plants normally grow. In other words, these pathogen

do not die at normal pH of the cultivated soils. However, soil pH affects the speed of disease cycle and thus, the intensity of disease incidence.

The plant pathogens as well as saprophytic organisms are affected by soil pH. Thus, pH may sometimes influence disease development through its effect on soil microflora. Strong antagonists such as Trichoderma viride & Penicillium sp. grow rapidly in acidic soils and inhibit the activities of plant pathogens. High alkalinity in soil also has a strong influence on survival of certain fungi.

Alkaline soil is favorable for the scab of potato (Streptomyces scabies). It usually develops between pH 5.2 to 8.0. The club root of Cruciferss (Plasmodiophora brassicae) is favored by acidic soils. It develops best at pH 5.7. Some of the diseases favored by alkalinity and acidity of the soil are listed below.

Diseases favored by alkaline soil are Verticillium wilt (Verticillium albo-atrum), wilt of peas (Fusarium oxysporum, Fusarium pisi), common cause of scab of potato (Streptomyces scabies). Texas root rot of cotton (Phymatotrichum omnivorum)

Diseases favored by acidic soils are- cotton wilt (Fusarium oxysporum, f. sp. vasinfectum), tomato wilt (F. oxysporum f. sp. lycopersici), Bacterial wilt of potato (Pseudomonas Solanacearum), club root of

PAGE No.
DATE

cabbage (plasmodiophora brassicae)

(4) wind :-

wind affect disease development through its effect on spread of pathogens and through speeding up the drying of wet plant surface. Most diseases spreading rapidly are caused by the pathogens (fungi, bacteria, viruses) that are spread by wind or insect vectors. The insect vectors are carried to long distance by wind. Uredospores of rusts and other conidia are carried over long distance by wind. Wind-blown rains help release spores and bacteria from infected tissues and then carry them through the air and deposit them on wet surfaces. Wind also influences the plant surfaces, that become susceptible to fungi, bacteria and viruses.