

Fungal foliar diseases

of pulses and their management

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Pulses plays a major role in the nutritional security of people having a cereal-based diet. The United Nations Food and Agriculture Organization (FAO) recognizes different types of pulses in India, viz. chickpea, lentil, faba bean, field pea, cowpeas, black gram, black-eyed bean, pigeonpea and red kidney beans. Besides their value as diet and having nitrogen fixation ability, pulses also play an important role in flourishing intensive agriculture by improving the physicochemical and biological properties of soil. Pulses are attacked by so many foliar fungal diseases which include *Ascochyta* blight, anthracnose, leaf rot, powdery mildew, leaf yellowing, stem canker and downy mildew.

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PULSES are one of the important food crops globally due to their higher protein content. They are also responsible for yielding large financial gains by amounting to a large part of the exports. The main areas under pulses cultivation with high productivity are Punjab, Haryana, Western Uttar Pradesh, West Bengal delta region, coastal Andhra Pradesh, Tamil Nadu, Kerala, coastal and eastern Karnataka and some parts of Maharashtra. The country has exported 410,375.89 MT of pulses to the world for the worth of ₹2,834.23 crores/379.74 USD millions during year 2021–2022. Of all categories of people, pulses form an integral part of Indian diet, providing much needed protein to the carbohydrate rich diet. Pulses are 20–25% protein by weight which is double as the protein content of wheat and three times that of rice.

Aerial fungi attack causes diseases like gray and chocolate spots, *Ascochyta* blight, anthracnose, leaf rot, powdery mildew, leaf yellowing, stem canker and downy mildew. These diseases are caused by a fungus that can be necrotrophic

or biotrophic, e.g. *Botrytis cinerea*, *B. fabae*, *Mycosphaerella rabiei*, *Colletotrichum*, *Puccinia recondita*, *Erysiphe polygoni* and *Perenospora* (Table 1).

Blight disease

Blight can be considered as complete chlorosis, which includes browning and death of plant tissues such as leaves, twigs, branches and floral organs, and fruits. Blight mostly appears as water-soaking spots, toward the edge of lower leaves where dew or water gets collected. Under cool and moist conditions, water-soaking spots enlarge faster, and a yellow broad portion might be seen around the lesion. While on the

underneath, white mold growing zone producing spore (approx. 0.1–0.2 inches wide) may appear at the lesion border. Spores are readily disseminated by rain splashing, over-irrigation or wind.



Blight disease of pea
Source: Agriculture Victoria

Table 1. Overview of common foliar diseases of pulses

Disease	Pathogen
Ascochyta blight	<i>Mycosphaerella rabiei</i>
Damping off	<i>Pythium</i> spp., <i>Fusarium</i> spp. and <i>Rhizoctonia</i> spp.
Collar rot	<i>Athelia rolfsii</i>
Rust	<i>Uromyces viciae-fabae</i>
Powdery mildew	<i>Erysiphe polygoni</i>
Wilt	<i>Fusarium oxysporum</i>
Sterility mosaic	Eriophyid mite (<i>Aceria cajanii</i>)
Yellow mosaic virus	Transmitted by vector
Botrytis gray mould	<i>Botrytis cinerea</i>

Anthracnose

This fungal disease mostly attacks plants during the spring, cool and wet weather, on leaves and twigs. Cool, rainy weather creates favourable conditions for the spores to spread. Fruiting bodies appear as tiny dispersed black-coloured flecks and pink masses of spores are seen at the center of the old black spot. *Colletotrichum* uses different strategies to cause infection of the host plant which starts from the hemibiotrophic intracellular mode up to the necrotrophic nutrition mode. The initial infection starts as the conidia attach to the host surface, germinate and produce appressoria following penetration of host epidermis.



Anthracnose in beans
Source: CABI, Plantwise Plus

Leaf rot

In leaf rot, lesions are water soaking with various colours and shape formed on the appearing spindle and young leaves; thus the leaflet does not open fully. Central shoots are affected, and further, all the crown leaves get rotted. The lesions enlarge and fuse leading to extensive rot of spindle leaves. Rotting results in the decay of buds as it extends toward the interior of the spindle which further causes the yellowing of leaves. The pathogen survives as long as debris of the infected plant remains. The remaining debris lying on the soil is often the source for primary inoculation that infects other plants of upcoming seasons. High humidity and moisture (dew) on the leaves are needed for the pathogen to infect the host. *Cercospora zeae-maydis* is an atypical pathogen, whose conidia before penetration can grow and survive for many days.

Powdery mildew

Mildew is marked by a white floury covering comprising of conidia. The lower leaves are mostly affected, but it is also seen above ground part of the plant as well. As the disease progresses, the spots get larger and denser as large numbers of asexual spores are formed and the mildew spreads on the entire host including pods. The optimum



Powdery mildew
Source: Department of Primary Industries and Regional Development

temperature between 68 and 77°F and relative humidity between 40% and 100% are favourable for spore germination. Powdery mildew development is also favoured by low and diffuse light. The mildew spreads faster as the disease cycle can be finished in about 72 hours.

Leaf yellowing

P. pauciseptata and *P. ramiseptata* are the most aggressive species causing leaf yellowing in plants. Yellowing of leaves may be caused by manganese, zinc or nitrogen deficiencies. It is widely known as chlorosis. The yellow spot of disease, caused by *Pyrenophora tritici-repentis*, is a stubble-borne disease. The fungus survives on stubble in small fruiting black bodies, asci, from season to season.



Leaf yellowing
Source: Research Gate

Leaf spot disease

Leaf spots, round in shape are found on the leaves of many plant species, mostly caused by fungi that are parasitic in nature. A typical spot has a defined edge and is often dark at the border. When many spots are present, together they can grow and form a blotch or blight. Spots of fungi are usually of free form or round in shape. In spring, when conditions are in favour of the fungus, ascospores discharge from perithecia and infect young leaves of plants. Once infected, a leaf serves as a good nutrient source for the fungus to produce secondary inoculum (conidia) inside pycnidia. When the leaves of the plant start falling, asci and ascospores are produced within perithecia and are protected until the following spring. A temperature of 30°C is favourable for maximum colony growth and acervuli production.



Leaf spot
Source: Wikipedia

Stem canker

Stem canker is often confused with Phytophthora stem rot. Necrosis and interveinal foliar chlorosis may occur as a result of fungus producing toxins. These symptoms may be similar to those of sudden death syndrome and brown rot. Stem canker is noticed at the latter half of the growing season. During the early reproductive stages of plants, reddish-brown stem lesions appear which are in the portion of the stem node. The pathogen can survive in the residue of host or the soil for many years in the form of spores which act as the primary source. During rainy weather, spores are produced in the early vegetative stages which splash onto plant tissue causing infection.

Downy mildew

Downy mildew is caused by oomycete organism. It is spread by airborne spores. The infection is enhanced by prolonging wetness of leaf. Spore formation can occur within 4 days after the initial infection. However, the typical period for germination of spores is 7–10 days. There are many downy mildew species capable of spore germination by the creation of a germ tube that enters in the host. Some species also germinate by zoospores. However, some downy mildew species cannot handle the cool weather and so are reintroduced to another area for another infection to occur.



Downy mildew
Source: Syngenta UK

Wilt

Wilt disease affects the vascular system of plants. It starts with vein clearing on younger leaves and dropping the old ones toward the lower side, followed by stunting, defoliation, marginal necrosis, yellowing of leaves toward the lower side, and death of the plant. The most abundant is microconidia. Chlamydospores can survive in the soil for a longer time. The mycelium grows intracellularly into the xylem through the root cortex, exclusively



Wilt disease
Source: The Beatsheet, Queensland Govt.

within the vessels, and produces microconidia. It enters the stream sap and is upwardly transported and germinates where the flow stops. Eventually, the mycelia and the spores clog the vessels of xylem, which prevents the plant from translocating nutrients and their uptake. In the end, the plant transports less and transpires more resulting in stomatal closure, wilting of leaves and death of the plant.

Management

Resistance of host plant: The interaction between the pathogen and the host defines race specificity or non-race specificity of resistance and it is based on the presence or absence of statistically significant interaction between host and pathogen genotypes. Most plant pathogenic fungi shows different interactions with their host plants, changing their relationship at different stages of their life cycle depending on the resistance of the host, physiology, the environment and associated virulence genes of the pathogens.

Disease modeling: Disease models help to understand how the disease develops and approaches to test potential mitigation steps. Plant diseases account for about 16% or more of the total yield losses every year. To forecast the spread of these diseases both locally and over long distances, numerical models and monitoring networks have been developed. The epidemics of these airborne diseases depend on the production of infectious propagules, their aerial transport, specific infectiousness and finally their reproduction.

Chemical control: Chemical fertilizers provide nutrients for healthy plant growth which are a combination of synthetic primary nutrients as nitrogen, potassium and phosphorus. They provide the benefit of having more nutrients than organic ones. The different types of chemicals used in agriculture are insecticides, herbicides, soil fumigants, desiccants, fungicides and plant growth regulators.

Biological control: Many microbes show antagonistic activity

against fungal pathogens which could be used to prepare solid or liquid microbial formulations to apply on sensitive and diseased plants. The use of these microbes helps the plants in developing resistance against the fungal infections, which also helps in plant growth promotion. They also induce a defense mechanism against the pathogens in host plants through induced systemic resistance (ISR).

Cultural practices: Cultural practices can control fungal diseases in pulses and other plants. The selection of resistant varieties of plants is necessary by proper screening in the field. Plantation needs to be done in a well-drained area, with full sunlight. Airflow and ventilation discourage fungal growth, so crowding of plants should be avoided. If the infestations are severe, the removal and destruction of the infected plants are effective. Among the treatments of bio-fungicide, leaf extracts of neem (*Azadirachta indica*), datura (*Datura stramonium*) and debdaru (*Polyalthia longifolia*) showed excellent performance in controlling disease.

SUMMARY

Pulses are an important group of crops in India responsible for yielding large financial gains by amounting to a large part of the exports. Aerial fungi attack causes several diseases in pulses resulting in reduced yield. So, the management of the different fungal diseases is becoming very necessary to smoothly carry the livelihood. To have strategies in the future with more effective biological control, it is critical that more research should be carried out. On some aspects, novel formulation development, understanding environmental factors' impact on biocontrol agents, mass production of biocontrol agents and nanotechnology, and biotechnology can be used for improving strategies and biocontrol mechanisms. Future perspectives of pulse disease control are promising and brighter.

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