

Field Diagnosis of Chickpea Diseases and their Control

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Abstract

Chickpea (*Cicer arietinum* L.) is one of the world's most important cool season food crops mostly grown in dry lands. The crop suffers from serious diseases that affect it in all growth stages. The pathogens that affect chickpea include fungi, bacteria, viruses, nematodes and mycoplasma, which results in severe economic losses globally. Among these, fungi are the largest and perhaps most important group affecting roots, stems, leaves, flowers and pods of chickpea. The handbook is designed to assist agricultural research and extension workers who may have had less formal training in plant pathology to diagnose chickpea diseases. The bulletin provides information on economic importance, distribution, field symptoms, epidemiology and control measures of major chickpea diseases, and will be useful to farmers, extension workers, students and scientists in facilitating identification of diseases. An index of technical terms used and supporting literature of major diseases is also provided.

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Cover: (Top L to R) Xylem blackening by fusarium wilt, white mycelial strands of Sclerotium rolfsii on roots, (Bottom L to R) ascochyta blight lesions on leaflets and pods, grayish mycelial growth of Botrytis cinerea on pods.

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Introduction

Nearly 172 pathogens have been reported so far that infect chickpea (*Cicer arietinum* L.) in different parts of the world (Nene et al. 1996), but only a few of them have the potential to devastate the crop. Some diseases are persistent problems in chickpea production in wide geographical areas, notably, ascochyta blight, fusarium wilt, dry root rot, stunt [caused by bean (pea) leaf roll virus], botrytis gray mold, collar rot, black root rot, phytophthora root rot, and pythium root and seed rot, while others are sporadic in occurrence or endemic in distribution. Diseases with limited distribution may still be economically important locally. Because of continuous changes in cultural practices, human interventions and climate change, some of the minor diseases may become economically important. One such example is dry root rot (*Rhizoctonia bataticola*) of chickpea, which is emerging as a potential threat to chickpea cultivation in semi-arid regions because the host plant is predisposed to infection by moisture stress and high temperatures during the flowering to pod filling stage (Sharma et al. 2010).

This bulletin has been prepared to assist in field diagnosis of chickpea diseases. The diseases are grouped into fungal, bacterial and viral diseases. In addition to symptomatology, information about distribution, economic importance, epidemiology and control measures were included to make the bulletin more useful to growers, extension workers, students and scientists. Specific management practices are provided whenever available.

For more detailed information on these diseases, refer to Nene et al. (1978), Nene and Reddy (1987), Pande et al. (2005; 2006 and 2010) and Chen et al. (2011).

Fungal diseases affecting aerial plant parts

Ascochyta blight [*Ascochyta rabiei* (Pass.) Labr.]

Distribution. Ascochyta blight (AB) is a major disease in west Asia, northern Africa, and southern Europe. The disease usually builds up in February and March in Pakistan and northern India when the crop canopy is very dense and temperatures are favorable to disease development. In West Asia, southern Europe and northern Africa, such conditions usually prevail in March, April and May. In the winter-sown chickpeas of the Mediterranean region, blight symptoms can be found in November and December when the weather is wet and warm. The disease has been reported from 35 countries across 6 continents and as recently seen in Australia and Canada, it can spread rapidly to new areas of chickpea production.

Economic importance. The disease can cause grain yield and quality losses up to 100%.

Epidemiology. AB is a seed borne disease. Diseased debris left over in the fields also serves as a source of primary inoculum. Ascospores were also found to play a role in the initiation of disease epidemics. Secondary spread is through pycnidiospores. Chickpea and its wild relatives are the only confirmed hosts of the fungus *A. rabiei*. However, Kaiser (1990) reported other hosts of the pathogen, outside the genus *Cicer*. Cool, cloudy and wet weather favors the disease development. The disease builds up and spreads fast when night temperatures are around 10°C, day temperatures are around 20°C, and rains are accompanied by cloudy days. Excessive canopy development also favors blight development.

Symptoms. The disease is usually seen around flowering and podding time as patches of blighted plants in the



Fig. 1. Patches of AB infected plants in the field.

field (Fig. 1). Symptoms are seen on all above-ground parts (Fig. 2) of the plant. However, the disease can appear at a very early stage of a crop's growth. When the pathogen is seed borne and conditions at the time of germination are conducive to disease development, the emerging seedlings develop dark brown lesions at the base of the stem. Affected seedlings may collapse and



Fig. 2. Symptoms of AB on stems, leaves and pods.

die (damping-off). Pycnidia may be formed on the lesions. Isolated infected seedlings may not be noticed. But at flowering and podding time, when conditions are usually favorable for disease development, the disease spreads from these isolated seedlings, resulting in patches of blighted plants. When the source of inoculum is airborne conidia or ascospores, the disease initially appears in the form of several small water-soaked necrotic spots on the younger leaves of almost all branches. Under conditions favorable for disease development these spots enlarge rapidly and coalesce, blighting the leaves and buds. Pycnidia are observed on the blighted parts. On a susceptible cultivar, the necrosis progresses from the buds downwards, killing the plant (Fig. 2a). In cases of severe foliar infection, the entire plant dries up suddenly.

If conditions are not favorable for disease development (hot dry weather), the plants do not die and the infection remains in the form of discrete lesions on the leaves, petioles, stems, and pods (Fig. 3). The symptoms on the leaflets are round spots with brown margins and a gray center that contains pycnidia, which are often arranged in concentric rings.



Fig. 2a. AB symptoms on aerial parts of plant.



Fig. 3. Lesions caused by AB on chickpea leaflets and pods.

On the stems and petioles, the lesions are obovate or elongate and bear pycnidia (Fig .4). The size of the lesions varies greatly; some may become 3 - 4 cm long on stems and often girdle the affected portion. The stems and petioles usually break at the point of girdling. If blight occurs at the pre-flowering stage and then conditions for its development become unfavorable (hot dry weather)



Fig. 4. Elongated lesions on stem and breaking of branches at the point of girdling.

the crop regrows fast but symptoms can still be seen on the older branches. Fully developed lesions on pods are usually round, up to 0.5 cm in diameter, usually with concentric rings of pycnidia (Fig. 5). Several lesions may appear on a single pod and if infection occurs in the early stages of pod development, the pod is blighted and fails to develop any seed (Fig. 6). Late infections result in shriveled and infected seed.

The fungus penetrates the pod and infects the developing seed. Symptoms on the seeds appear as a brown discoloration and often develop into deep, round or irregular cankers, sometimes bearing pycnidia visible to the naked eye (Fig. 7).



Fig. 5. Close up of lesions caused by AB on pod wall with pycnidial bodies arranged in concentric rings.



Fig. 6. AB lesions on green pods.



Fig. 7. Lesions caused by AB on kabuli seeds (healthy seeds at left).

Botrytis gray mold [*Botrytis cinerea* Pers. ex Fr.]

Distribution. Botrytis gray mold (BGM) is a serious disease in parts of Bangladesh, India, Nepal, Pakistan, Australia and Argentina. BGM has also been reported from Canada, Chile, Colombia, Hungary, Mexico, Myanmar, Spain, Turkey, the USA and Vietnam.

Economic importance. BGM can cause yield losses up to 100%.

Epidemiology. BGM is a seed borne disease. The fungus has a very wide host range. The disease is usually seen at flowering time when the crop canopy is fully developed. Excessive vegetative growth due to too much irrigation or rain, close spacing, and varieties that have a spreading habit favor disease development. Temperatures between 20 and 25°C and excessive humidity around flowering and podding time favor disease development. As temperatures favorable to BGM are slightly higher than those for ascochyta blight, these diseases may occur one after the other with ascochyta blight appearing first.

Symptoms. Lack of pod setting is the first indication of the disease (Figs. 8 and 9). Leaves and stems may not show any symptoms. Under weather conditions highly favorable to the disease, foliage shows clear symptoms and plants often die in patches (Fig. 10).



Fig. 8. Plants affected by BGM with no podding.



Fig. 9. BGM infected branches, leaves and flowers.



Fig. 10. Patches of chickpea plants infected with BGM in the field.



Fig. 11. Mycelial growth and grayish sporulation of Botrytis cinerea on chickpea stem.

The disease is more severe on portions of the plant hidden under the canopy and is obvious if the canopy is parted to expose the symptoms. Shed flowers and leaves covered with the spore mass can be seen on the ground under the plants.

When humidity is very high, the symptoms appear on stems, leaves, flowers and pods as gray or dark brown lesions covered with moldy sporophores. Lesions on stem are 10 - 30 mm long and girdle the stem completely (Fig. 11). Tender branches break off at the point where the gray mold has caused rotting. Affected leaves and flowers turn into a rotting mass (Fig. 12). Lesions on the



Fig. 12. Fungal sporulation on infected stem, branches and flowers.



Fig. 13. Healthy (left) and BGM infected (right) pods.

pod are water-soaked and irregular (Fig. 13). On infected plants, the pods contain either small, shriveled seeds or no seeds at all (Fig. 14). Grayish white mycelium may be seen on the infected seeds (Fig. 15). Further details on integrated crop management, with emphasis on botrytis gray mold is found in Pande et al. (2006).



Fig. 14. Grayish mycelial growth on infected pods.

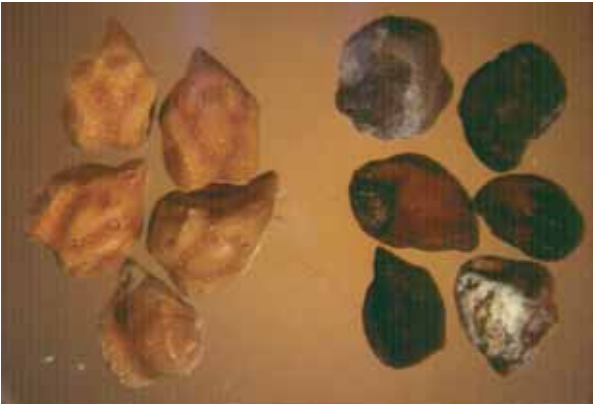


Fig. 15. Healthy seed (left) and lesions caused BGM on infected seed (right).

Alternaria blight [*Alternaria alternata* (Fr.:Fr.) Kiessler]

Distribution. Alternaria blight is a seed and soil borne disease considered serious in parts of Bangladesh and India.

Epidemiology. Like ascochyta blight and botrytis gray mold, alternaria blight also appears at flowering and podding time when the crop has built up its maximum canopy. Weather conditions (temperature and humidity) that favor the development of this disease are similar to those for ascochyta blight and botrytis gray mold, and all three diseases can occur together.

Symptoms. Shedding of lower leaves and sparse podding are the most obvious symptoms of the disease. Infection is generally severe on leaves. Initially, lesions on leaflets are water-soaked, small, circular, and purple (Fig. 16). These lesions are surrounded by chlorotic tissues without definite margins. Lesions later turn brown to dark brown. When humidity is high, they coalesce, cover the leaf area, and cause rapid withering of individual leaflets. Sporulation can be observed with a hand lens



Fig. 16. Lesions of alternaria blight on leaflets.

(10X). On the stems, the lesions are elongated and are brown to black. The infected flowers die (Fig. 17). On the pods, the lesions are circular, slightly sunken, and irregularly scattered. Affected pods turn dirty black. On mature pods, the lesions remain as localized, tiny, black superficial flecks. Infected seeds are shriveled. Under favorable weather conditions the entire foliage can die.



Fig. 17. Flowers killed by alternaria blight.

Colletotrichum blight [*Colletotrichum dematium* (Pers. ex Fr.) Grove]

Distribution. Colletotrichum blight is a minor seed and soil borne disease reported only from India.

Epidemiology. The disease is generally fatal when the crop is sown early (September) when the temperatures are high (25 – 30°C) and the young crop is caught in the rains during late September or early October. The disease does not normally occur in the post-rainy season crop, but if there are unusual rains, the disease can affect the crop.

Symptoms. The disease can kill the plants at any stage of crop growth, depending on the weather conditions and amount of inoculum present. Plants and branches that have dried up and get scattered throughout the field are an indication of colletotrichum blight (Fig. 18). On seedlings, two kinds of symptoms can be observed: (1) elongated, sunken, dark brown spots on the lower part of the stem, extending to the root, and (2) wilting and drying due to severe collar and root infection. In adult plants, lesions are seen on all the above-ground parts. On leaves and pods, lesions are circular to elongate, sunken at the center, and



Fig. 18. A row of dried plants affected by collectotricum blight.



Fig. 19. Lesions on pods and seeds.

with yellow margins. On stems they are elongated and black. The fruiting bodies (acervuli) are scattered within the affected tissues. The fungus penetrates the pod wall and infects the seed (Fig. 19).

Phoma blight [*Phoma medicaginis* Malbr. & Roum]

Distribution. Phoma blight is a minor disease reported from Australia, Bangladesh, India, Syria and USA.

Symptoms. It usually affects the crop in the reproductive phase. The field symptom is the appearance of patches of drying plants. The symptoms are somewhat similar to those of ascochyta blight. Irregular, light brown lesions on the leaves, stems, and pods have dark margins (Fig. 20). Dark, minute, submerged pycnidia are irregularly scattered in the infected tissue (Fig. 21). Seeds from infected pods are discolored and shriveled. The conditions favorable to phoma blight are similar to those that favor ascochyta blight. Further details can be found in Haware and Nene (1981).



Fig. 20. Lesions on stem, leaves and pods.



*Fig. 21. Pycnidial bodies of *Phoma medicaginis* on chickpea pods.*

Stemphylium blight [*Stemphylium sarciniforme* (Cav.) Wilts.]

Distribution. Stemphylium blight is a minor disease reported from Bangladesh, India, Iran, Nepal and Syria.

Epidemiology. Excessive vegetative growth, high humidity, and cool weather (15 - 20°C) favor disease development.

Symptoms. It usually affects the crop from the flowering stage onwards. Defoliation, especially of the lower branches is conspicuous. Lesions on the leaflets consist of roughly ovoid necrotic spots, which may measure up to 6 x 3 mm (Fig. 22). The spots are dark brown at the center, with a broad gray border. Minute, dark brown, elongated spots also develop on the stems.



Fig. 22. Stemphylium blight lesions on leaflets

Rust [*Uromyces ciceris-arietini* (Grogn.) Jacz. & Beyer]

Distribution. Rust is prevalent in the Mediterranean region, southeastern Europe, southern Asia including India, eastern Africa and Mexico. It is not considered serious as it appears late in the season when the crop is maturing.

Epidemiology. Moderate warm weather favors rust development.



Fig. 23. Rust pustules on chickpea leaves.

Symptoms. The severely infected crop looks rusty because the foliage is coated with rust pustules and urediniospores. The rust appears first mainly on the leaves as small, round or oval, cinnamon brown, powdery pustules (Fig. 23). These pustules tend to coalesce. Sometimes a ring of small pustules can be seen around larger pustules, which occur on both leaf surfaces but more frequently on the lower one (Fig. 24). Occasionally pustules can be seen on stems. Severely infected plants



Fig. 24. Rust lesions on the lower surface of leaflets.

may dry up prematurely. Cool and moist weather favors rust buildup; rain does not appear to be essential for the infection to spread.

Powdery mildew [*Leveillula taurica* (Lev.) Salmon]

Distribution. Powdery mildew is a minor disease reported from India, Mexico, Morocco, Pakistan, and Sudan.

Epidemiology. Cool and dry weather favors powdery mildew development.

Symptoms. Like rust, powdery mildew appears late in the season when the crop is nearing maturity, except in highly susceptible genotypes, when it appears earlier. Severe infection of powdery mildew can be easily recognized by the white powdery growth on the foliage, which is a characteristic feature of the powdery mildews (Fig. 25). Small patches of white powdery coating initially develop on both surfaces of older leaves. These patches grow and may cover a large area. Affected leaves turn purple and then die. When infection is severe, stems, young leaves and pods are also covered with the powdery coating.



Fig. 25. Powdery mildew symptoms on leaves.

Sclerotinia stem rot [*Sclerotinia sclerotiorum* (Li b.) de Bary]

Distribution. Sclerotinia stem rot is reported from most of the chickpea growing regions of the world. At present, it is a minor disease.

Epidemiology. Excessive vegetative growth, high soil moisture, and cool weather (20°C) favor disease development.

Symptoms. It can affect the crop at any stage. The pathogen has been observed to cause collar rot of seedlings in North African chickpea-growing regions. Otherwise it usually appears after the crop canopy has covered the ground. The disease is characterized by the appearance of chlorotic or drying branches or whole plants scattered in the field. Such drying plants or branches rot at the collar region (Fig. 26) or at any point on the branch. The leaves of affected plants/branches turn yellow or droop while remaining green, then dry up and turn straw colored.



Fig. 26. Rotting of the stems at the basal region.



Fig. 27. Extended grayish lesions with mycelial coating.

A web of white mycelial strands appears at the collar region and above (up to 5 cm) and may cover the base of the branches (Fig. 26). Extended grayish lesions with or without mycelial coating can also be seen on the upper parts of the stems. Whitish or brownish irregular-shaped sclerotia can be seen, occasionally mingled with mycelial strands on branches (Fig. 27), or inside the stem (Fig. 28).



Fig. 28. Brownish sclerotial bodies in a split stem.

Fungal diseases affecting root/stem base

Fusarium wilt [*Fusarium oxysporum* Schlechtend. emend. Snyder et Hans. f. sp. *ciceri* (Padwick) Matuo et K. Sato]

Distribution. Fusarium wilt disease is now widely spread in most chickpea-growing areas of Asia, Africa, southern Europe and the Americas.

Economic importance. Yearly yield losses are estimated at 10-15% in India and Spain, with losses of 70-100% in years of severe outbreaks of the disease.

Epidemiology. Wilt is a seed and soil-borne disease. Wilt incidence is generally higher when chickpea is grown in warmer and drier climates (> 25°C) and when crop rotations are not practiced.

Symptoms. The field symptoms of wilt are dead seedlings or adult plants, usually in patches (Fig. 29). The disease can affect the crop at any stage.



Fig. 29. Patches of fusarium wilt-affected plants.



Fig. 30. Young plant with dull green leaves killed by fusarium wilt.

Seedling stage. The disease can be observed within 3 weeks of sowing. Whole seedlings (3 - 5 weeks after sowing) collapse and lie flat on the ground. These seedlings retain their dull green color (Fig. 30). When uprooted, they usually show uneven shrinking of the stem above and below the collar region (soil level). The shrunken portion may be about 2.5 cm or longer.

Affected seedlings do not rot on the stem or root surface. However, when split open vertically from the collar downwards or cut transversely, dark brown to black discoloration of the internal stem tissues is clearly visible (Figs. 31 and 32). In seedlings of



Fig. 31. Internal blackening of the stem caused by fusarium wilt.



Fig. 32. A transeverse cut of stem showing xylem blackening, caused by fusarium wilt.

highly susceptible cultivars, eg, JG 62, which dies within 10 - 15 days after emergence, the black discoloration may not be clearly visible. However, internal browning from root tip upwards is clearly seen.

Adult stage. The affected plants show typical wilting, ie, drooping of the petioles, rachis and leaflets (Fig. 33). Drooping is visible initially in the upper part of the plant but within a day or two, the entire plant droops.



Fig. 33. Drooping of fusarium wilt-affected plant.

The lower leaves are chlorotic, but most of the other leaves droop while still green. Gradually, however, all the leaves turn yellow and then light brown or straw colored. Dried leaflets of infected plants are not shed at maturity. Affected plants, when uprooted and examined before they are completely dry, show no external rotting, drying, or root discoloration. When the stem is split vertically, internal discoloration can be seen. Around the collar region, above and below, the xylem in the central inner portion (pith and part of the wood) is discolored dark brown or black. In the initial stage of wilting, the discoloration may not be continuous. Discoloration also extends several centimeters above the collar region into the main stem and branches. If the collar region is cut transversely with a sharp razor blade, black discoloration of both pith and xylem can be seen. Sometimes only a few branches are affected, resulting in partial wilt. In certain cultivars (eg, T3), the lower leaves dry up before the plants wilt.

Verticillium wilt [*Verticillium albo-atrum* Reinke & Berthier.]

Distribution. Verticillium wilt is considered important in Italy, Pakistan and Tunisia, and was recently observed in Syria.

Epidemiology. Verticillium wilt is favored by the similar weather conditions that promote fusarium wilt.

Symptoms. The disease can affect the crop at any stage. The field symptoms of verticillium wilt are similar to those of fusarium wilt. The foliage of affected plants may turn yellow before wilting. The xylem tissue shows a brown discoloration, lighter than that caused by *F. oxysporum* f. sp. *ciceri* (Fig. 34). For additional information, see Erwin (1958).

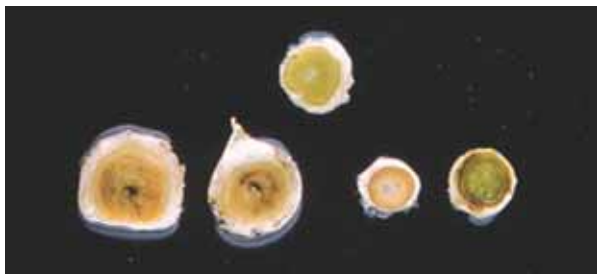


Fig. 34. Transverse sections of stem showing internal discoloration caused by verticillium wilt.

Collar rot [*Sclerotium rolfsii* Sacc.]

Distribution. Collar rot occurs in every region where chickpea is cultivated.

Epidemiology. It is a widely prevalent disease and can cause considerable loss to the plant stand when soil moisture is high and temperatures are warm (30°C) at sowing time. The incidence decreases with the age of the crop. The disease is favored by the presence of undecomposed organic matter on the soil surface and excessive moisture at the time of sowing and at the seedling stage. Disease incidence is higher when chickpea is sown after rice.

Symptoms. Drying plants whose foliage turns slightly yellow before death, scattered throughout the field is an indication of collar rot infection (Fig. 35). Most often, collar rot is seen at the seedling stage (up to 6 weeks after sowing), particularly if the soil is wet. Affected seedlings turn yellow. Young seedlings may collapse, but older seedlings may dry without collapsing. Leaves do not droop. When uprooted, the seedlings show rotting at the collar region and downwards. The rotten portion is covered with whitish mycelial strands (Fig. 36). A white mycelial coating can be seen on the tap root of completely dried seedlings, even several days after death. If affected seedlings are uprooted from moist soil in the earlier stages of infection, rapeseed-like sclerotia



Fig. 35. Plants killed by collar rot scattered in the field.

(1 mm in diameter), attached to mycelial strands around the collar are seen (Fig. 37). The non-affected portion of the root is white inside, as is normal.



Fig. 36. Yellowing of leaves and constriction at the collar region.



Fig. 37. White mycelial strands of Sclerotium rolfsii on root system.

Wet root rot [*Rhizoctonia solani* Kuhn]

Distribution. Wet root rot is a minor disease and is reported from several countries.

Epidemiology. No-till or reduced-till conditions favor growth of the pathogen and development of the disease. The pathogen can infect at a wide range of soil temperatures, but cool (11-18°C), wet soil conditions are optimum.

Symptoms. The field symptoms are almost the same as those of collar rot, ie, drying plants scattered throughout the field. Like collar rot, this disease is most often seen at the seedling stage (up to 6 weeks after sowing) in soils with relatively high moisture content. However, in irrigated chickpea, the disease may occur at later stages in the crop growth. Affected seedlings gradually turn yellow and petioles and leaflets droop. Seedlings do not usually collapse. A distinct dark brown lesion appears above the collar region on the main stem and can extend to lower branches in older plants (Fig. 38). The stem and root below the lesion show rotting, frequently with pinkish mycelial growth. Sclerotia are not usually seen.



Fig. 38. Symptoms of wet root rot on the root and lower portions of the branches.

Dry root rot [*Rhizoctonia bataticola* (Taub.) Butler]

Distribution. Dry root rot is the most important root rot disease in chickpea particularly in the semi-arid tropics of Ethiopia and in central and southern India. It has also been reported from Australia, Bangladesh, Iran, Kenya, Lebanon, Myanmar, Mexico, Nepal, Pakistan, Spain, Sudan, Turkey and the United States.

Epidemiology. The pathogen is a facultative sporophyte and is both seed borne and soil borne. Maximum ambient temperatures above 30°C, minimum above 20°C, and moisture stress (dry conditions) at the reproductive stages favor disease development.

Symptoms. The disease generally appears around flowering and podding time in the form of scattered dried plants (Figs. 39 and 40). The seedlings can also get infected. The susceptibility of the plant to the disease increases with age.

Drooping of petioles and leaflets is confined to those at the very top of the plant. Sometimes when the rest of the plant is dry, the topmost leaves are chlorotic. The leaves and stems of affected plants are usually straw



Fig. 39. Scattered dried chickpea plants in field affected by dry root rot.

colored, but in some cases the lower leaves and stems are brown. The lower portion of the tap root usually remains in the soil when plants are uprooted. The tap root is dark, shows signs of rotting, and is devoid of most of its lateral and finer roots (Fig. 41). Dark, minute sclerotial bodies can be seen on the roots exposed or inside the wood.



Fig. 40. Dry root rot affected plant.



Fig. 41. Rotting root system.

Black root rot [*Fusarium solani* (Mart.) Sacc.]

Distribution. Black root rot is a minor disease reported from Argentina, Chile, India, Mexico, Spain, Syria and USA.

Epidemiology. Excessive moisture and moderately high temperatures (25-30°C) encourage disease development.

Symptoms. The disease can occur at any stage. Affected plants turn yellow and wilt. Dead plants are seen



Fig. 42. Scattered dead plants caused by black root rot.

scattered in the field (Fig. 42). The root system is rotten, most of the finer roots are shed, and the remaining roots turn black (Fig. 43). Affected plants dry prematurely but may go on producing new roots if sufficient moisture is available. Further details can be found in Nene and Reddy (1987).



Fig. 43. Rotting of tap root and lateral roots (right).

Phytophthora root rot [*Phytophthora medicaginis* E. M. Hans & D. P. Maxwell]

Distribution. Phytophthora root rot is an important disease in Australia. It is also reported from Argentina, India, Pakistan and Spain.

Symptoms. Symptoms of phytophthora root rot in chickpea can develop from seedling emergence to near maturity. The disease is commonly lethal, causing wilting chlorosis and rapid death of plants a week or more after rains. Patches of dead plants are seen in the field. Symptoms on individual plants are yellowing and drying of foliage with basal rot symptom on stem (Fig. 44) and decay of lateral roots and the lower portion of the tap



Fig. 44. Symptoms of basal stem rot caused by phytophthora root rot.

root (Fig. 45). On the upper portion of the tap root, dark brown to black lesions are seen, which in some cases extend to the stem base. The advancing margins of these lesions are often reddish brown. These symptoms can be easily confused with those of wet root rot. The disease incidence is high in low lying areas where water stagnates. For additional information, refer to Vock et al. (1980).



Fig. 45. Symptoms of phytophthora root rot.

Pythium root and seed rot [*Pythium ultimum* Trow]

Distribution. It is a minor disease reported from Brazil, Canada, Spain, India, Iran, Turkey, and USA. The large-seeded kabuli types of chickpea are much more susceptible than the dark-seeded, small, irregularly shaped desi types that have thick seed coats.



Fig. 46. Poor emergence of seedlings in certain genotypes due to Pythium seed rot.

Symptoms. Emergence is poor because seeds are rotten (Figs. 46 and 47). Affected seedlings are stunted. The larger roots are necrotic, discolored and devoid of rootlets. Stunted plants often die before they flower. For additional information, refer to Kaiser and Hannan (1983).



Fig. 47. Section of rotting seeds (bottom row) caused by Pythium ultimum in naturally infested soil and healthy seedling at right.

Foot rot [*Operculella padwickii* Kheswala]

Distribution. Foot rot is a minor disease reported only from India, Bangladesh, and Nepal.

Symptoms. Dead plants are seen in patches or are seen scattered in the field. The symptoms of this disease on the above-ground plant parts are similar to those of fusarium wilt, particularly the drooping of petioles and rachis. Rotting from the collar region downwards is distinct, but there is no visible mycelial growth (Fig. 48). The stem above the rotten portion is discolored, but this discoloration is brown and does not involve the pith, unlike the brown-to-black discoloration in verticillium and fusarium wilts. The disease appears when the soils are wet.



Fig. 48. Foot rot showing rotting of root and drooping leaf.

Bacterial disease

Bacterial blight [*Xanthomonas campestris* pv. *cassiae* Kulkarni et al.]

Distribution. Bacterial blight is a minor disease reported only from India.

Symptoms. Leaves dry up and are shed (Fig. 49). The disease may show up as post emergence damping off, killing the seedlings within 3-4 days. Water-soaked lesions are seen on the radicle; lesions on leaves turn dark brown, and cause a soft rot of infected tissues. On adult plants, lesions are initially water soaked and soon turn into dark brown spots, 1-2 mm in diameter with chlorotic halos. As the disease advances, the spots coalesce causing severe chlorosis of the leaflet and producing typical leaf blight symptoms. Wet and warm (30°C) conditions favor disease development. For additional information, refer to Rangaswami and Prasad (1960).



Fig. 49. Drying and defoliation of leaves due to bacterial blight.

Viral diseases

Stunt [bean (pea) leaf roll virus]

Distribution. Stunt is the most important viral disease of chickpea prevalent in most of the chickpea-growing countries.

Epidemiology. Early sowing (September) and wider spacing favor stunt incidence in India. The aphid vector activity (*Aphis craccivora*, *Myzus persicae*) also influences disease incidence (Fig. 54).

Symptoms. All other viral diseases are minor. Stunting is most conspicuous in early infections. It occurs because of shortened internodes. In later infections, stunting may not be obvious, but plant discoloration and phloem browning are seen. Affected plants can be easily spotted in the field by their yellow, orange, or brown discoloration and stunted growth (Fig. 50). The disease is not seed borne. Leaflets are small and yellow, orange, or brown. In some cases, stems turn brown. The tips and margins of leaflets often become chlorotic before turning reddish brown. In general, leaf discoloration is more pronounced in desi types (reddish) than in kabuli types (yellow).



Fig. 50. Stunt infected plant in field.



Fig. 51. Phloem browning at the collar region caused by stunt.

The stems and leaves of diseased plants are stiffer and thicker than normal.

The most characteristic symptom of stunt is phloem browning (Fig. 51). It becomes obvious if the bark is removed at the collar region (by cutting a thin slice length-ways). A transverse cut (Fig. 52) reveals a brown ring or a split through the collar region and reveals brown streaks of discolored phloem vessels (Fig. 53). The interior wood of the root is white, as is normal, without xylem discoloration. If the plants survive up to the podding stage, pod set is sparse. Many plants dry up prematurely. Sometimes



Fig. 52. A transverse section of a stunt-infected plant showing brown phloem ring at the collar region.



Fig. 53. A vertical section of stunt infected chickpea plant showing the phloem browning at collar region.

stunt and fusarium wilt infection occur together. In such cases, xylem discoloration, which is typical of fusarium wilt, is also seen. The wilting is the result of combined infection. Mechanical damage to the phloem by chewing insects, which attack the plant at the collar region (Fig. 54), can also result in leaf discoloration and stunting similar to stunt. But there will be no phloem browning.



Fig. 54. Colonies of Aphis crassivora on the stem.

Mosaic [alfalfa mosaic virus]

Distribution. Mosaic is a minor disease reported from Algeria, India, Iran, Morocco, New Zealand, and USA.

Symptoms. The first visible symptoms of mosaic in the field are chlorosis of the terminal bud and twisting, followed by necrosis, and the subsequent proliferation of secondary branches. Such new secondary branches are stiff and erect, with smaller leaflets that show a mild mottle. Mosaic is clearly seen in kabuli types, which have larger leaflets (Fig. 55). Very few pods are produced. Premature drying is common. Terminal bud necrosis can also be caused by iron deficiency, but proliferation of branches is not seen in iron deficient plants. Wilting is seen when cultivars such as NEC-10 are inoculated at the seedling stage. It is possible, therefore, that seedlings that wilt without internal or external discoloration may be affected by the mosaic virus.



Fig. 55. A mosaic-infected plant showing small leaflets and stiff and erect branches.

Proliferation [cucumber mosaic virus]

Distribution. Proliferation is a minor disease reported from Bulgaria, Colombia, India, Iran, Morocco, USA and USSR.

Symptoms. Characteristic symptoms are bushy and stunted plants (Fig. 56). Similar symptoms are produced by a *poty* virus. Diseased plants produce few flowers and pods, and many die prematurely. Isolated stands of chickpea surrounded by other legumes that attract the aphid vectors (*A. craccivora*, *M. persicae*) show a higher incidence of the disease. For additional information, see Kaiser and Danesh (1971) and Chalam (1982).



Fig. 56. Proliferation symptoms caused by cucumber mosaic virus.

Narrow leaf [bean yellow mosaic virus]

Distribution. Narrow leaf is a minor disease reported from India, Iran, and USA.

Symptoms. Yellowing and drying of the plants with feathery and deformed leaves are common (Fig. 57). In chickpea plants inoculated with the virus, twisting of the terminal bud occurs 6-7 days after inoculation, later than plants inoculated with cucumber mosaic virus. This is followed by the initiation of very narrow leaves from new buds, which become evident 15 days after inoculation. Such abnormal vegetative growth continues, resulting in long and thin branches with very narrow or filiform leaves. The leaves below the proliferated branches turn yellow, show interveinal chlorosis, or mosaic depending on the genotype tested. The overall height of the plant is reduced. Affected plants produce very few and distorted flowers that develop into very small pods. The seeds from infected plant are black, small, and shriveled. For additional information, see Kaiser and Danesh (1971) and Chalam (1982).



Fig. 57. Narrow leaf symptoms in a seedling infected with bean yellow mosaic virus.

Necrosis [lettuce necrotic yellows virus]

Distribution. Necrosis is a minor disease reported only from Australia.

Symptoms. Field symptoms of the disease are most prominent on the terminals of the main and axillary shoots, which are usually twisted. The newest leaves show a bleached, necrotic tip burn. The stem and bases of the larger, older leaves develop reddish brown patches, particularly at the nodes. Symptoms on leaflets begin as yellow flecks on veins but the flecks enlarge to produce general chlorosis and kill the leaflet. Infected plants wilt and die.

Phyllody [mycoplasma]

Distribution. Phyllody is a minor disease reported from Ethiopia, India and Myanmar. Characteristic symptoms are excessive proliferation of branches with smaller leaflets, giving a bushy appearance to the plant. Diseased plants are scattered in the field and are more easily spotted at flowering and podding time. The flowers are converted into leafy structures (Fig. 58). At the time of crop maturity, when the healthy plants are drying, the diseased plants in the field will be conspicuously green. For additional information, see Ghanekar et al. (1988).



Fig. 58. Twig (left) showing phyllody symptoms (normal twig at right).

Control measures

Resistant varieties/lines

Country	Disease	Resistant cultivars	Seed type
Australia	Phytophthora blight	ICC11870, Yorker	desi
Bangladesh	Root diseases	Sabour 4, Fatehpur 1, Bhaugora	desi
	Botrytis gray mold	Barichola 5, ICCCL 87322	-
Bulgaria	Ascochyta blight	Plovdiv 019, Obratsov chijlik 1 Plovdiv 8	desi kabuli
Chile	Root rot	California INIA, Guasos SNA	kabuli
Cyprus	Ascochyta blight	ILC 3279	desi
Ethiopia	Wilt	Chefe	desi
Italy	Ascochyta blight	Ali, Sultano, Califfo,	desi
India	Ascochyta blight	F8, C 12/34, C 235, G 543, H 75-35, GG 688, GNG 146, Gaurav, BG 261, GG 588, Hima chana-1, Gaurav, Vardan, Samrat, PBG 1 and BG 261	desi desi kabuli

Country	Disease	Resistant cultivars	Seed type
	Ascochyta blight	ICCV 04052, 04509, 04505, 04512, 04513, 04523, 04524, 04525, 04526, 04530, 04537, 05502, 05503, 05511, 05512, 05513, 05514, 05515, 05523, 05530, 05531, 05546, 05551, 05571, 98811, 98816, 98818	
	Wilt	No. 10, S 26, G 24, C 214, BG 244, Pusa 212, Avrodhi, JG 315, JG 14, JG 11, JGK 2, KAK 2, Vijay, Vaibhav, JG 63, Birsacanna-3, WR 315, JG 74, JAKI 9218, Vihar, JG 1265, BG 1053, PDG 4, Gujarat gram 4, Gujarat gram 1, BGM 47, COG 29-1, L551	desi
	Root diseases	ICCC 32, GL 769	
	Botrytis gray mold	BG 276, GL 90159, GL 91040, GL 91071 and GL 92162	-
Mexico	Wilt	Surutato 77, Sto. Domingo, Senora, UC 15 and UC 27	kabuli
Morocco	Ascochyta blight	Pch 46	kabuli

Country	Disease	Resistant cultivars	Seed type
Nepal	Botrytis gray mold	ICC 14344	-
Pakistan	Ascochyta blight	F8, C 12/34, C 727, C 235, CM 72, C 44	desi
	Ascochyta blight and wilt	AUG 480	desi
Syria	Wilt	Punjab 2000	desi
	Ascochyta blight	ILC 482, Ghab 2	kabuli
Sudan	Wilt	ICCV 2, UC 15, FLIP 85-20C, FLIP 85-29C and FLIP 85-30C	kabuli and desi
Spain	Ascochyta blight	Fardan, Zegri, Almena, Alcazaba	desi
	Wilt	FLIP 84-43, FLIP 85-20, FLIP 85-29C, ILCs 127, 219, 237, 267, 513 and CA 2954	desi
Turkey	Ascochyta blight	Guney Sarisi 482, ILC 195	desi
USA	Root rot	Mission	kabuli
USSR	Ascochyta blight	VIR 32, Nut Zimistoni	intermediate
			desi

Fungicides

Disease	Seed treatment*	Foliar application#
Ascochyta blight	2-h immersion in malachite green 5 mg/l	Wettable sulphur
	4-h immersion in formal in 12-h immersion in pimaicin 150 mg/L	zineb
	Phenthiuram @ 2 g/kg Thiram @ 2 g/kg	ferbam
	Azoxistrobin @ 1g/kg	maneab captan
	Benomyl @ 2 g/kg	captafol
	Calixin M® (tridemorph + maneab) @ 3 g/kg	chlorothalonil
	Calixin M® (tridemorph + maneab) + thiram (1:1) @ 2-5 g/kg	dithianon (Dosage @ 3 g/l)

Disease	Seed treatment*	Foliar application#
	Calixin M® (tridemorph + maneb) + Bavistin® (carbendazim) (1:1)	
	Bavistin® (carbendazim) + thiram (1:3) thiabendazole (3 g/kg)	
Botrytis gray mold	carbendazim + thiram (1:1)	vinclozolin
	vinclozolin, carbendazim	carbendazim @ 1g/L + thiram @ 2g/L
	triadimefon	carbendazim @ 1 g/L
	Dithane M 45® (maneb)	captan
	Triadimenol	chlorothalonil
	thiabendazole	mancozeb
	iprodione	thiophonate methyl
	thiram	(Apply at 50 days after sowing or at the first sign of symptoms)

Disease	Seed treatment*	Foliar application#
Fusarium wilt	Carbendazim @ 2.5 g/kg Benlate T® (benomyl + thiram) @ 1.5 g/kg	
Dry root rot	captan thiram	
Wet root rot	captan, thiram, Benlate®	
Black root rot	thiram + benomyl thiram + captan	
Pythium root and seed rot	metalaxyl	
Collar rot	Rizolex® Vitavax 200®	

*Wherever not specified, the dose is 3 g/kg of seed.
#3 g or 3 ml per liter of water

Cultural practices

Disease	Practices
Ascochyta blight	<p>Sow late.</p> <p>Remove and destroy dead plant debris.</p> <p>Rotate crops.</p> <p>Sow deep (15 cm or deeper).</p> <p>Wider row spacing</p> <p>Adopt low seeding rate</p> <p>Intercrop with wheat, barley, mustard.</p> <p>Bury diseased debris 10 cm or deeper.</p> <p>Sow disease-free seed</p>
Botrytis gray mold	<p>Use disease-free seed</p> <p>Burn infected debris</p> <p>Deep ploughing</p> <p>Adopt late sowing and wider row spacing.</p> <p>Intercrop with linseed or wheat</p>

Disease	Practices
Alternaria blight	<p>Avoid excessive vegetative growth.</p> <p>Avoid excessive irrigation.</p> <p>Use erect and compact varieties</p>
Sclerotinia stem rot	<p>Maintain low plant density</p> <p>Avoid excessive irrigation</p> <p>Deep plowing</p> <p>Avoid excessive vegetative growth.</p> <p>Avoid excessive irrigation.</p> <p>Use upright growth habit cultivars</p> <p>Wide row spacing</p>
Fusarium wilt	<p>Use disease-free seed.</p> <p>Avoid sowing when temperatures are high (late sowing).</p> <p>Follow 4-year crop rotations</p> <p>Soil solarization during summer months</p>
Dry root rot	<p>Avoid drought</p> <p>Sow on time so that the crop escapes hot weather.</p>

Disease	Practices
Wet root rot	<p>Avoid excessively rich soil. Avoid high soil moisture at sowing.</p>
Black root rot	<p>Avoid high soil moisture.</p>
Pythium root and seed rot	<p>Adopt late planting Treat seeds with <i>Penicillium oxalicum</i>, <i>Pythium oligandrum</i>, <i>Pseudomonas fluorescens</i> and <i>Bacillus subtilis</i></p>
Collar rot	<p>Avoid high soil moisture at sowing and seedling stage. Adopt wide row spacing</p>
Verticillium wilt	<p>Remove all undecomposed organic matter while preparing seedbed Soil solarization during summer months Use disease free seeds</p>
Phytophthora blight	<p>Crop rotation with wheat Avoid poorly drained fields Crop rotation with wheat</p>
Stunt	<p>Adopt close spacing. Sow when aphid vector activity is low.</p>
	<p>It could be early or late sowing depending on research results for a location</p>

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