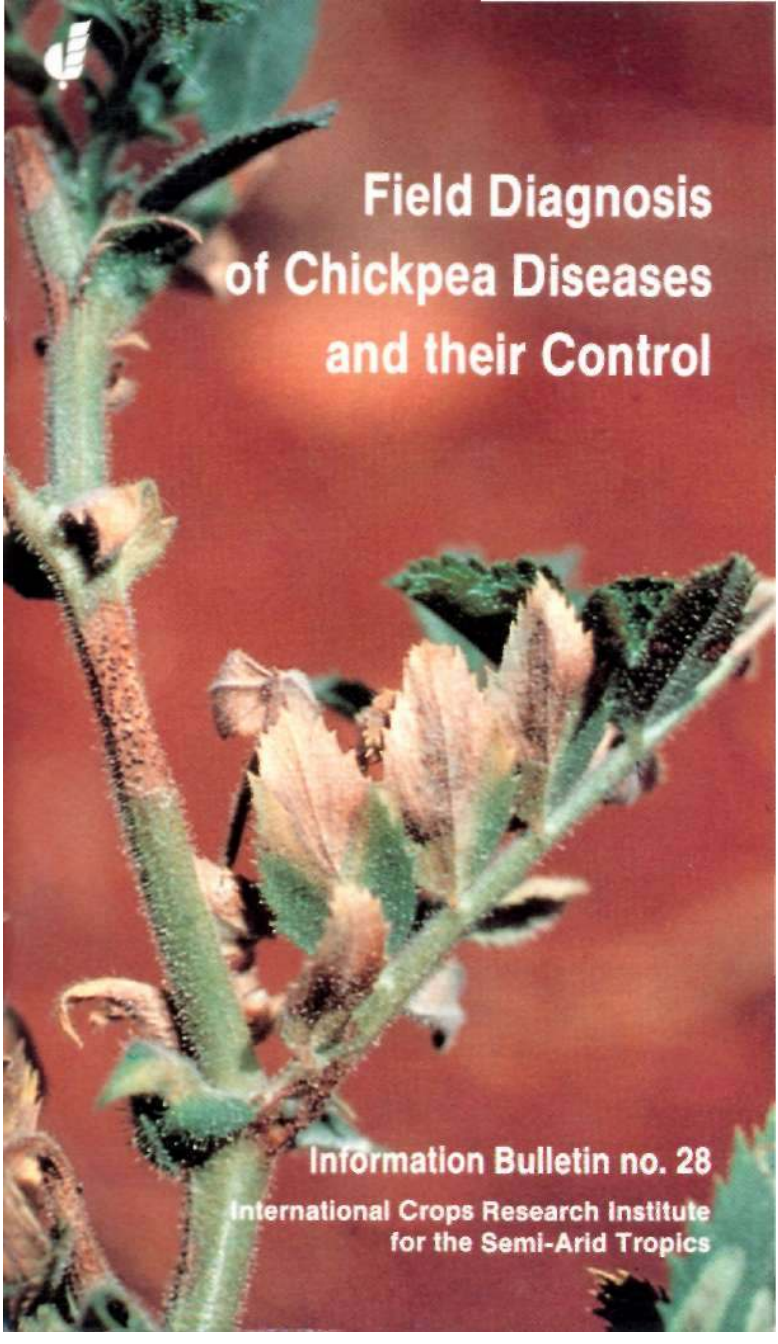

Field Diagnosis of Chickpea Diseases and their Control

Information Bulletin no. 28

International Crops Research Institute for the Semi-Arid Tropics

Abstract

Nene, Y.L., Reddy, M.V., Haware, M.P., Ghanekar, A.M., and Amin, K.S. 1991. Field diagnosis of chickpea diseases and their control. Information Bulletin no. 28. Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Chickpea is an important cool season food crop grown mainly in dry lands. The crop suffers from serious diseases which affect it in all growth stages. The pathogens that affect chickpea include fungi, bacteria, viruses, and mycoplasma. Among these, the most important are fungi, affecting roots, stems, leaves, flowers, and pods. This information bulletin provides information on the distribution of major diseases, field symptoms, environmental conditions favoring these diseases and control measures. Color photographs are included to facilitate identification of the diseases. An index of the technical terms used is also given.

Résumé

Nene, Y.L., Reddy, M.V., Haware, M.P., Ghanekar, A.M. et Amin, K.S. 1991. Diagnostique au champ des maladies du pois chiche et moyens de lutte. Bulletin d'information n° 28. Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Le pois chiche est une culture vivrière importante de saison fraîche exploitée principalement sur les terres pluviales. La culture subit plusieurs maladies graves qui l'attaquent à tous les stades de développement. Les agents pathogènes qui affectent le pois chiche comprennent les champignons, les bactéries, les virus et les mycoplasmes. Les plus importants pathogènes, les champignons, atteignent les racines, les tiges, les feuilles, les fleurs et les gousses. Ce Bulletin d'information offre des informations sur la distribution des principales maladies, les symptômes en milieu réel, les conditions de l'environnement favorisant ces maladies, et les mesures de lutte. Des photographies en couleur permettent l'identification facile des maladies. Un index des termes techniques employés est également offert.

Resumen

Nene, Y.L., Reddy, M.V., Haware, M.P., Ghanekar, A.M. y Amin, K.S. 1991. El diagnóstico de las enfermedades en garbanzo y su control. Boletín de Información no. 28. Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

El garbanzo es un importante alimento que se produce en la estación fría principalmente en las tierras áridas. La cosecha sufre de enfermedades serias que la afectan en todas las etapas de crecimiento. Los agentes patógenos que afectan el garbanzo incluyen hongos, bacterias, virus y micoplasma. Entre ellos, se destacan los hongos, que afectan las raíces, tallos, hojas, flores y vainas. Este boletín provee información sobre la distribución de las principales enfermedades, sus síntomas externos, condiciones ambientales que las favorecen así como las medidas de controlarlas. Se incluyen fotografías a color a fin de facilitar la identificación de la enfermedad. También se halla un índice de términos técnicos empleados en el texto.

Cover: Stem showing pycnidial bodies on the elongated lesion caused by ascochyta blight.

Field Diagnosis of Chickpea Diseases and their Control

Y.L. Nene, M.V. Reddy,
M.P. Haware, A.M. Ghanekar,
and K.S. Amin

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Contents

Introduction 1

Fungal diseases affecting aerial plant parts 1

Ascochyta blight 1
Botrytis gray mold 6
Alternaria blight 10
Colletotrichum blight 12
Phoma blight 13
Stemphylium blight 15
Rust 15
Powdery mildew 16
Sclerotinia stem rot 17

Fungal diseases affecting root/stem base 20

Fusarium wilt 20
Verticillium wilt 24
Collar rot 24
Wet root rot 27
Dry root rot 28
Black root rot 30
Phytophthora root rot 30
Pythium root and seed rot 32
Foot rot 34

Bacterial disease 35

Bacterial blight 35

Viral diseases 36

Stunt 36
Mosaic 39
Proliferation 40
Narrow leaf 41
Necrosis 43
Phyllody 43

Control measures 45

Resistant varieties 45
Fungicides 46
Cultural practices 48

References 49

Index 51

Introduction

More than 50 pathogens have been reported so far to infect chickpea (*Cicer arietinum* L.) in different parts of the world (Nene et al. 1989) but only a few of them have the potential to devastate the crop. The important diseases are 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. This bulletin describes the symptoms of these and other common diseases to make their identification easier under field conditions. Some information on control measures is also provided. For more detailed information on these diseases, refer to Nene et al. (1978) and Nene and Reddy (1987).

Fungal diseases affecting aerial plant parts

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

This 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 for disease development In West Asia, southern Europe, and northern Africa, such conditions usually prevail in March, April, and May. In the winter-sown chickpeas in the Mediterranean region, blight symptoms can be found in November and December when the weather is wet and warmer. It is a seedborne disease. Diseased debris left over in the fields also serve 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.*

Figure 1. Field showing large patches of dry plants affected by ascochyta blight.

Figure 2. Symptoms of ascochyta blight on stems, leaves, and pods.

The disease is usually seen around flowering and podding time as patches of blighted plants in the field (Fig. 1). Symptoms are seen on all above-ground parts (Fig. 2).

However, the disease can appear at a very early stage of a crop's growth. When the pathogen is seedborne 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 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 (cool, cloudy, wet weather) these spots enlarge rapidly and coalesce, blighting the leaves and buds. Pycnidia arc observed on the blighted parts. On a susceptible cultivar, the necrosis progresses from the buds downwards, killing the plant (Fig. 3). In cases of severe foliar infection, the entire plant dries up suddenly.

Figure 3. A susceptible cultivar (right) killed by ascochyta blight.

If conditions (hot dry weather) are not favorable for disease development, the plants do not die and the infection remains in the form of discrete lesions on the leaves, petioles, stems, and pods (Fig. 4). The symptoms on the leaflets are round spots with brown margins and a grey center that contains pycnidia, that are often arranged in concentric rings.

Figure 4. Symptoms of ascochyta blight on stems, leaflets, pods, and seeds.

On the stems and petioles, the lesions are obovate or elongate and bear pyenidia (Fig. 5). 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 preflowering stage and then conditions for its development become unfavorable (hot dry weather) 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 pyenidia (Fig. 6). 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. Late infections result in shrivelled and infected seed.

Figure 5. Stem showing pycnidial bodies on the elongated lesion caused by ascochyta blight.

Figure 6. Close up of lesion caused by ascochyta blight on pod wall, with pycnidial bodies arranged in concentric rings.

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).

Figure 7. Lesions caused by ascochyta blight on kabuli chickpea seeds (healthy seeds at left).

The disease builds up and spreads fast when night temperatures are around 10°C, day temperatures around 20°C, and rains are accompanied by cloudy days. Excessive canopy development also favors blight development.

Botrytis gray mold (*Botrytis cinerea* Pers. ex Fr.)

This is a serious disease in parts of Bangladesh, India, Nepal, and Pakistan. It is a seedborne disease. The fungus has a very wide host range. The disease is usually seen at flowering time when the crop canopy is fully developed.

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).

Figure 8. Plant affected by botrytis gray mold with no podding.

Figure 9. Flowers killed by botrytis gray mold.

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

Figure 10. Plants killed by botrytis gray mold.

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

Figure 11. Stem affected by botrytis gray mold showing grayish fungal mycelium and sporulation.

flowers turn into a rotting mass (Fig. 12). Lesions on the pod are water-soaked and irregular (Fig. 13).

On infected plants, the pods contain either small, shrivelled seeds or no seeds at all (Fig. 14). Grayish white mycelium may be seen on the infected seeds.

Figure 12. Twigs showing rotting symptoms caused by botrytis gray mold infection.

Figure 13. Pods showing lesions caused by botrytis gray mold.

Figure 14. Lesions caused by botrytis gray mold on seed and inner pod walls.

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 botrytis gray mold are slightly higher than those for ascochyta blight, these diseases may occur one after the other with ascochyta blight appearing first.

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

It is a seed- and soilborne disease considered serious in parts of Bangladesh and India. 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. 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. 15). 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 (10X). On the stems, the lesions are elongated and are brown to black.

The infected flowers die (Fig. 16). 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. Seed is infected and shrivels. Under favorable weather conditions the entire foliage can die.

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.

Figure 15. Lesions of alternaria blight on leaflets.

Figure 16. Flowers killed by alternaria blight.

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

It is a minor seed- and soilbornc disease reported only from India. 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, scattered throughout the field, are an indication of colletotrichum blight (Fig. 17).

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 arc seen on all the above-ground parts. On leaves and pods, lesions are circular to elongate, sunken at the center, and with yellow margins. On stems they arc elongated and black. The fruiting bodies (acervuli) are scattered within the affected tissues. The fungus penetrates the pod wall and infects the seed (Fig. 18).

Figure 17. A row of dried plants affected by colletotrichum blight.

Figure 18. Symptoms of colletotrichum blight on pods and seeds.

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 postrainy-scason crop. But if there arc unusual rains, the disease can affect the crop.

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

It is a minor disease reported from Australia, Bangladesh, India, and USA. It usually affects the crop in the reproductive phase. The field symptom is the 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. 19). Dark, minute, submerged pycnidia are irregularly scattered in the infected tissue (Fig. 20). Seeds from infected pods arc discolored and

shrivelled. The conditions favorable to phoma blight are similar to those that favor ascochyta blight. Further details can be found in Haware and Nene (1981).

Figure 19. Lesions caused by phoma blight, on stems, leaves, and pods.

Figure 20. Pycnidial bodies of *Phoma medicaginis* on chickpea pods.

Figure 21. Stemphylium blight lesions on leaflets.

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

This is a minor disease reported from Bangladesh, India, Iran, and Syria. 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. 21). The spots are dark brown at the center, with a broad gray border. Minute, dark brown, elongated spots also develop on the stems.

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

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

This disease is prevalent in most of the chickpea-growing countries but is not considered serious as it appears late in the season when the crop is maturing. The severely infected crop looks rusty because the foliage is coated with rust pustules and urediniospores.

Figure 22. Rust lesions on the lower surfaces of leaflets.

The rust appears first mainly on the leaves as small, round or oval, cinnamon brown, powdery pustules (Fig. 22). 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. Occasionally pustules can be seen on stems.

Severely infected plants 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 [*Oidiopsis taurica* (Lev.) Salmon]

This is a minor disease reported from India, Mexico, Morocco, Pakistan, and Sudan. Like rust, powdery mildew appears late in the season when the crop is nearing maturity, except in highly susceptible genotypes. Severe infection of powdery mildew can be easily recognized by white powdery growth on the foliage, which is a characteristic feature of the powdery mildews (Fig. 23).

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. Cool and dry weather favors powdery mildew development.

Figure 23. Powdery mildew symptoms on some leaflets.

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

It is reported from most of the chickpea-growing regions of the world. At present, it is a minor disease. 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 below the crop. 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. 24) or at any point on the branch (Fig. 25). The leaves of affected plants/branches turn yellow or droop while remaining green, then dry up and turn straw colored.

Figure 24. Rotting of the stems at the basal region caused by sclerotinia stem rot.

Figure 25. Lesion on the stem caused by sclerotinia stem rot.

Figure 26. Whitish mycelial growth on a lesion caused by sclerotinia stem rot.

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).

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

Figure 27. Whitish mycelial growth and brownish sclerotia of *Sclerotinia sclerotiorum* on stem.

Figure 28. Brownish sclerotial bodies of *Sclerotinia sclerotiorum* in a split stem.

Fungal diseases affecting root/ stem base

Fusarium wilt [*Fusarium oxysporum* Schlecht. emend Snyd. & Hans. f. sp. *ciceri* (Padwick) Snyd. & Hans.]

Fusarium wilt is prevalent in most chickpea-growing countries and is a major disease. It is a seed- and soilborne disease. 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.

Figure 29. Patches of plants 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.

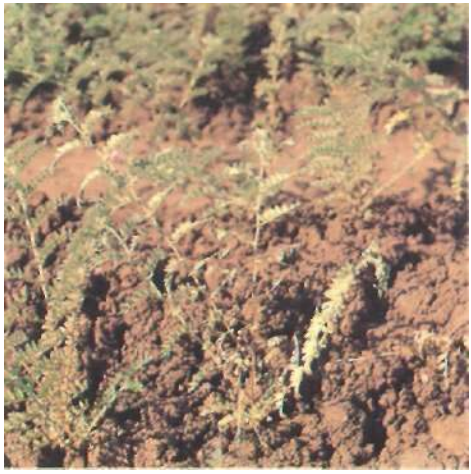

Figure 30. Young plants with dull green leaves, killed by fusarium wilt.

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

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

Figure 32. A transverse cut of stem showing xylem blackening, caused by fusarium wilt.

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

Figure 33. Drooping of leaves caused by fusarium wilt.

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 (e.g., T 3), the lower leaves dry up before the plants wilt. Wilt incidence is generally higher when chickpea is grown in warmer and drier climates (> 25°C) and when crop rotations are not practiced.

Verticillium wilt (*Verticillium albo-atrum* Reinke & Berth.)

This disease is considered important in Pakistan and Tunisia. 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).

Figure 34. Transverse sections of stem showing internal discoloration caused by verticillium wilt (Source: Erwin, D.C, University of California).

Collar rot (*Sclerotium rolfsii* Sacc.)

It is a widely prevalent disease and can cause considerable loss to plant stand when soil moisture is high and temperatures are warmer (30°C) at sowing time. The incidence decreases with the age of the crop. Drying plants whose foliage turns slightly yellow before death, scattered throughout the field is an indication of collar rot infection (Fig. 35).

Figure 35. Plants killed by collar rot.

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 after several days of death (Fig. 37).

If affected seedlings arc uprooted from moist soil in the earlier stages of infection, rapeseed-like sclerotia (1 mm in diameter), attached to mycelial strands around the collar arc seen (Fig. 38). The nonaffected portion of the root is white inside, as is normal.

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.

Figure 36. White mycelial growth at the collar region, caused by collar rot.

Figure 37. White mycelial strands of *Sclerotium rolfsii* on root system.

Figure 38. Sclerotial bodies of *Sclerotium rolfsii* in the soil near the collar region of a plant affected by collar rot.

Wet root rot (*Rhizoctonia solani* Kuhn)

It is a minor disease and is reported from several countries. The field symptoms are almost the same as those of collar rot, i.e., 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 higher 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. 39). The stem and root below the lesion show rotting, frequently with pinkish mycelial growth. Sclerotia are not usually seen.

Figure 39. Symptoms of wet root rot on the root and lower portions of the branches.

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

It is the most important root rot disease in chickpea and is prevalent in most of the chickpea-growing countries. The disease generally appears around flowering and podding time in the form of scattered dried plants (Fig. 40). The seedlings can also get infected. The susceptibility of the plant to the disease increases with age.

Figure 40. Scattered dried plants affected by dry root rot.

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 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 (Fig. 41). The tap root is dark, shows signs of rotting, and is devoid of most of its lateral and finer roots. Dark, minute sclerotial bodies can be seen on the roots exposed or inside the wood (Fig. 42).

Maximum ambient temperatures above 30°C, minimum above 20°C, and moisture stress favor disease development..

Figure 41. Symptoms of dry root rot. Note the lack of finer roots.

Figure 42. Part of exposed root tissue showing sclerotial bodies of *Rhizoctonia bataticola.*

Figure 43. Symptoms of black root rot.

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

It is a minor disease reported from Argentina, Chile, India, Mexico, Spain, Syria, and USA. The disease can occur at any stage; affected plants turn yellow and wilt. Dead plants are seen scattered in the field. 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. Excessive moisture and moderately high temperatures (25 - 30°C) encourage disease development. Further details can be found in Nene and Reddy (1987).

Phytophthora root rot (*Phytophthora megasperma* Drechs.)

This is an important disease in Australia. It is also reported from Argentina, India, and Spain. Patches of dead plants are

seen in the field (Fig. 44). Symptoms on individual plants are yellowing and drying of foliage and decay of lateral roots and the lower portion of the tap root (Fig. 45). On the

Figure 44. Plants dried due to phytophthora root rot.

Figure 45. Symptoms of phytophthora root rot.

Figure 46. Symptoms of basal stem rot caused by phytophthora root rot.

upper portion of the tap root, dark brown to black lesions are seen, which in some cases extend to the stem base (Fig. 46). 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).

Pythium root and seed rot (*Pythium ultimum* Trow)

It is a minor disease reported from India, Iran, Turkey, and USA. Emergence is poor because seeds are rotten (Figs. 47 and 48). 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).

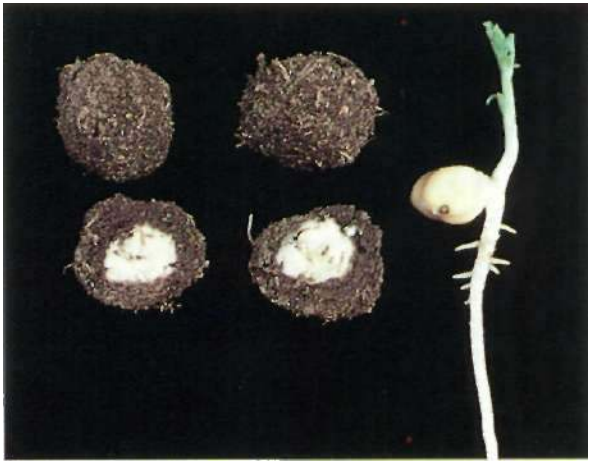

Figure 47. Section of rotting seeds (bottom row) caused by *Pythium ultimum* in naturally infested soil and healthy germinated seedling at right.

Figure 48. A chickpea field showing poor emergence of seedlings in certain genotypes owing to pythium seed rot.

Foot rot (*Operculella padwickii* Kheswalla)

It is a minor disease reported only from India. Dead plants arc seen in patches or are seen scattered in the field.

The symptoms of this disease on the above-ground plant parts arc 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. 49). 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.

Figure 49. Foot rot showing root rot and leaf-drooping symptoms.

Bacterial disease

Bacterial blight (*Xanthomonas cassiae* Kulkarni et al.)

It is a minor disease reported only from India. Leaves dry up and are shed (Fig. 50).

The disease may show up as postemergence 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 arc 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).

Figure 50. Drying and defoliation of leaves owing to bacterial blight.

Viral diseases

Stunt [bean (pea) leaf roll virus]

This is the most important viral disease of chickpea prevalent in most of the chickpea-growing countries. 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. 51). The disease is not seedborne.

Figure 51. Plant affected by stunt.

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

The most characteristic symptom of stunt is phloem browning (Fig. 52). It becomes obvious if the bark is removed at the collar region (by cutting a thin slice length-

Figure 52. Phloem browning at the collar region caused by stunt.

ways). A transverse cut (Fig. 53) reveals a brown ring or a split (Fig. 54) through the collar region reveals brown streaks of discolored phloem vessels.

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 pre-

Figure 53. A transverse cut of a stunt-infected plant showing brown phloem ring at the collar region.

Figure 54. A split stunt-infected chickpea plant showing phloem browning at the collar region.

maturely. Sometimes 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, can also result in leaf discoloration and stunting similar to stunt. But there will be no phloem browning.

Early sowing (September) and wider spacing favor stunt incidence. The aphid vector activity (*Aphis craccivora, Myzus persicae*) also influences disease incidence (Fig. 55).

Figure 55. Colonies *of Aphis craccivora* on the stem.

Mosaic (alfalfa mosaic virus)

This is a minor disease reported from Algeria, India, Iran, Morocco, New Zealand, and USA. 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. Mottle is clearly seen in kabuli types, which have larger leaflets (Fig. 56).

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 arc inoculated at the seedling stage. It is possible, therefore, that seedlings that wilt without internal or external discoloration may be affected by the mosaic.

Figure 56. A mosaic-infected plant showing small leaflets and stiff and erect branches.

Proliferation (cucumber mosaic virus)

This is a minor disease reported from Bulgaria, Colombia, India, Iran, Morocco, USA, and USSR. Characteristic symptoms are bushy and stunted plants (Fig. 57). Similar symp-

Figure 57. Proliferation symptoms caused by cucumber mosaic virus.

toms 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).

Narrow leaf (bean yellow mosaic virus)

This is a minor disease reported from India, Iran, and USA. Yellowing and drying of the plants with feathery and deformed leaves are common (Fig. 58).

Figure 58. Narrow leaf symptoms in a seedling artificially inoculated with bean yellow mosaic virus.

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, distorted flowers that develop into very small pods. The seeds from infected plants are black, small, and shrivelled.

For additional information, see Kaiser and Danesh (1971) and Chalam (1982).

Necrosis (lettuce necrotic yellows virus)

This is a minor disease reported only from Australia. 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)

This is a minor disease reported from Ethiopia, India, and Myanmar. Characteristic symptoms are excessive proliferation of branches with smaller leaflets, giving a bushy appear-

Figure 59. Twig (left) showing phyllody symptoms (normal twig at right).

ance 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. 59). 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).

Control measures

Resistant varieties (Singh, 1987)

Country	Disease	Resistant cultivars	Seed type
Bangladesh	Root diseases	Sabour 4, Fatehpur 1, Bhaugora	desi
Bulgaria	Ascochyta blight	Plovdiv 019, Obraztsov chijlik 1	desi
		Plovdiv 8	kabuli
Chile	Root diseases	California INIA	kabuli
	Root rot	Guasos SNA	kabuli
Cyprus	Ascochyta blight	ILC 3279	intermediate
India	Ascochyta blight	F8,C 12/34, C 235, G 543, H 75-35, GG 688, GNG 146,Gaurav, BG 261, GG 588	desi
	Wilt	No. 10, S 26, G 24, C 214, BG 244, Pusa 212, Avrodhi, JG 315	desi
	Root diseases	ICCC 32	kabuli
		GL 769	desi
Mexico	Wilt	Surutato 77, Sto. Domingo	kabuli
Morocco	Ascochyta blight	Pch 46	kabuli
Pakistan	Ascochyta blight	F8,C 12/34, C 727, C 235, CM 72, C 44	desi
	Ascochyta blight and wilt	AUG 480	desi
Syria	Ascochyta blight	ILC 482	kabuli
USA	Root rot	Mission	kabuli
USSR	Ascochyta blight	VIR 32	intermediate
		Nut Zimistoni	desi

Fungicides (Nene and Reddy, 1987)

Disease	Seed treatment[1]	Foliar application[2]
Ascochyta blight	2-h immersion in malachite green 5 mg L^{-1}	Bordeaux mixture wettable sulphur
	4-h immersion in formalin	zineb
	12-h immersion in pimaricin 150 mg L^{-1}	ferbam maneb captan
	phenthiuram 2g kg^{-1}	captafol
	thiram 2g kg^{-1}	Daconil® (chlorothalonil) Bravo 500® (chlorothalonil)
	benomy1 2g kg^{-1}	dithianon
	Calixin M® (tridemorph + maneb) 3g kg^{-1} Calixin M® (tridemorph + maneb) + thiram(1:1)2.5gkg^{-1} Calixin M® (tridemorph + maneb) + Bavistin® (carbendazim) (1:1) Bavistin® (carbendazim) + thiram (1:3) thiabendazole (3g kg-')	
Botrytis gray mold	carbendazim + thiram (1:1) vinclozolin carbendazim triadimefon Didiane M 45® (maneb) triadimenol thiabendazole iprodione thiram	vinclozolin carbendazim + thiram carbendazim
Fusarium wilt	Bavistin® (carbendazim) 2.5 g kg^{-1} Benlate T® (benomyl + thiram) 1.5 g kg^{-1}	
Dry root rot	captan thiram PCNB	
Wet root rot	captan thiram Benlate® PCNB	

Continued

Fungicides *continued.*

Disease	Seed treatment[1]	Foliar application[2]
Black root rot	thiram + benomyl thiram + captan	
Pythium root and seed rot	metalaxyl	
Collar rot	Rizolex® Vitavax 200®	

1. Wherever not specified, the dose is 3 *g* kg^{-1} seed.
2. 3 g or 3 ml L^{-1} water

Cultural practices (Nene and Reddy, 1987)

Disease	Practices
Ascochyta blight	Sow late. Remove and destroy dead plant debris. Rotate crops. Sow deep (15 cm or deeper). Intercrop with wheat, barley, mustard. Bury diseased debris 10 cm or deeper. Sow disease-free seed.
Botrytis gray mald and altemaria blight	Adopt wider spacing. Intercrop with linseed. Avoid excessive vegetative growth. Avoid excessive irrigation. Sow late. Use compact varieties.
Scierotinia stem rot	Avoid excessive vegetative growth. Avoid excessive irrigation.
Fusarium wilt	Use disease-free seed. Avoid sowing when temperatures are high. Follow 6-year crop rotations.
Dry root rot	Avoid drought Sow on time so that the crop escapes hot weather.
Wet root rot	Avoid excessively rich soil. Avoid high soil moisture at sowing.
Black root rot	Avoid high soil moisture.
Pythium root and seed rot	Treat seed with conidia of *Peniciltium oxalicum.*
Collar rot	Avoid high soil moisture at sowing. and seedling stage. Remove all undecomposed organic matter while preparing seedbed.
Stum	Adopt close spacing. Sow when aphid vector activity is low. It could be early or late sowing depending on research results for a location.

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Index

alfalfa mosaic virus 39
Alternaria alternata 10
alternaria blight 10,11, 48
Aphis vraccivora 39,41
ascochyta blight 1,2,3,4,5,6,10,13,14,45,46,48
Ascochyta rabiei 1
bacterial blight 35
bean (pea) leaf roll virus 1, 36
bean yellow mosaic virus 41,42
black root rot 1,30, 47,48
Botrytis cineria 6
botrytis gray mold 1,6,7,8,9,10,46,48
collar rot 1,24,25,26,47,48
colletotrichum blight 12,13
Colletotrichum dematium 12
cucumber mosaic virus 40, 41
damping-off 3,35
dry root rot 1, 28, 29, 46, 48
foot rot 34
Fusarium oxysporum f. sp. *ciceri* 20, 24
Fusarium solani 30
fusarium wilt 1,20,21,22,23,24,34,39,46,48
lettuce necrotic yellows virus 43
mosaic 39,40
mycoplasma 43
Myzus persicae 39,41
narrow leaf 41
necrosis 43
Oidiopsis taurica 16
Operculella padwickii 34
phoma blight 13,14
Phoma medicaginis 13,14,15
phyllody 43
Phytopthora megasperma 30
phytophthora root rot 1, 30, 31, 32
poty virus 41
powdery mildew 16,17

proliferation 40
pythium root rot 1, 32,47,48
pythium seed rot 1,32, 33,47,48
Pythium ultimum 32,33
Rhizoctonia bataticola 28,29
Rhizoctonia solani 27
root rot 34, 45
rust 15,16
Sclerotium rolfsii 24, 26
Sclerotinia scterotiorum 17,19, 20
sclerotinia stem rot 17,18,19,48
stemphylium blight 15
Stemphylium sarciniforme 15
stunt 1,36,37,38,39,48
Uromyces ciceris-arietim 15
Verticillium albo-atrum 24
verticillium wilt 24,34
wet root rot 27, 32,46,48
wilt 23,45
Xanthomonas cassiae 35

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