CP 1142

A chapter from

Adaptation of Chickpea in the West Asia and North Africa Region

1367

Edited by

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1996

5.3. Chickpea Diseases: Distribution, Importance, and Control Strategies

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Introduction

Chickpea, the third most important grain legume crop in the world, is traditionally grown as a spring-sown crop in WANA, and as a postrainy season crop in East Africa on conserved soil moisture. In South Asia, it is grown as a winter-season crop. Decreasing trends in chickpea production and yield in WANA and SAT are considered to a large extent to be due to disease incidence.

Although more than 70 pathogens have been reported so far on chickpea from different parts of the world (Nene et al. 1984), only a few of them are widespread and internationally important. These include ascochyta blight (*Ascochyta rabiei*), botrytis gray mold (*Botrytis cinerea*), fusarium wilt (*Fusarium oxysporum*), dry root rot (*Rhizoctonia bataticola*), and stunt virus. These diseases are responsible, to a large extent, for the instability in the yield of the crop in the major production areas in the world. Of these, on a global basis, ascochyta blight and fusarium wilt are the two most important diseases. In this section, the distribution and importance of chickpea diseases and strategies for their control in WANA, East Africa, and South Asia are discussed.

Important Diseases of Chickpea

The important diseases affecting chickpea in WANA, East Africa, and South Asia and their relative importance are listed in Table 5.3.1. The major diseases in different regions, in decreasing order of importance, are:

West Asia: Ascochyta blight, fusarium wilt, stunt, and diseases caused by nematodes;

North Africa: Ascochyta blight, fusarium wilt, stunt, and seed and seedling diseases;

East Africa: Fusarium wilt, dry root rot, stunt, and seed and seedling diseases;

South Asia: Fusarium wilt, ascochyta blight, dry root rot, botrytis gray mold, stunt, and seed and seedling diseases.

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Table 5.3.1. Major diseases of chickpea and their relative importance in West Asia, North Africa, East Africa, and South Asia.

Disease	West Asia		North Africa		East Africa	South Asia
	W[1]	S[1]	W	S		
Seed and seedling diseases	3[2]	3	3	5	5	5
Ascochyta blight	9	9	9	9	1	8
Botrytis gray mold	1	1	1	1	1	6
Fusarium wilt	3	5	5	7	7	9
Dry root rot	3	3	3	3	7	7
Stunt	3	5	3	5	5	5
Diseases caused by nematodes	3	3	2	2	-[3]	3

1. W = Winter-sown, and S = Spring-sown chickpea.
2. Rated on a 1–9 scale, where 1 = not important; 3 = slightly important; 5 = moderately important; 7 = important; 9 = very important.
3. Information not available.

Ascochyta blight

Ascochyta blight is reported from almost all the chickpea-growing countries in WANA, East Africa, and South Asia as a major and widespread constraint to chickpea production (Nene 1984). Infected seeds and diseased crop debris are the main sources of primary inoculum for the development of the disease.

Fusarium wilt

Fusarium wilt is widespread and known to occur in most of the chickpea-growing countries of these regions. However, it is particularly important in Tunisia, Morocco, Iran, Ethiopia, India, and Pakistan. The disease is seed- and soilborne. It can survive in the soil in the absence of a host for more than 6 years (Haware et al. 1990).

Dry root rot

Dry root rot is known to occur in Ethiopia, Iran, Lebanon, Syria, India, and Pakistan. The disease is more important in central and southern India, and in Ethiopia (Beniwal et al. 1992), and is much less important in WANA. The causal fungus is soilborne through black sclerotia that serve as the chief source of inoculum.

Botrytis gray mold

Botrytis gray mold is the second most important foliar disease of chickpea. It has been reported from Bangladesh, India, Nepal, Pakistan, and Turkey. The fungus is seedborne and also survives as black sclerotial bodies on infected seed and plant debris.

Stunt virus

Chickpea stunt, caused by the bean leaf roll virus (BLRV) and other related viruses belonging to the luteovirus group, is the most important viral disease of chickpea. The disease has been observed in Algeria, Libya, Morocco, Tunisia, Lebanon, Syria, Turkey, Egypt, Ethiopia, Sudan, Bangladesh, India, and Pakistan. The causal virus is phloem-specific and not transmissible mechanically.

Seed and seedling diseases

Seed and seedling diseases (*Sclerotium rolfsii*, *R. solani*, *F. solani*, *Pythium ultimum*) are important in those chickpea-growing regions where soil moisture is abundant at the seedling stage. These diseases can kill seedlings up to 6 weeks after the seeds are sown and can thus adversely affect plant stand and yield. They are known to occur in India, Pakistan, Bangladesh, Egypt, Ethiopia, Sudan, Iran, Syria, Turkey, Tunisia, and Morocco.

Nematodes

Among the nematodes that infect chickpea, the root-knot nematodes *Meloidogyne incognita* and *M. javanica* are important in India and Nepal, and *M. artiella* in Syria (Nene and Sheila 1992). The chickpea cyst nematode (*Heterodera ciceri*) and the root-lesion nematode (*Pratylenchus thornei*) have caused marked yield losses in Syria (Greco 1987). The reniform nematode (*Rotylenchulus reniformis*) is also a common pathogen on chickpea in India (Greco and Sharma 1990).

Crop Losses

Although information on crop losses caused by ascochyta blight in all the countries is not available, severe incidence of the disease in several countries has resulted in heavy crop losses. In Pakistan, the disease caused extensive losses in 1980 (48%), 1981 (up to 15%), and 1982 (42%). The damage in Pakistan caused a shortfall in chickpea production and resulted in massive imports of pulses (US$ 7.45 million) in 1982/83 (Malik 1986). In 1971, Morocco lost US$ 10 million worth of chickpea harvest due to ascochyta blight. In Syria, the crop loss to the disease ranged from 5–30% in 1981/82, while 40% loss was reported from Tunisia in 1981. Susceptible chickpea varieties are completely killed by the disease, whereas yield reduction in resistant cultivars (ILC 183 and ILC 202) is less than 10% (Reddy and Singh 1990a).

No precise information on losses caused by fusarium wilt in chickpea is available. An annual loss of US$ 1 million was reported from Pakistan (Sattar et al. 1953) and an annual average of about 10% is roughly estimated for India (Singh and Dahiya 1973). At ICRISAT, early wilting caused a greater loss than late wilting (Haware and Nene 1980). Seeds harvested from late-wilted plants were lighter than those from healthy plants and dull in color.

Botrytis gray mold of chickpea occurs in epiphytotic form in Bangladesh, Nepal, Pakistan, and in northern India. During 1978/79, the disease destroyed around 20 000 ha of chickpea in the *Tal* area of Bihar state in India. In 1980/81, it caused serious losses in the northern states of India (Grewal and Laha 1983). During the 1987/88 season, the loss due to the disease in Nepal was estimated to be 40% (Reddy et al. 1988).

Yield loss estimates due to stunt are not available, although it is particularly serious in northern India, Pakistan, Ethiopia, and Tunisia. Infection during early stages of plant growth leads to a total yield loss. If plants survive up to the pod-setting stage, very few pods are produced. Many plants die prematurely (Nene and Sheila 1992).

No precise information is available on the yield loss due to nematode diseases of chickpea. However, survey results indicated that losses due to root-knot nematodes in India could be negligible to very high in many parts of India, and in the *Terai* region of Nepal (Greco and Sharma 1990). In Syria, damage due to *M. artiella* was found to be more severe in spring than in winter chickpea. The chickpea cyst nematode is reported to cause complete crop failure in fields infested with more than 64 eggs g^{-1} of soil (Greco 1987).

Present Status of Disease Control

So far, the major emphasis on controlling chickpea diseases has been the use of chemicals, cultural practices, and host-plant resistance.

Chemical Control

Foliar sprays of fungicides have been tested in controlling ascochyta blight and botrytis gray mold. These are generally ineffective and uneconomical in susceptible varieties under epiphytotic situations. Moreover, these are not popular with farmers. However, their use in controlling seedborne infection is very effective. Calixin-M® (11% tridemorph + 36% maneb) and thiabendazole (Tecto-60®) eradicates seedborne inoculum of *A. rabiei* effectively (Reddy and Kabbabeh 1984). Seedborne inoculum of fusarium wilt can be successfully eradicated by seed dressing with Benlate-T® (benomyl 30% + thiram 30%) at 1.5 g kg^{-1} of dry seed (Haware et al. 1978). Similarly, seedborne *B. cinerea* can be eradicated through dry-seed dressing with vinclozolin (Ronilan®), a combination of methyl benzimidazole carbamate (MBC) + thiram or MBC alone (Grewal and Laha 1983). Preemergence damping-off phase of dry root rot is reduced by seed treatment with captan, thiram, or PCNB at 2.5 g kg^{-1} of seed.

Cultural Practices

Certain cultural practices have been used to control/reduce diseases of chickpea. Use of crop rotation, clean cultivation (removal of diseased crop debris), and deep plowing (10 cm and deeper) have been recommended to eliminate or reduce the primary source of *A. rabiei* inoculum. Use of healthy seed has been recommended to control the seedborne primary inoculum. For northern India, cultivars that can mature by the end of Feb, should be able to escape the severe effect of the disease in Mar (Nene and Sheila 1992).

Clean cultivation and use of healthy seed is recommended against botrytis gray mold. Use of cultivars with erect and compact growth habit at wider spacing is known to reduce disease severity.

Normal crop rotations are not effective against fusarium wilt as the fungus can survive in the soil for up to 6 years. In India, the disease decreased when sowing was delayed until Oct or Nov when it is cooler than in Sep, when the crop is traditionally sown. Soil amendments with oilseed meal reduced the fungus population in soil and also the disease incidence. In WANA, winter-sown chickpea is observed to have loswer wilt incidence than the spring-sown crop. Use of inoculum-free seed is important to guard against the chances of introduction of the pathogen into new areas. Soil solarization reduced the pathogen population and wilt incidence (Chauhan et al. 1988), but its use in extensive rainfed agriculture is not feasible.

Early sowing, use of short-duration genotypes, and irrigation have been suggested to minimize dry root rot incidence. Soil amendment with mature crop residue of wheat or oat is reported to significantly reduce the pathogen population and also the infection in a pot experiment.

Host-plant Resistance

Considering the socioeconomic status of most farmers in WANA, East Africa, and South Asia, the use of resistant varieties promises to be the most practical and effective method of controlling the economically important diseases of chickpea. Effective methods for field screening and a rating scale to screen large numbers of chickpea germplasm and breeding populations for resistance to ascochyta blight have been developed and standardized (Nene et al. 1981). Greenhouse screening techniques have also been developed at ICARDA and ICRISAT. A system for multilocational evaluation has been developed by ICARDA, which has proved to be effective. Several resistance sources have been identified (Table 5.3.2). Also, sources of resistance to multiple *A. rabiei* races have been identified (Singh and Reddy 1990a). These include three lines (ILC 202, ILC 3856, and ILC 5928) with resistance to five races, six lines (ILC 72, ILC 201, ILC 2506, ILC 2956, ILC 3279, and FLIP 83-48C) resistant to four races, and three (ILC 190, ILC 482, and ICC 3996) resistant to three races. Ninety-two kabuli breeding lines resistant or moderately resistant to ascochyta blight under both field and greenhouse conditions have also been identified (Singh and Reddy 1992). Resistant lines with other desirable characters such as earliness, large seed, and tallness are listed in Table 5.3.3. Several chickpea lines resistant to ascochyta blight have also been identified and released for cultivation in Tunisia, Morocco, and Algeria.

Table 5.3.2. Selected sources of resistance available for chickpea diseases.

Disease	Resistance sources
Ascochyta blight	ILC 72, ILC 195, ILC 201, ILC 202, ILC 2506, ILC 3274, ILC 3279, ILC 3956, ILC 4421, G 688
Fusarium wilt	ICC 3634, ICC 4200, ICC 4248, ICC 4368, ICC 5124, ICC 6981, and ICC lines, ICCC 32, ICCV 2, ICCV 3, ICCV 4, ICCV 5, ICCV 10, JG 315
Botrytis gray mold	ICCV 87322, ICCV 88510, ICC 4102-21, ICC 4102-41
Chickpea stunt	ICC 403, ICC 591, ICC 685, ICC 2285, ICC 2546, ICC 3718, ICC 6433, ICC 6934, ICC 10425, ICC 40596

Table 5.3.3. Ascochyta blight resistant lines with desirable characters identified at ICARDA.[1]

Characteristics	Line
Resistant lines with a disease rating of 3	FLIP 84-124C, FLIP 90-96C, FLIP 91-18C, FLIP 91-26C, FLIP 91-62C
Short-duration (130 days to 50% flowering) and blight-resistant lines	FLIP 88-83C, FLIP 90-98C, FLIP 91-22C, FLIP 91-45C, FLIP 91-46C
Large seeded (40–50.6 g 100-seed mass) and blight-resistant lines	FLIP 91-2C, FLIP 91-18C, FLIP 91-24C, FLIP 91-50C, FLIP 91-54C
Short-duration, large resistant lines	FLIP 91-18C
Tall (50–58 cm) and blight-resistant lines	FLIP 90-56C, FLIP 91-4C, FLIP 91-6C, FLIP 91-11C, FLIP 91-14C, FLIP 91-26C, FLIP 91-53C
Tall, large-seeded, and blight-resistant lines	FLIP 91-3C, FLIP 91-8C, FLIP 91-12C, FLIP 91-13C, FLIP 91-15C, FLIP 91-19C, FLIP 91-21C, FLIP 91-37C, FLIP 91-39C

1. Source: Singh and Reddy (1992).

Progress has been made in identifying resistance in desi and kabuli chickpeas to fusarium wilt at ICRISAT. Field, pot, and water-culture techniques to screen for resistance have been developed and perfected (Nene et al. 1981). Good sources of resistance and resistant lines are now available in India (Table 5.3.2), Tunisia (Halila et al. 1984), and Ethiopia (Ahmed et al. 1990). Some of these lines have resistance against other major soilborne and foliar diseases (Table 5.3.4).

Chickpea lines with resistance to botrytis gray mold and stunt have been identified (Table 5.3.2). Kabuli types are generally less susceptible to botrytis than desi ones.

Table 5.3.4. Lines/varieties identified for multiple disease resistance in chickpea[1].

Diseases	Line/Variety
Wilt, dry root rot, black root rot	ICC 7862, ICC 9023, ICC 10803, ICC 11560, ICC 11551, ICC 12235 to ICC 12269
Wilt, ascochyta blight, botrytis gray mold	ICC 1069
Wilt, dry root rot, stunt	ICC 10466
Wilt, sclerotinia stem rot	ICC 858, ICC 959, ICC 4914, ICC 8933, ICC 9001
Wilt, ascochyta blight	FLIP 83-43C, FLIP 85-20C, FLIP 85-29C, FLIP 85-30C

1. Adapted from Nene (1988).

Integrated Control

Few attempts towards integrated control of chickpea diseases have been made so far. Generally, a combination of host-plant resistance and fungicides is mostly used, e.g., to control ascochyta blight (Reddy and Singh 1990b; M.H. Halila, personal communication), and botrytis gray mold (Reddy et al. 1992).

Multiple Disease Control

Since more than one disease often affects chickpea in a given situation (Nene 1988), genotypes with multiple disease resistance are required. Chickpea genotypes resistant to two or more diseases are listed in Table 5.3.4. In Tunisia, good progress has been made in combining resistance to ascochyta blight and fusarium wilt, and 10 resistant lines are now in yield trials (Halila and Harrabi 1990).

Gaps in Knowledge

Gaps in our knowledge of major chickpea diseases have been earlier identified by Reddy et al. (1990); Haware et al. (1990); Kaiser et al. (1990); Greco and Sharma (1990), and Beniwal et al. (1992). These gaps are briefly highlighted here, in order to indicate possible future areas of research.

Ascochyta blight

- Lack of complete understanding of the disease epidemiology;
- Insufficient understanding of pathogenic variability and its geographic distribution;
- Unavailability of high levels of stable genetic resistance in large-seeded varieties; and
- Inadequate disease monitoring.

Fusarium wilt

- Unavailability of sources of resistance in large-seeded kabuli chickpeas for WANA;
- Lack of information on variability in *F. oxysporum* f. sp *ciceri* and on the distribution of its races in WANA and East Africa;
- The need to develop wilt-sick plots in certain countries to support breeding for disease resistance;
- Insufficient information on the distribution of wilt and root rots and their epidemiology in WANA and East Africa; and
- Integrated management of wilt and root rots.

Botrytis gray mold

- Lack of proper understanding of the disease epidemiology;
- Unavailability of desired levels of genetic resistance;
- Lack of information on pathogenic variability and its geographic distribution; and
- Lack of knowledge of the effects of cultural practices on disease incidence.

Stunt

There is a need to:
- Document occurrence and severity of the disease in different geographic areas;
- Identify sources of resistance;
- Understand the disease epidemiology;
- Determine pathogen variability and its geographic distribution; and
- Understand the influence of cultural practices on disease development.

Seed and seedling diseases

More information is required on:
- Distribution and importance of these diseases in WANA and East Africa;
- Influence of cultural practices on their incidence and build up; and
- Seed treatments with chemicals for multiple disease control.

Nematodes

More information is needed on
- Distribution, races, and biology of nematodes in different agroecological regions;
- Yield losses due to nematodes;
- Sources of resistance; and
- Influence of cropping systems and management practices on nematode populations.

Future Strategies for Disease Control

Integrated Disease Management

The best strategy for controlling chickpea diseases in WANA, East Africa, and South Asia will be through integrated disease management (IDM) of multiple chickpea diseases. IDM should be effective particularly for management of diseases where the desired levels of resistance are not available in germplasm. This approach would also be economical and environment-friendly. However, its relevance will depend upon the nature and severity of disease incidence.

The IDM option will combine various methods including chemical, cultural, and host-plant resistance. Its applicability will depend upon such factors as the socioeconomic status and attitudes of farmers in the target area.

Host-plant resistance is the most efficient, safe, economical, and convenient method of disease control. However, greater emphasis is required on the identification of sources of multiple disease resistance. High-yielding varieties with durable multiple-disease/race resistance in agronomically acceptable genetic backgrounds need to be developed.

The effects of cultural practices in IDM crop rotation, use of disease-free seed, sowing time, tillage practices, management of crop residues after harvest, fertilizer application, cropping system, and eradication of alternative pathogen hosts, particularly on soilborne diseases caused by fungi and nematodes, are important. These cultural methods have proved to be effective in developing countries where there is a long history of their use.

Although fungicides have been used to control various diseases, their use is limited in developing countries, as the chemicals are expensive and also because dry conditions prevail during the crop-growing season in many regions. However, they will have to be used in certain situations (Nene 1988). Similarly, the use of seed dressing with fungicides has tremendous scope for controlling seedborne pathogens and seed and seedling diseases. These include captan, thiram, mancozeb, or systemic benzimidazole used individually or in combination (e.g., the first three in mixtures with fungicides specific to oomycetes or with systemic benzimidazole).

Multiple Disease Management

It is essential to develop effective management practices against diseases that occur together in certain chickpea-growing areas (e.g., ascochyta blight and fusarium wilt together in WANA; ascochyta blight and botrytis gray mold in the northern parts of India and Pakistan). The best method to address this situation will be to develop varieties with multiple-disease resistance combined with the use of recommended cultural practices. As suggested by Reddy et al. (1990) and Nene and Sheila (1992), development of cold-tolerant chickpeas that can mature by end of Feb in India, Pakistan, Bangladesh, and Nepal may help in avoiding major foliar diseases as the low temperatures (<15–25°C) prevailing at that time will not favor their epiphytotics.

Short- and Long-term Strategies

In the short term, the major emphasis should be on managing ascochyta blight and fusarium wilt in WANA; fusarium wilt and dry root rot in East Africa; and ascochyta blight, fusarium wilt, dry root rot, and botrytis gray mold in South Asia. The remaining diseases in these regions should receive a lower emphasis in the short term. For the various diseases, the following areas should be given high priority:

Ascochyta blight: Epidemiology; variability in *A. rabiei* and its distribution; genetics of resistance; good and stable genetic resistance in large-seeded varieties.

Fusarium wilt: Development of wilt-sick plots to aid breeding programs; variability in the causal fungus and its distribution in WANA and East Africa; distribution of wilt and root rots in WANA and East Africa.

Botrytis gray mold: Good level of genetic resistance; variability in the causal fungus and its distribution; influence of cultural practices on disease development and build up; epidemiology.

Chickpea stunt: Distribution and importance in different geographic areas; influence of cultural practices on disease development.

Seed and seedling disease: Distribution and importance in different regions; identification of new fungicides for seed treatment to control multiple diseases.

Nematodes: Distribution and importance in different regions.

In the long term, aspects of ascochyta blight, fusarium wilt, and botrytis gray mold not mentioned in short-term strategies but highlighted under "Gaps in knowledge" should receive attention. Management of less important diseases such as stunt, seed and seedling diseases, and nematodes should be included in the long term strategy.

Future Action

In order to address the major diseases of chickpea, the following action will be required:

- Concerted research efforts to fill the gaps in knowledge;
- Development of IDM technology for multiple disease control;
- Efforts on transfer of IDM technology;
- Enhanced efforts by ICARDA and ICRISAT, and laboratories in developed countries in complementing NARS research efforts; and
- Development of national and/or regional networks, and formation of working groups.

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