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# Growing Chickpea in India

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This booklet has been written jointly by the scientists of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, Indian Council of Agricultural Research, and various state Agricultural Universities mentioned on page ii, to help researchers, extension workers, and farmers not only to grow a good crop of chickpea, but to spot, diagnose, and, hopefully to alleviate the problems that may occur during the crop cycle from seed for sowing to send for storing.

# Growing Chickpea in India


**Indian Council of Agricultural Research**
**Krishi Bhawan, Dr Rajendra Prasad Road,**
**New Delhi 110 001, India**

**ICRISAT**
**International Crops Research Institute**
**for the Semi-Arid Tropics**
**Patancheru 502 324, Andhra Pradesh, India**

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# Authors

**Jagdish Kumar, H A van Rheenen, C Johansen, N P Saxena, M P Haware, J A Wightman**
International Crops Research Institute for the Semi-Arid Tropics, Patancheru

**N B Singh**
Indian Council of Agricultural Research, New Delhi

**A N Asthana** and **M Ali**
Indian Institute of Pulses Research, Kanpur

**R L Pandey**
Indira Gandhi Krishi Vishwa Vidyalaya, Raipur

**S C Agrawal**
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Sehore

**M M Verma**
Punjab Agricultural University, Ludhiana

**R B Gaur**
Rajasthan Agricultural University, Sriganganagar

**A Satyanarayana**
Andhra Pradesh Agricultural University, Lam

**R P Aher**
Mahatma Phule Krishi Vidyapeeth, Rahuri

**K B Wanjari**
Punjabrao Krishi Vidyapeeth, Akola

**M S Patil**
University of Agricultural Sciences, Gulbarga

**M M Rahman**
Bangladesh Agricultural Research Institute, Joydebpur

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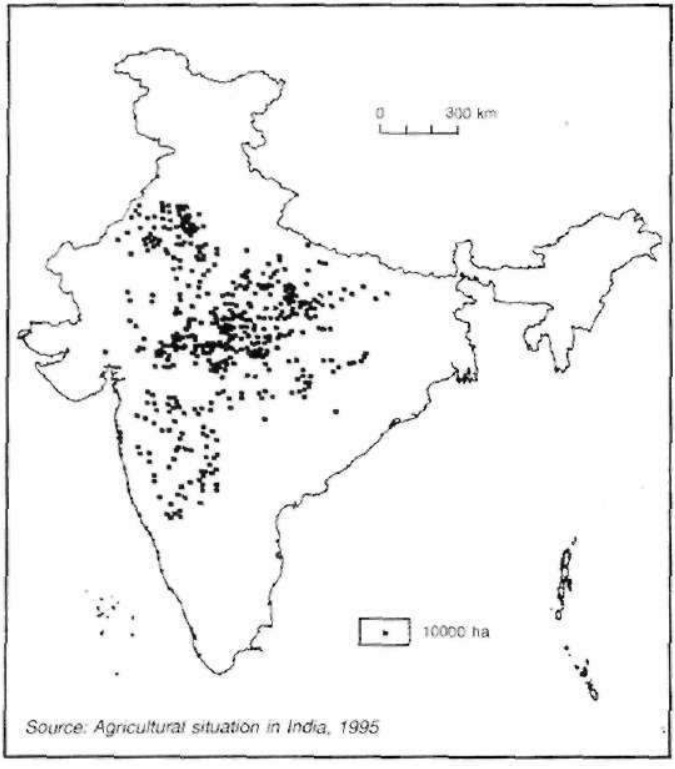
**Chickpea distribution in India**



# Introduction

India is the largest producer of chickpea, accounting for about 75% of world production (Table 1). The states of Madhya Pradesh, Uttar Pradesh and Rajasthan, together produce about 4.64 million tons of chickpea annually; this constitutes about 75% of India's total

**Table 1. Chickpea area, production, and productivity in major chickpea producing states of India and in the neighboring countries, 1994/95.**

| Country/State | Area ('000 ha) | Production ('000 t) | Productivity (kg $ha^{-1}$) |
|---|---|---|---|
| India[1] | 7260 | 6210 | 855 |
| Madhya Pradesh | 2570 | 2370 | 925 |
| Rajasthan | 1590 | 1370 | 864 |
| Uttar Pradesh | 990 | 900 | 908 |
| Maharashtra | 760 | 470 | 615 |
| Karnataka | 440 | 230 | 519 |
| Haryana | 400 | 440 | 1099 |
| Gujarat | 150 | 120 | 799 |
| Bihar | 130 | 140 | 1083 |
| Andhra Pradesh | 130 | 90 | 665 |
| Orissa | 30 | 20 | 606 |
| Punjab | 20 | 20 | 990 |
| West Bengal | 20 | 18 | 889 |
| Others | 30 | 20 | - |
| Bangladesh[2] | 90 | 67 | 745 |
| Nepal[2] | 24 | 14 | 563 |
| Pakistan[2] | 1065 | 559 | 525 |
| World[2] | 11156 | 8036 | 720 |

1. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi, March 1996, p. 24-25.
2. FAO Quarterly bulletin of Statistics. 1996, (1/2): p 51.

production. *Desi* (brown-seeded) types are predominantly grown, however, there is an increasing interest in growing cream-seeded *kabuli* types. Both types have a similar range of adaptation, however, the *kabuli type* is generally more prone to various stresses than is the *desi* type.

Chickpea is grown in a number of production systems in the postrainy (*rabi*) season, following a rainy-season (*kharif*) fallow or short-duration *kharif* crops. The mean productivity generally is low. In northern, northwestern, and eastern India where the cropping season is characterized by cold to cool winters, the crop matures in 150 to 180 days. Here, potential seed yields are relatively high even if they are not often realized. The growing season in the warmer-winter environments of central and peninsular India becomes progressively shorter as the Equator is approached, varying from 120 to as little as 80 days. Crop growth constraints to productivity, and ways to alleviate them vary across the agroecosystems of India. These differences are highlighted in this handbook.

Productivity can be considerably improved if the adverse effects of abiotic (soil and climate) and biotic (living organisms) stresses are alleviated. In this publication, the major constraints to increasing the productivity of chickpea in India are discussed, and the current knowledge about how they can be overcome is summarized.

This booklet is based on Growing chickpea in eastern Africa, Growing chickpea in Bangladesh and eastern India, and two ICRISAT Information Bulletins (IBE 26 and IBE 28). This publication is available in English and several other languages from ICRISAT and Indian Institute of Pulses Research, Kanpur 208 024, U.P., India.

**A good crop of chickpea**

in northern India

in central India

in peninsular India

# Abiotic constraints from sowing to harvest

## Seedbed

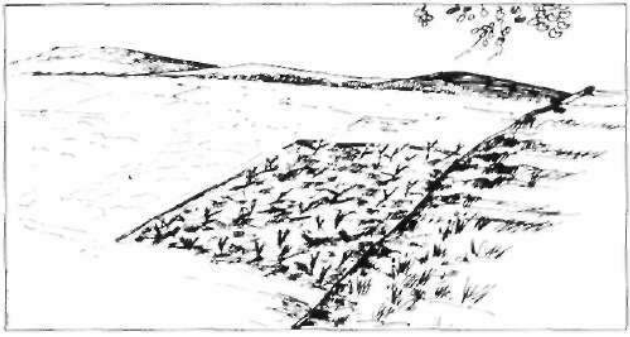
Chickpea is generally cultivated on conserved soil moisture. Presowing irrigation is given where it is feasible and required. In uplands where canal water is not available, moisture is conserved by preparing the seedbed in advance by plowing and sowing soon after the rainy season ends. A healthy root system ensures that the plant is properly equipped to overcome possible nutrient and drought stresses. The first step towards this is a good seedbed with loose tilth, that should be well drained and free from stubble and debris. Residues from the previous crop can harbor the pathogen that causes collar rot disease. To avoid the buildup of pathogens, grow chickpea only once every 3 years or so in the same field. Avoid saline fields and those with a high water table.

## Sowing

The seed should be of good quality. If in doubt, test the seeds well in advance of sowing for their ability to germinate. Take 50 seeds, put them between clean moist towels or gunny cloth, at room temperature, and inspect after 4-5 days. If fewer than 40 seeds have germinated, better quality seed is needed. Alternatively, increase the seed rate to compensate for the lower germination percentage (Table 2).

**Table 2. Germination and seed rates.**

| Number of seeds germinated (out of 50) | Extra seed required (as % of the normal) |
|---|---|
| 50 | normal |
| 48 | 5 |
| 46 | 10 |
| 44 | 15 |
| 42 | 20 |
| 40 | 25 |



Seedbed with stubble

Seedbed without stubble

Good germination

Inoculating the seed with *Rhizobium* culture improves nodulation. If chickpea has never been grown in a field before, the seeds need to be inoculated by coating them with *Rhizobium.* To coat the seeds, use a mixture of 70 g of peat inoculum (each gram of which contains 1 billion rhizobia) and 300 ml of 10% jaggery solution (1 kg of jaggery : 9 L water). The mixture has the consistency of a slurry,and is sufficient to treat 20 kg seed. Place the seeds in a plastic container, pour the slurry over them, and shake thoroughly. The treated seeds should be dried in the shade and sown as soon as possible thereafter.

If there is any doubt about whether the seed should be inoculated, it is better to apply *Rhizobium* rather than to risk poor nodulation, so long as the inoculum is readily available. However, a small-scale experiment is recommended to compare the yields from plots sown with and without inoculated seeds to test whether inoculation is necessary at a particular location.

If the seed is to be treated with pesticides, always apply insecticides first, followed by fungicides and finally treat with *Rhizobium* culture. The application of insecticides/fungicides should be done at least 3 days before sowing if *Rhizobium* inoculation is required.

If the land is fertile, or the previous crop has been fertilized adequately, the quantity of chemical fertilizer may be adjusted accordingly. Otherwise, the following rates (for 1 ha) are generally recommended: 20-30 kg N, 50-85 kg $P_2O_5$, 25-35 kg $K_2O$, 10-20 kg S, and 3-5 kg Zn. Fertilizer requirements often differ from field to field and, if a soil analysis service is available, the soil of each field should be analyzed. Otherwise, help from the local office of the Department of Agriculture should be sought.

Poor germination

Good nodulation

Poor nodulation

Applying fertilizers

A good plant stand is the first step in producing high seed yields, and a plant density of 25-30 plants $m^{-2}$ is recommended. This stand can be obtained by spacing the rows 30-40 cm apart and placing the seeds every 10 cm within the row. Table 3 shows the quantity of seed required for 1 ha, depending on the size of the seeds. However, under optimum moisture conditions, such as those prevailing in northern, northwestern, and eastern India, the crop may grow vigorously and wider spacing is advisable.

**Table 3. Seed rate per hectare.**

| 100-seed mass (g) | Seed rate (kg $ha^{-1}$) |
|---|---|
| 10 | 24-33 |
| 15 | 38-50 |
| 20 | 50-66 |
| 25 | 62-83 |
| 30 | 75-99 |

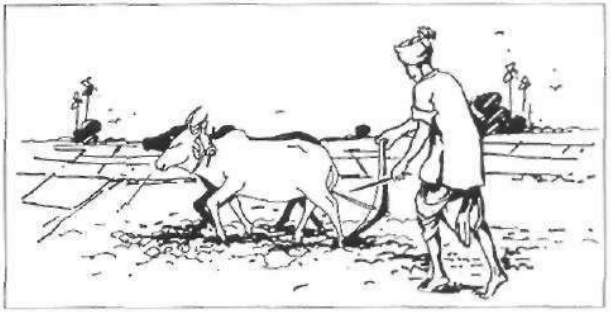
If seed quality (in terms of germination percentage) is low, more seed will be needed. **Question:** If the germination on a moist towel is 83% and the weight of 100 seeds is 15 g, how much seed will be required to sow 1 ha? **Answer:** 100/83x50 = about 60 kg.

Sowing can be done with a small seed drill, or through a simple pipe attached to the plow. If soil moisture is adequate, seed can also be dropped into the furrow by a person following the plow. A simple test used to check whether the soil has adequate moisture is to take a handful of soil and squeeze it into a ball; if it readily forms a ball, the soil has enough moisture. Throw the ball into air and let it drop onto your palm from a height of about 30 cm. It should break up on impact; if it does not, the soil contains more moisture than necessary.

The seed needs to be sown deeply enough to make contact with moist soil. Pressing the soil with a roller or a plank after sowing also helps the seeds to germinate uniformly.

Good plant stand

Poor plant stand



Harrowing

### *Paira* or *utera* (relay cropping)

Relay cropping is sometimes practiced in rice-based systems in eastern India.

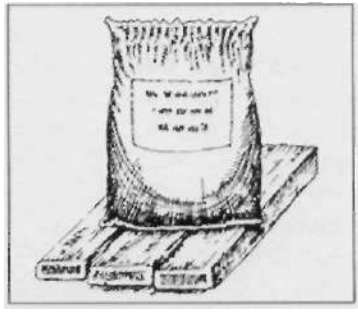
In this system chickpea seeds are broadcast into a standing crop of rice 3 to 4 weeks before the rice is harvested. It is difficult to ensure an optimum plant population in such a cropping system. However, this system permits timely sowing of chickpea. About 20% more seed is required for *paira* cropping than that for normal sowing. For a good *paira* crop, a starter dose of fertilizer should be applied after the rice crop has been harvested.

### Excessive vegetative growth

This is a problem of long growing season environments, as in northern and eastern India when soil moisture and temperature conditions remain favorable during chickpea's early reproductive growth stages. Excessive vegetative growth is not a problem in central and peninsular India.

Excessive vegetative growth changes the crop canopy, and thereby its microclimate. This can lead to outbreaks of foliar diseases and poor pod set, and also causes lodging. In areas where the problem is common, delaying sowing by 2 to 3 weeks prevents excessive vegetative growth and should result in better pod setting. Wider plant spacings can also alleviate the problem.

Germinated seed



If germination is 100%, less seed is required

If germination is less than 100%, more seed is required (see Table 2)

*Paira or utera* (relay cropping)

## Crop growth

After emergence, the growth of seedlings depends on many factors that cannot be controlled, e.g., sunlight and temperature. Depending on the type of soil, harrowing or mulching may be useful to loosen soil that has been compacted by heavy rain. Growing conditions vary in different parts of India. Among the abiotic stresses, drought is the major limiting factor for increased productivity.

### Drought

Drought occurs in most rainfed situations but is consistently a more severe constraint in peninsular and central India than in northern India.

Chickpea being a postrainy season crop, is subjected to terminal drought stress. Depending upon the total rainfall and its distribution, drought may occur at germination, and/or during the vegetative and reproductive stages of crop growth.

#### *Symptoms*

- Non-uniform and sub-optimal plant stands
- Stunted growth, reduced branching, and pale color of the lower leaves
- Early senescence

#### *Management*

- Use drought escape varieties
- Practice presowing management to conserve rainfall
- Control weeds to avoid loss of soil moisture

### Cold injury

In subtropical (latitude >25°N) India flowering may begin from December onwards, depending upon the time

Effects of drought in chickpea (Maharashtra)

Effects of drought in chickpea (Rajasthan)

Failure of pod set (in the middle plant) because of susceptibility to chilling cold

of sowing and the earliness of a variety. However, pod set may not occur because of the sensitivity of the conventional varieties to chilling temperatures (<8℃) that cause flowers to abort. Effective podding, generally begins with the rise in temperature in early February.

### Symptoms

- Flowers wither and become discolored
- Pod wall may develop but seeds do not set (empty discolored pods)
- Excessive vegetative growth over a longer duration with little podding

#### *Management*

- Use chilling-tolerant varieties.
- Use cultural practices to avoid coincidence of the flowering stage with the occurrence of low temperature, e.g., delayed sowing at high density, and application of fertilizers and irrigation

### Soil salinity

*Cause*

Saline soil.

#### *Symptoms*

- Growth is stunted.
- Leaf margins, particularly those of older leaves, turn yellowish brown.

#### *Control*

Land reclamation.
Judicious irrigation.

Salinity injury: stunted growth

Salinity injury: yellow-brown leaf margins

## Iron chlorosis

### *Cause*

Reduced uptake of iron, especially during early growth stages. This can result from, amongst other causes, waterlogging caused by unusually heavy winter rains.

### Symptoms

- Younger leaves turn bright yellow.
- Plants are somewhat stunted.
- If the deficiency is severe, leaves turn brown and even die.

### *Control*

Foliar application of 5 g ferrous sulphate in 1 L of water, together with 1 mL of liquid soap (e.g., Teepol$^{(R)}$) as a sticker. About 600-700 L solution is required for each hectare. If iron chlorosis is a recurring problem, use resistant varieties (seek advice from extension personnel).

Iron chlorosis: stunting

Severe symptoms of iron chlorosis

Iron chlorosis: bright-yellow coloration

## Excessive moisture

### *Symptoms*

- Yellowing of foliage because of reduced nutrient uptake and nitrogen fixation.
- Shedding of pinnules of lower leaves and reduced branching.

### *Control*

- Drain the excess water from the field as soon as possible.
- If vegetative growth is excessive, remove alternate rows of chickpea to increase aeration and expose the crop to the sun. This will prevent buildup of excessive humidity and other conditions conducive to disease development.

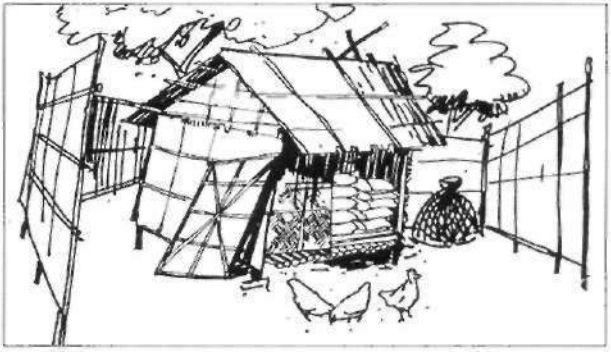
## Harvesting and threshing

The crop is judged to be physiologically mature when leaves and pods start yellowing. Harvest and thresh the crop as soon as it matures. At this stage the plants can be cut or pulled out and dried in the sun.

Thresh the plants when they are fully dried and the seeds separate easily from pods. Use a mechanical thresher or let a pair of bullocks tread on the dried plants. Take care to ensure that seeds are not split during mechanical threshing. Store the harvested seeds in bags to protect them from rain, wind, fire, or even theft.

Excessive vegetative growth

Mature crop, ready for harvest



Storing seeds in bags

# Biotic constraints from sowing to harvest

Biotic constraints caused by living organisms such as weeds, fungal or other pathogens, and insects, may occur at all stages of crop growth and result in crop losses. Effective control of these organisms can substantially increase crop productivity.

## Seedbed

Keep the seedbed free from weeds: chickpea seedlings are not very robust, and cannot compete effectively with weeds when they emerge 4-6 days after sowing.

- To control an early flush of weeds, use pre-sowing/ pre-emergence herbicides.
- Delay first irrigation.

## Sowing

If the seed is of good quality, and the conditions for germination are satisfactory, good emergence can be expected. However, it is advisable to treat seed with recommended protectants before sowing. When using such chemicals, always follow the instructions given by the manufacturer.

In regions where termite attacks can be a problem, insecticides should be applied before sowing (see page 52).

Rodents can dig out chickpea seeds or damage seedlings. If such damage is noticed, place poisoned baits in the field at the site of the damage.

A weed-free field

A field with many weeds

Treating seeds

## Crop growth

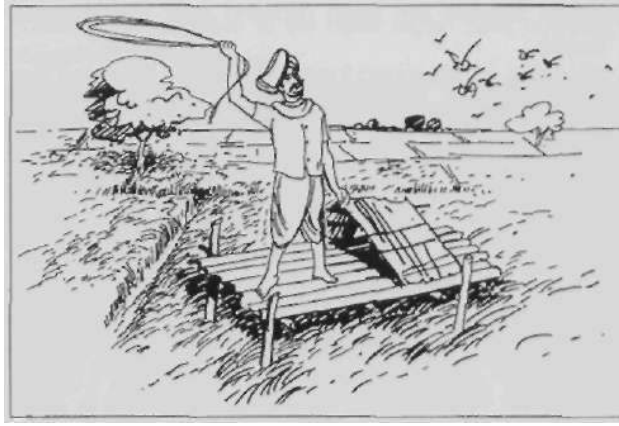
Occasionally, young plants are eaten by birds and rabbits; they should be driven away!

The crop should be protected from the many diseases and pests that can attack it throughout the cropping season.

## Diseases

In general foliar diseases are more prevalent than root diseases in northern, northwestern, and eastern India. In central and peninsular India, root diseases cause heavier losses than in other parts of India. Foliar diseases are of little significance in peninsular India, because the crop does not produce much biomass in the prevailing droughty conditions.

Seedling emergence



Scaring the birds away

## Collar rot

This disease is common in areas where soil moisture is high and temperatures are warm (30℃) at sowing time. The disease is favored by the presence of undecomposed organic matter near the soil surface.

### *Cause*

*Sclerotium rolfsii,* a fungus.

### *Symptoms*

- Seedlings turn yellow, and wilt.
- The collar region is constricted and begins to rot.
- White strands are seen growing over the affected tissue.
- Sclerotia, small round fungal structures that look like mustard seeds, are seen on the dead tissues.

### *Control*

Remove undecomposed debris from the field before sowing.

Collar rot: yellowed plants

Collar rot: constriction at the collar region (left); sclerotia in fungal strands (right)

## Fusarium wilt

A major disease that is prevalent throughout the country. Losses can be substantial if the pathogen is present in the soil or is carried by seed.

### *Cause*

*Fusarium oxysporum* f. sp *ciceri,* a fungus.

### *Symptoms*

- Seedlings collapse; internal tissue from the collar region downwards becomes dark and discolored.
- Adult plants wilt, with their petioles and rachises drooping.
- If the plant is cut across the collar region, the central tissue is seen to be discolored brown or black.

### *Control*

Use resistant varieties. Exclude chickpea from the crop rotations of infested fields for at least 3 years.

Seedling collapse caused by fusarium wilt

Plants with drooping petiole's

Central portion of stem affected by fusarium wilt

## Dry root rot

The most important root rot disease of chickpea, appears around flowering and podding time.

### *Cause*

*Rhizoctonia bataticola,* a fungus.

### *Symptoms*

- Whole plants dry up and turn straw-colored; such plants are scattered throughout the field.
- Roots become brittle and have only a few lateral roots or none at all.
- Minute sclerotia are seen on the exposed roots or inside the base of the stem.

### *Control*

Use resistant varieties and rotate crops.

Plants affected by dry root rot

Sclerotia on bark

Dry root rot: adult plant (left); roots (right)

## Black root rot

A minor disease that occurs in soils with a relatively high moisture content.

### *Cause*

*Fusarium solani,* a fungus.

### *Symptoms*

- Dark brown lesions are seen on stems above the collar region.
- Roots turn black and rot.

### *Control*

Improve drainage.

Black root rot: lesions above the collar region (left); symptoms on roots (right)

## Stunt

The most important viral disease, prevalent in most chickpea-growing states of the country.

### *Cause*

There are recent indications that more than one virus may be involved in causing stunt-like symptoms in different parts of India.

### *Symptoms*

- Plants are stunted, with short internodes.
- Leaflets are smaller, and turn yellow, orange, or brown. They are stiffer than those of healthy plants.
- Phloem tissue turns brown.

### *Control*

- Use resistant varieties.
- Control leaf hoppers and aphids.
- Sow late.

Stunted growth

Stunt: discolored leaflets (left); browning of phloem (right)

### Ascochyta blight

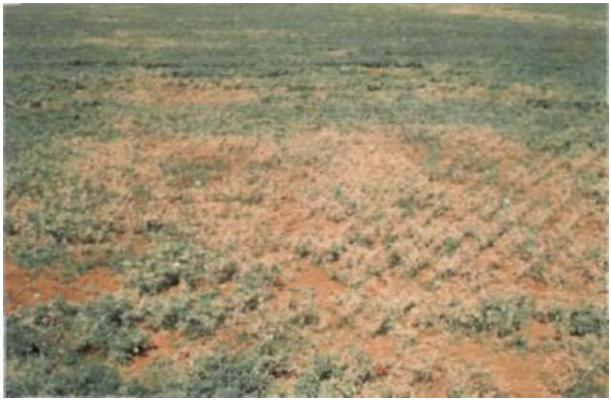
This potentially devastating disease is prevalent only in northwestern India. Dense crop canopies, high humidity, and cool temperatures favor disease development. However, such conditions occur only occasionally.

#### *Cause*

*Ascochyta rabiei,* a fungus

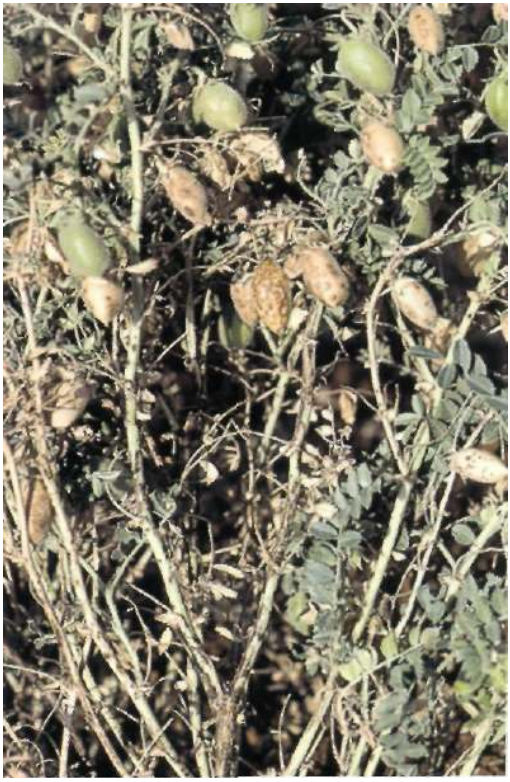
#### *Symptoms*

- The disease usually appears around flowering and podding time as patches of blighted plants in the field. It can also appear at an earlier stage of crop growth.
- Dark brown lesions develop at the base of the stem and the seedlings may collapse and die. Pycnidia may be formed on the lesions. However, isolated infected seedlings are difficult to notice.
- Pycnidia are observed on the blighted parts. Necrosis spreads killing the plant. In severe cases entire plants dry up suddenly.
- If conditions do not favor disease development the plants may survive, and the infection may be contained in the form of discrete lesions on the leaves, petioles, stems, and pods.
- On the leaves the lesions are round with brown margins and a gray center that contain pycnidia, often arranged in concentric circles.



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

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



- Lesions on the stems and petioles are obovate or elongate. The size of the lesions varies and 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.
- Fully developed lesions on pods are usually round and measure up to 0.5 cm in diameter, with concentric rings. Several lesions may appear on a single pod and if infection occurs in the early stages of pod development, the pods are blighted and fail to develop seed. Late infections result in shrivelled and infected seed.
- Symptoms on the seeds appear as a brown discoloration and often develop into deep, round, or irregular cankers.

***Control***

- Use resistant varieties
- Rotate crops
- Remove and destroy dead debris of infested plants, or bury it 10 cm deep
- Avoid using seed from infected crops
- Sow late to minimize excessive vegetative growth

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

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

## Botrytis gray mold

Occurrence of this disease is restricted to the sub-tropics, and is a most severe yield reducer in the *Terai* and northeastern regions of the country.

### *Cause*

*Botrytis cinerea,* a fungus.

### *Symptoms*

- The disease usually appears around flowering time, when the crop canopy is fully developed and weather conditions favor infection and disease development. Failure to set pods, and flower drop are the first indications of the disease. Leaves and stems may not show any symptoms. However, under high humidity, foliage shows clear symptoms in the form of gray or dark brown lesions. Plants often die in patches.
- Excessive vegetative growth is conducive to disease development.
- The disease is more severe on plant parts that are hidden under the canopy. Shed flowers and leaves, covered with spore masses, can be seen on the ground under the plants.
- Lesions on the stem can girdle the stem completely. Tender branches break off where gray mold has caused the tissues to rot. Lesions on the pod are irregular and water-soaked.
- If produced at all, pods are either empty or contain only shrivelled seeds. Grayish white mycelial strands can be seen on infected seeds.

### *Control*

- Adopt wider spacing in disease-prone areas, or thin out an infected crop to allow more light to penetrate the canopy.
- Intercrop with a crop such as linseed, which is resistant to the pathogen.

Plants affected by botrytis gray mold with no podding.

Flowers killed by botrytis gray mold.

- Prevent excessive vegetative growth.
- Sow late.
- Use varieties with an erect and open growth habit.

### Alternaria blight

Like botrytis gray mold altemaria blight is also prevalent in northern parts of India. However, the disease is only of minor importance.

#### *Cause*

*Altemaria alternata,* a fungus

#### *Symptoms*

- The disease appears at flowering and podding time when the crop has built up its maximum canopy.
- Lower leaves may shed and podding is sparse.
- Initially the lesions on the leaves are small, circular, and purple in color. They are surrounded by chlorotic tissues without definite margins. Lesions later turn brown to dark brown. Under high humidity they coalesce, cover the leaf area and cause rapid withering of individual leaflets.
- On the stems, the lesions are elongated and are brown to black in color.
- Infected flowers die.
- On the pods, the lesions are circular, and irregularly scattered. Affected pods turn dirty black. On mature pods, the lesions remain as localized, black superficial flecks.
- Seed is infected and shrivelled.

#### *Control*

- Use wide spacing.
- Prevent excessive vegetative growth of the crop.
- Rotate crops.

Lesions of alternaria blight on leaflets.

Flowers killed by alternaria blight.

## Stemphylium blight

This is a minor disease in the northern parts of the country. Excessive vegetative growth, high humidity, and temperatures around 15-20℃ favor disease development.

### *Cause*

*Stemphylium sarciniforme,* a fungus.

### *Symptoms*

- Lesions on leaves and pods are in the form of rough ovoid necrotic spots with a dark brown center and a broad gray border.
- The disease usually affects the crop from the flowering stage onwards. Defoliation, especially of the lower branches, is conspicuous.
- Excessive vegetative growth, high humidity, and cool weather favor disease development.

### *Control*

The disease can be controlled by adopting measures similar to those suggested for controlling botrytis gray mold.

## Sclerotinia stem rot

Sclerotinia stem rot is also a minor disease. However, in recent years increased incidence of the disease has been reported from northern India. Like other foliar diseases, this disease is also favored by excessive vegetative growth of the crop and high humidity.

### *Cause*

*Sclerotinia sclerotiorum,* a fungus

Stemphylium blight

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

***Symptoms***

- Usually appear when there is heavy canopy growth, high soil moisture, and cool weather.
- First signs are chlorotic or drying branches, or whole plants scattered in the field. Such drying plants or branches rot at the collar region 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.
- Webs of white mycelial strands appear at the collar regions and above and may cover the bases of the branches.
- 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 or inside the stem.

***Control***

- Prevent excessive vegetative growth of the crop.
- Use wider spacing.
- Rotate crops.

Lesions on the stem caused by sclerotinia stem rot.

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

## Root-knot nematodes

These nematodes can cause damage in lighter soils, and can become severe yield reducers in heavily infested soils.

### *Cause*

*Meloidogyne* spp (*M. incognita* and *M. javanica*), soil nematodes.

### *Symptoms*

- Crop growth is uneven.
- Infected plants are stunted and yellowish, and yield poorly.
- Knots (galls) appear on roots.

### *Control*

Rotate crops and use tolerant varieties if available.

Root knots

## Insects

### Pod Borer

This is a severe yield-reducer of increasing importance throughout India.

#### *Cause*

*Helicoverpa* spp (usually *H. armigera*)

#### *Symptoms*

- Eggs (1 mm diam) are found on the leaflets and stem. Larvae can be green, brown, yellow, or pink, but are usually striped, irrespective of their color. They achieve a length of 4 cm before moving to the soil surface to pupate. Moths fly at night and are mottled grey with a wing span of about 3.5 cm. Larvae feed on leaves during the vegetative stage and the flowers, and pods as soon as they have developed.

#### *Control*

The action threshold is 1-2 larvae per plant. Most insecticides are ineffective because of insecticide resistance. Carbamates, such as methomyl (lannate) are likely to be most effective as are commercial blends of an organophosphate and pyrethroid insecticide. Nuclear Polyhedrosis Virus (NPV) and neem, applied at label rates, have some beneficial effect. These insecticides are ineffective for the control of large larvae.

Predatory birds (cattle egrets, drongos, and mynahs) should be encouraged onto farms because they eat the larger larvae. Bird perches contribute to the attraction process. Early sowing, especially of a short-duration variety, results in the crop avoiding attack in northern India.

*Helicoverpa:* adult moth (left); eggs (right)

*Helicoverpa:* larva and pupa (inset)

## Cutworm

This insect may reduce plant stands in both the tropics and subtropics. Increased damage may occur if there are relatively high levels of moisture and organic matter in the soil at sowing time. Generally, it is a pest of minor importance.

### *Cause*

*Agrotis ipsilon*

### *Symptoms*

- Seedlings are cut through by larvae at or below ground level. In some areas, more than 30% of the plants can be affected.
- Gray-black larvae hide beneath the soil surface during the day, and become active at night.
- Moths are about 25 mm long and have brown forewings and pearly hind wings with brown margins.
- Cream-colored eggs are laid singly on the plants or on the surface of the soil.

### *Control*

If farmers feel the need to apply insecticide to kill cutworms, quinalphos as a spray or in a bran bait should have the desired effect.

Seedling damaged by cutworm

Cutworm moth

## Termites

Termites can cause minor damage. Damage is most likely to occur in light soils, for instance in Rajasthan, but can also appear on heavier soils for instance in Maharashtra.

### *Cause*

*Odontotermes* spp
*Microtermes* spp,

### *Symptoms*

Tunnelling in the roots and stem via entry holes in the root cause rapid plant death. Plants may also be sheeted with soil that covers the feeding galleries.

Farmers anticipating damage can treat the soil with chlorpyriphos or carbofuran granules at the time of sowing.

### *Control*

Damage is rarely serious enough to merit specific control measures.

Damage caused by *Microtermes* sp.

## Postharvest constraints

### Storage pests

Bruchids (*Callosobruchus* spp) are common in stored pulses. They can completely destroy the contents of an infested container. Seed should be clean and sun-dried before storage. It can be protected by mixing it with a dust (sand, wood ash, clay dust, etc.) or by coating the seed with vegetable oil, and/or by adding moth balls (naphtha) or neem leaves to the container, which should be sealed.

Seeds damaged by bruchids

**Copies of this booklet are available from**

The Distribution Officer
Information Management and Exchange Program
International Crops Research Institute
for the Semi-Arid Tropics
Patancheru 502 324, Andhra Pradesh
India

Indian Institute of Pulses Research
Kanpur 208 024
Uttar Pradesh
India

## About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is cosponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

## About ICAR

The Indian Council of Agricultural Research (ICAR) is a registered society and is the apex body responsible for promoting, conducting and coordinating research, education and primary extension education in the fields of agriculture, animal science, fisheries and allied sectors in the country. In order to perform these functions in an integrated manner, ICAR has created a National Grid of Cooperative Research in which ICAR institutes, state agricultural universities and other educational and scientific institutions participate in their programs as equal partners. ICAR is directly involved in research through its 49 central institutes that include 4 national bureaux, 30 national research centers, and 8 project directorates on fundamental and applied aspects of individual crops, commodities, and disciplines, that have direct relevance to agriculture, animal husbandry, fisheries, and allied sectors. ICAR also operates 70 all India coordiated research projects on important commodities and research areas that are multilocational and multidisciplinary in nature. Research on pulses including chickpea is carried out by the Indian Institue of Pulses Research (IIPR), Kanpur, and various State Agricultural Universities. The All India Coordinated Chickpea Improvement Project has its headquarters at IIPR.

**ICRISAT**

**International Crops Research Institute for the Semi-Arid Tropics**
**Patancheru 502 324, Andhra Pradesh, India**

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