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DISEASES OF PIGEONPEA AND CHICKPEA AND THEIR MANAGEMENT

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1. INTRODUCTION

Pigeonpea and chickpea are the major pulse crops grown in India, where pulse crops have always occupied a very important position in rainfed farming systems, to meet the dietary needs of the people, and in their capacity to restore soil fertility. Unfortunately, the growth rate in production, area, and the yield of pulse crops during the period 1949-50 to 1978-79 in India has been far less than 1% per annum. The production of pulses has varied between 10 and 13 million metric tonnes and the area between 22 and 24 million hectares (Swaminathan, 1980).

Diseases are the major factor affecting both production and yield stability of pigeonpea and chickpea in India. Frequent epiphytotic of ascochyta blight cause serious losses in chickpea production in northwest India. The recent (1980-82) epiphytotic of ascochyta blight and botrytis gray mold caused a loss of nearly one million tonnes of chickpea in northern India. Sterility mosaic of pigeonpea has become a serious problem especially in the States of Uttar Pradesh and Bihar (Kannaiyan *et al.*, 1984). Wilt and root rots continue to take heavy toll of both crops.

Because yields are unstable as a result of disease-increased losses, farmers are disinclined to invest in inputs such as fertilizers that would increase potential yields.

This paper summarizes important and potentially serious diseases of pigeonpea and chickpea in India their causal agents, symptoms, and control measures.

2. PIGEONPEA (*CALANUS CALAN*)

More than 50 pathogens including fungi, bacteria, viruses and mycoplasma are known to affect pigeonpea (Nene *et al.*, 1984).

Important diseases, their causal agents, and distribution are listed in Table 1. Table 2 gives a brief account of their control measures.

2.1 Sterility mosaic (SM)

SM is the most important pigeonpea disease in India causing an annual loss of 205,000 tonnes of grain, especially in Bihar, Gujarat, Karnataka, Tamil Nadu, and Uttar Pradesh (Kannaiyan *et al.*, 1984). The disease is presumed to be caused by a virus, whose exact identity is not yet known (Capoor, 1952).

Pigeonpea plants can be partially or wholly infected by SM. Symptoms of the SM infection are light and dark green mosaic patterns on the leaves, proliferation of the branches, and sterility. Some genotypes produce ring-spot lesions on leaves; these genotypes are not sterile and produce normal yields.

The disease is not seed borne, it is transmitted by an eriophyid mite *Aceria cajani* Channabasavanna and spreads rapidly in the direction of the wind for distances of 2 km from the source of inoculum (diseased plants carrying mites). Volunteer diseased pigeonpea plants that survive through the summer period serve as a good source of inoculum to spread the disease in subsequent crops. *Atylosia scarabaeoides*, a wild relative of pigeonpea, which is a common weed on field bunds may act as an alternate host for both the pathogen and its vector.

Though most of the insecticides used to control pigeonpea pests such as pod borer (*Heliothis armigera*) can also reduce the spread of SM by reducing mite population, the use of resistant varieties such as Bahar, HY 3C, and ICPL 151 is the most practical way of controlling the disease (Table 2).

2.2 Wilt

Wilt is the second important pigeonpea disease in India especially in Bihar, Maharashtra, and Uttar Pradesh, causing an annual loss of 97,000 tonnes (Kannaiyan *et al.*, 1984). It is caused by a soilborne fungus *Fusarium ulum* Bulter which kills plants by blocking xylem vessels and restricting the plants water supply. Seedlings are infected in the field, but the symptoms continue to appear throughout the crop growth period. Plants are most severely affected during the flowering and podding stages when their water requirement is maximal and the available moisture in the soil is low.

The early symptoms of wilt are yellowing of foliage followed by wilting of the plant. Wilted plants show partial or complete premature drying usually with the leaves retained on the dried plant. Dark brown bands on the main and lateral branches extend upwards from ground level and brown or black streaks under the bark and in the wood are also characteristic symptoms.

The fungus is seedborne but can survive up to 3 years in the diseased stubbles left in the field (Haware, M.P., unpublished).

Resistant or tolerant varieties such as NPWR 15, C 11, BDN 1, ICP 8863 (Maruti), and ICPL 87 (Pragati) (Table 2) can play an effective role in control of the disease. Crop rotation and mixed cropping can also help in controlling wilt.

2.3 Phytophthora blight

Phytophthora blight is the third most important pigeonpea disease in India. It is caused by a fungus *Phytophthora drechsleri* f. sp. *cajani* (Pal *et al.*) Kannaiyan *et al.* This disease mainly occurs when the crop is subjected to waterlogging. Sym-

ptoms appear as large, watersoaked, irregular lesions on the leaves which are often totally blighted. Brown, shrunken, and elongated lesions occur on stems girdling them and causing them to break. In the field, symptoms are usually seen on the main stem, just above ground level. Seedling infections kill the plants. Phyto-pathology studies indicate that there are physiologic races in the blight fungus which survives in the soil on the diseased plant debris during the off-season. The pigeonpea varieties GAU 82-53 and GAU 82-55 are reported to be tolerant, but the best way to avoid this disease is not to sow pigeonpea in fields that are prone to waterlogging (Table 2).

2.4 Other potentially serious diseases

Diseases such as powdery mildew (*Erysiphe taurina*), alternaria blight (*Alternaria tenuisema*), bacterial stem canker and leaf spot (*Xanthomonas cajani*), and macrophomina stem canker and root rot (*Rhizoctonia bataticola*) have the potential to cause serious losses in pigeonpea. These diseases are minor at present, and have not as yet been studied in detail. While breeding for resistance to the major diseases such as wilt, SM, and phytophthora blight, care should be taken to avoid susceptibility to these diseases.

2.5 Progress in breeding for disease resistance

Breeding pigeonpea varieties resistant to the major diseases in India got momentum with the starting of work at ICRISAT. Earlier some varieties such as C 11, BDN 1 (medium maturity), NPWR 15 (late maturity) tolerant to wilt were developed.

Intensive resistance breeding work at ICRISAT resulted in the development of an early-maturing wilt-tolerant cultivar ICPL 87 (Pragati) and a medium maturing wilt resistant cultivar ICP 8863 (Maruti). Work on the development of wilt-resistant varieties in the extra-early and late-maturity groups is in progress. Good work on screening for wilt resistance is going on at Gulbarga, Badnapur, Rahuri, and Parbhani.

Although some early work on SM was carried out at Delhi, Coimbatore, and Pantnagar, systematic resistance breeding was initiated at ICRISAT in 1975. This has resulted in the identification of several immune sources of resistance and the development of an early-maturing resistant cultivar ICPL 151. Work on the development of resistant cultivars in the medium and late-maturity groups is now in progress. Breeding for phytophthora blight resistance has not met with success because stable sources of resistance are not available. Good progress has been made in developing lines with combined resistance to wilt and sterility mosaic in the early-, medium-, and late-maturity groups at ICRISAT and Badnapur.

3. CHICKPEA (*CICER ARIETINUM*)

About 50 pathogens have been reported on chickpea from different parts of the world (Nene *et al.*, 1984). The important diseases in India (Nene, 1980) are listed in Table 3. The crop suffers from some serious diseases such as wilt (*Fusarium oxysporum*

f. sp. *ciceri*) and ascochyta blight (*Ascochyta rabiei*). In northern India chickpea is facing the twin problems of being pushed into marginal lands by high yielding varieties of wheat and the frequent epiphytotics of ascochyta blight and botrytis gray mold (*Botrytis cinerea*). Until these two diseases are checked the prospects for chickpea production in northern India look bleak.

3.1 Wilt

Wilt is prevalent throughout the chickpea-growing areas of India. Wilt is a vascular disease caused by the soil-borne fungus *Fusarium oxysporum* Schlecht. emend Synd. & Hans. f.sp. *ciceri* (Padwick) Synd. & Hans. estimated to cause about 10% loss in production.

Typical wilt symptoms are sudden drooping of leaves and petioles, discoloration of xylem and pith, and eventual plant death. The fungus is internally seedborne (Haware *et al.*, 1978) and can survive as chlamydospores and mycelium in dead plant debris in the soil for 6 years (Haware *et al.*, 1986).

Suggested control measures are: (1) growing resistant varieties such as Avrodhi, JG 315, ICCV 32, BG 244, (2) use of healthy seed and seed dressing with benomyl and thiram mixture (Haware *et al.*, 1978), and (3) crop rotation (Table 4).

3.2 Root and stem rots

Chickpea suffers from several root and stem rot diseases. The different root and stem rots, their causal organisms, and symptoms are given in Table 5. Edaphic and climatic requirements favourable for these root and stem rots are different. Though they are omnipresent, fortunately the losses caused by these problems are not large.

Dry root rot caused by *Rhizoctonia bataticola* (Taub.) Butler usually occurs late in the season when the crop is flowering or podding and when the soil moisture is low, and ambient temperature is high (30°C). It is the most important soilborne disease after wilt in India. It is relatively serious in central and southern India where the maturing crop usually suffers from drought stress and high temperatures. Early sowings, growing early-maturing varieties, irrigation, and disease-tolerant varieties can help in minimizing the diseases' effect.

Wet root rot caused by *Rhizoctonia solani* Kuhn usually appears at the seedling stage when soil moisture is high, but can infect an irrigated crop at any stage. This disease is more prevalent in situations where chickpea is sown after the rice harvest. Avoiding sowing chickpea under wet soil conditions can minimize the problem.

Black root rot (*F. solani* (Mart.) Sacc.) and foot rot (*Operculella padwickii* Kheswalla) are not serious or widespread. Crop rotation and tolerant cultivars a.g. ICCV 32 can be useful in minimising attack by these pathogens.

Collar rot caused by *Sclerotium rolfsii* Sacc. usually appears at the seedling stage when the soil moisture and temperature are high and an unimposed organic matter is present in the soil. Clean cultivation can help in avoiding losses from collar rot.

Stem rot, caused by *Sclerotinia sclerotiorum* (Lib.) de Bary, appears at the seedling stage causing collar rot of the plants when the soil moisture is high. Growing conditions vary with an open canopy, less dense vegetative growth (e.g. K 355), late sowings, and avoiding excessive irrigation can be useful in minimizing losses.

3.3 Ascochyta blight

Ascochyta blight (*Ascochyta rabiei* (Pass.) Labr.) does not appear regularly but is very serious whenever it occurs as it can cause severe and extensive losses. Ascochyta blight is a problem in the northern and north-western parts of India. The disease strikes when prolonged cool (20°C) and wet (winter rainfall > 150 mm) conditions prevail at flowering and podding stage of the crop in the months of February and March. Ascochyta blight affects all the above-ground parts of the plant. The symptoms include blighting of the buds, circular spots on the leaflets and pods with pycnidia usually seen in concentric rings; elongated lesions on stems and petioles, and cankerous lesions on the seeds. Under favourable conditions for infection, susceptible varieties may be totally blighted.

Initially the disease appears in the field in small patches arising from either seed-borne inoculum, or diseased debris left over from the previous season's crop. The disease spreads very rapidly over large areas when rain is accompanied by winds and cloudiness.

Suggested control measures are: (1) growing resistant tolerant varieties such as C 235, G 543, G 688, (2) seed-dressing with tridemorph and maneb mixture (Calxon M) or thiobendazole (Tecto 60), (3) foliar spraying with chlorothalonil (Bravo 500), (4) using healthy seed from disease free areas, and (5) destroying diseased plant debris from the previous season.

3.4 Botrytis gray mold

Botrytis gray mold (*Botrytis cinerea* Pers. ex Fr.) has recently gained importance. During the 1980-81 season it caused serious yield losses in parts of northern India. Not much work has been done on this seedborne disease which develops under similar conditions as that of ascochyta blight.

Symptoms of infection appear on stems, leaves, inflorescences, and pods as gray or dark brown lesions covered with moldy sporophores. Tender branches break off at the point where the pathogen causes rotting. Affected leaves and flowers turn into a rotting mass. On thick hard stems, the mycelium is gradually transformed into a dirty gray mass containing dark green to black sporodochia. Lesions on the pod are water-soaked and irregular with sometimes black sclerotial bodies scattered in the infected tissues.

Grayish white mycelium may be seen on immature seeds inside the pods. At times, either no seed or only small, shrivelled seeds are formed in affected pods.

Suggested control measures are (1) using healthy seed from disease-free areas (2) dressing seed with carbendazim + thiram (Bavistin 25% + TMTD 50%) and foliar sprays with vinclozolin (Ronilan) and carbendazim (Bavistin 50 wp) - thiram combination at 0.1% or Bavistin 50 wp alone at 0.2% (Table 4) (Grewal and Laha, 1983).

3.5 Alternaria blight

Alternaria blight (*Alternaria alternata* (Fr.) Klesler) is generally a problem in a crop with excessive vegetative growth and a closed canopy under wet soil conditions. Infection is generally severe on leaves where lesions that appear on leaflets initially are water-soaked, restricted in size, circular, and purple in color. 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 the individual leaflets. Under favourable weather conditions for infection the entire foliage is killed. Sporulation can be observed on necrotic tissues under the stereo-binocular microscope. On stems lesions are elongated, and brown to black, while on pods they are circular, slightly sunken, and scattered irregularly. Young pods become dirty black, and infected seeds shrivel. On mature pods, tiny, black superficial flecks remain localized. Control measures need to be worked out.

3.6 Rust

Rust (*Uromyces ciceris-arietini*) is not a serious disease in India - infection usually occurs late in the season when the crop is maturing, and thus does not cause much yield loss. Brown to dark brown, round to oval, powdery pustules appear on older leaves. These pustules may coalesce and form bigger pustules. They are more often noticed on the lower surface of leaves, may also appear on the upper surface. In severe cases, pustules can be seen on petioles and stems. The disease is favored by cool and humid weather. At present, in India rust is not serious warranting control measures.

3.7 Stunt

Stunt disease, caused by pea leaf-roll virus, is the most important virus disease prevalent throughout India. It is not seedborne, but is transmitted by aphids such as *Aphis carceivora* Koch and *Acyrtosiphon pisum* Harris. Symptoms include stunting of plants, yellowing in kabuli types or browning in desi types of the foliage, smaller and leathery leaflets, phloem browning, and premature plant death. Disease incidence depends on the virus-bearing aphid population, and is usually high in early and spaced-sown crops. Cultivars developed in northern India such as G 130, L 550, Pant G 114, K 850 are tolerant to the disease.

3.8 Progress in breeding for disease resistance

Breeding chickpea varieties resistant to wilt has made good progress. Effective screening work is going on at Badnapur, Jabalpur, Ludhiana, Kanpur, Hisar, and ICRISAT. Several wilt-resistant varieties have been developed (CP 51, Anniger, WR 315, Avrodhi, JG 74, ICC 32, etc.). But there is need to develop varieties with combine resistance to wilt and root rots especially dry root rot for southern India. Work on the development of lines with resistance to wilt and root rots is in progress at ICRISAT.

There is an urgent need to develop varieties with resistance to ascochyta and botrytis blight for northern India. Satisfactory sources of resistance to these diseases should be identified to intensify breeding activities. At present some ascochyta resistance breeding work is going on at Ludhiana and Hisar (HAU-ICRISAT Cooperative Program) but it needs to be strengthened. Varieties with combined resistance to ascochyta and botrytis blights and wilt are also needed.

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Table 1. Important and potentially serious diseases of pigeonpea and their distribution in India.

Disease	Causal agent	States and regions where the disease is prevalent
Wilt	<i>Fusarium udum</i> Butler	Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Uttar Pradesh, West Bengal.
Sterility mosaic	Virus?	Bihar, Gujarat, Karnataka, Rajasthan, Tamil Nadu, Uttar Pradesh.
Phytophthora blight	<i>Phytophthora drechleri</i> f. sp. <i>cajani</i> (Pal et al.) Kannaiyan et al.	Uttar Pradesh, West Bengal
Alternaria blight	<i>Alternaria tenuisima</i> (Kunze ex. Pers.) Wiltshire	Bihar
Powdery mildew	<i>Leveillula taurica</i> (Lev.) Arnaud	Southern and central India.
Bacterial stem canker and leaf spot	<i>Xanthomonas cajani</i> Kulkarni et al.	All over India but at present a minor problem
Macrophomina stem canker and root rot	<i>Rhizoctonia bataticola</i> (Taub.) Butler (<i>Macrophomina phaseolina</i>) (Maubl.) Ashby	Uttar Pradesh
Yellow mosaic	Virus	Bihar, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh

Table 2. Package of suggested control measures for important diseases of pigeonpea.

Disease	Control measures
Wilt	<ol style="list-style-type: none"> 1. Growing resistant/tolerant varieties such as NPWR 15, BDN 1, C 11, ICPL 87 (Pargati), ICP 8863 (Maruti) 2. Crop rotation with a 3-year gap between two pigeonpea crops. Growing pigeonpea in rotation with cereal crops such as sorghum, millet is a common practice and a 3-year rotation could be adopted by many farmers. 3. Mixed/intercropping with cereals such as sorghum, a common practice in many areas.
Sterility mosaic	<ol style="list-style-type: none"> 1. Growing resistant varieties such as Bahar, ICPL 151, HY 3C. 3. Breaking the pigeonpea crop cycle by crop rotation. 3. Destroying volunteer diseased plants during the off-season. 4. Spraying the crop with acaricide during its first 3 months.
Phytophthora blight	<ol style="list-style-type: none"> 1. Growing tolerant varieties such as GAU 82-53, GAU 82-55. 2. Avoiding sowing pigeonpea in fields prone to waterlogging. Farmers usually do not sow pigeonpea in low-lying fields, hence the losses due to phytophthora blight are not severe.

Table 3. Important diseases of chickpea and their distribution.

Disease	Causal agent	States and regions where the disease is prevalent
Wilt	<i>Fusarium oxysporum</i> Schlect. emend Syd & Hans. f.sp. <i>ciceri</i> (Padwick) Syd.	All over India
Dry root rot	<i>Rhizoctonia bataticola</i> (Taub.) Butler	Central and southern India
Wet root rot Black root rot Foot rot	<i>R. solani</i> Kuhn <i>F. solani</i> (Mart.) Sacc. <i>Ooperutella padwickii</i> Khetwalla	All Over India Northern India Punjab
Collar rot Stem rot	<i>Sclerotium rolfsii</i> Sacc. <i>Sclerotinia sclerotiorum</i> (Lib.) de Bary	All over India Northern India
Ascochyta blight	<i>Ascochyta rabiei</i> (Pass.) Labr.	Northern India especially in Punjab, Haryana, Uttar Pradesh, Himachal Pradesh.
Botrytis gray mold	<i>Botrytis cinerea</i> Pers. ex Fr.	Haryana, Uttar Pradesh, Rajasthan Bihar, and West Bengal.
Alternaria blight	<i>Alternaria alternata</i> (Fr.) KieSSLer	North-eastern India
Rust	<i>Uromyces ciceris arvensis</i> (Cronq.) Jacz and Beyer.	Northern India
Stunt	Bean leaf roll virus	All over India

Table 4. Package of suggested control measures for some important diseases of chickpea in India

Disease	Control measures
Wilt	<ol style="list-style-type: none"> 1. Growing resistant varieties such as Avrodhi, JG 315, ICC 32, BG 244. 2. Seed treatment with Benlate T (benomyl 30% + thiram 30%) at 0.15% and use of healthy seed 3. Crop rotations with 6-years gap between two chickpea crops. For many farmers with small holdings this may not be feasible.
Ascochyta blight	<ol style="list-style-type: none"> 1. Growing tolerant varieties such as C 235 G 543, G 688, GNG 146, Gaurav, GIG 588, BG 261. 2. Seed dressing with Calixin M or thiazendazole (3 g/kg) 3. Foliar spraying with Bravo 500 (chlorothalonil) (3 mL) in combination with tolerant varieties 4. Using healthy seed from disease free areas.
Root and stem rots	<ol style="list-style-type: none"> 5. Destroying diseased plant debris from the previous season. 1. Cultural practices such as adjusting sowing date, controlled irrigation, clean fields, and use of tolerant varieties. Except for sowing date which is determined by the cessation of monsoon rains in rainfed areas and not under the control of farmers, other practices can be adopted by the farmers
Botrytis gray mold	<ol style="list-style-type: none"> 1. Use of seed from disease-free areas. 2. Seed dressing with Bavistin 25% + TMTD 50 (2 g/kg) in case of seed harvested from diseased area. 3. Spraying with Ronilan and Bavistin-thiram combination (0.1%) or Bavistin 50 wp alone (0.2%)

Table 5. Common root and stem rots of chickpea and their symptoms.

Disease	Causal organism	Characteristic symptoms
Dry root rot	<i>Rhizoctonia bataticola</i> (Taub.) Butler	<ol style="list-style-type: none"> 1. Sudden drying of the plants with straw color foliage. 2. Rotting of the lateral and main roots and shredding and brittleness of the dead roots. 3. Development of sclerotia under the bark and inside the wood and pith of dead roots.
Wet root rot	<i>Rhizoctonia solani</i> Kuhn	<ol style="list-style-type: none"> 1. Yellowing of the foliage and gradual death of the plant. 2. Dark brown cankerous lesion at ground level with rotting extending above ground on the main stem.
Black root rot	<i>Fusarium solani</i> (Mart.) Sacc.	<ol style="list-style-type: none"> 1. Yellowing and gradual death of the plant. 2. Black lesions on the roots.
Foot rot	<i>Operculella padwickii</i> Khosawala	<ol style="list-style-type: none"> 1. Rotting of the collar region and root. 2. Internal discoloration above the rotten portion except the pith.
Collar rot	<i>Sclerotium rolfsii</i> Sacc.	<ol style="list-style-type: none"> 1. Yellowing and gradual death of the plant. 2. Rotting of the collar region with white mycelium and rapeseed-like sclerotia.
Stem rot	<i>Sclerotinia sclerotiorum</i> (Lib.) de Bary	<ol style="list-style-type: none"> 1. Yellowing and gradual death of whole plant or individual branches. 2. Stem rotting at the collar region or above-ground parts with web of whitish mycelium and large sclerotia.

INSECT PESTS OF MUNG, URID, COWPEA AND PEA AND THEIR MANAGEMENT

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1. INTRODUCTION

Pulse crops occupy premier place in the rainfed farming systems. The production of pulses in India has remained almost static around 12 million tonnes, during 1961 to 1981. The per capita daily availability has declined from 70 g in 1950-51 to 42 g / in 1980-81, while 80 to 100 g / is the minimum requirement for balanced nutrition.

It is seen that nearly 35 per cent of total pulse acreage and about 27 per cent of total pulse production in India is by mungbean (mung), uridbean (urid), cowpea and pea. Among these four crops mung and urid occupy important position.

Among the constraints responsible for the miserably low yields of these pulses, the incidence of a wide array of insect pests, from seedling to maturity is considered to be important. According to recent reviews on insect pests of these crops, (Lal *et al.*, 1981; Lal, 1985), 64 species of insects are known to attack mung, urid and cowpea (Table 1). Singh (1983) reported that over 55 species of insects and mites infest field pea in India (Table 2). However, only a few species are considered of to be major importance which cause economic damage to the crop. This paper covers the details of major pests as below:

2. INSECT PESTS

2.1 Mung, urid and cowpea

Most of the insect pests infesting mung, urid and cowpea are common and therefore, are dealt together. The following are considered to be the major insect pest species:

1. Whitefly, *Bemisia tabaci* Genn.
2. Leaf hopper, *Empoasca kerri* Pruthi
3. Black aphid, *Aphis craccivora* Koch
4. Bihar hairy caterpillar, *Diacrisia obliqua* (Wik.)
5. Galerucid beetle, *Mahurasia obscurella* Jacoby
6. Lycaenid borer, *Euchrysops cneplus* Fabr.
7. Spotted caterpillar, *Maruca testulalis* Geyer.
8. Stemfly, *Ophiomyia centrosematis* de Meijere (= *O. phaseoli* Tryon)