COWPEA PESTS AND DISEASES

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Introduction

This booklet is intended as a guide to the field recognition of cowpea pests and diseases for use both by agricultural research and extension staff and cowpea producers. Certain pests and pathogens are not reliably identified in the field and, in such cases, laboratory diagnostic features are included. In other cases, specialist identification may be necessary; therefore, notes on the collection and preparation of plant disease and insect specimens are included in Appendix 1.

The pests and diseases described are those which we feel are of greatest economic importance throughout the world; but the emphasis has been on tropical African conditions under which the bulk of the crop is grown. We have included non-parasitic diseases so that they may be distinguished from parasitic attack. Virus symptoms in cowpea are generally not diagnostic, and specialist identification is essential; only four of the numerous cowpea viruses are illustrated, the other important viruses are summarized in Appendix 2.

In view of the rate at which pesticide recommendations become obsolete, insecticides have not been emphasized; currently effective chemicals are given in Appendix 3. Sources of resistance to pests and diseases in cowpea are given in Appendix 4.

We have included references that extend the use of the booklet to research workers who may require greater detail.

COWPEA PESTS AND DISEASES

by
S.R. SINGH
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LEAFHOPPERS

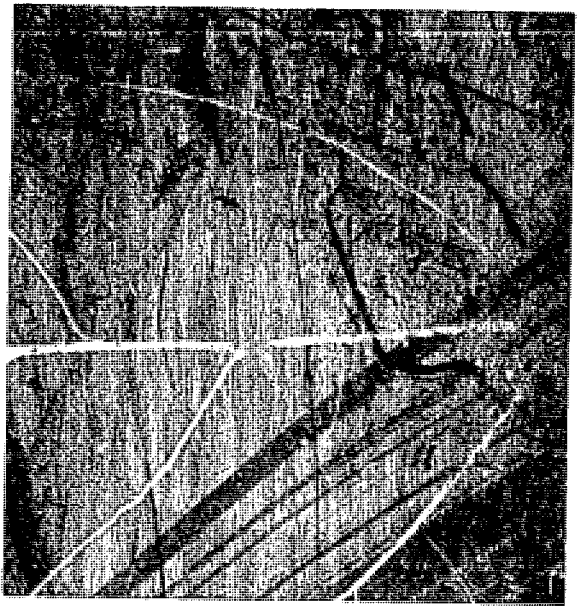
Empoasca spp.

Distribution and Importance: Widely distributed in the tropics and subtropics. Important species include *E. kerri* in Asia, *E. dolichi* in Africa, and *E. kraemeri* in Central and South America.

Biology and Damage: The biology of the several species of *Empoasca*, which closely resemble each other in appearance is generally similar (Plate 1). Eggs, which are laid on the underside of leaves, hatch into nymphs within 7-10 days. There are five stages (instars) in nymphal development which last about 10 days before the adult appears. The adults' life expectancy varies from 30 – 60 days.

Leafhoppers infest cowpeas at the seedling stage. The symptoms of damage are yellow discoloration of the leaf veins and margins, followed by cupping of the leaves (Plate 2). Severely infested plants become stunted, so leading to confusion with virus symptoms and may dry prematurely. Cowpea cultivars resistant to *Empoasca* have been identified (Appendix 4).

Reference: 42, 43, 44.



COWPEA APHID

Aphis craccivora

Distribution and Importance: *A.craccivora* is an important legume pest of Asia and recent observations suggest that aphids may also be seasonally important in parts of Africa. This species of aphid not only causes direct damage to its hosts (including groundnut as well as cowpea) but also transmits cowpea aphid-borne mosaic virus.

Biology and Damage: *A. craccivora* is a medium sized, shiny black aphid (Plate 3) whose biology varies depending on climate and soil. Under favorable conditions a generation may take only 13 days. Adults live from 6-15 days and may produce more than 100 progeny.

On cowpea aphids normally feed on the undersurface of young leaves, on young stem tissue and on pods of mature plants. When present in large numbers, they cause direct feeding damage. The plants become stunted, leading to leaf distortion, premature defoliation and death of seedlings. An indirect and generally more harmful effect, even of small populations, is the transmission of cowpea aphid-borne mosaic virus (page 40). Cowpea cultivars resistant to this pest have been identified (Plate 4, Appendix 4).

Reference: 43, 44.

SUSCEPTIBLE
RESISTA
SUSCEPTIBLE
RESISTA

FOLIAGE BEETLE

Ootheca mutabilis

Distribution and Importance: This beetle is widely distributed in Africa where it is an important foliage feeder on cowpea seedlings. In East Africa a related species, *O. bennigseni*, is also found.

Biology and Damage: Adults are about 6 mm long, oval, and normally shiny reddish brown (Plate 5), although this varies considerably and black or brown adults may occur. Yellow egg masses are laid in soil, and there are three larval instars. Adults feed interveinally on the leaves, later enlarging damage into feeding holes. High beetle populations can totally defoliate cowpea seedlings and kill them. The larvae feed on cowpea roots but seldom cause serious damage. Adult beetles are effective vectors of cowpea (yellow) mosaic virus. *Ceratoma* spp. in tropical America cause similar damage to cowpea and are vectors of cowpea (severe) mosaic virus (page 86).

References: 42, 44, 49.

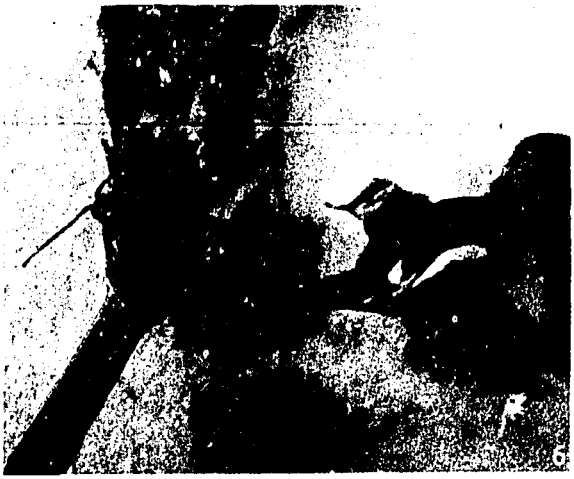
STRIPED FOLIAGE BEETLE

Medythia quaterna (= Luperodes lineata = Paraluperodus quaternus)

Distribution and Importance: *M. quaterna* is known from the forest zone of West and Central Africa where it is a sporadic pest. Its distribution is less wide than *Ootheca mutabilis.*

Biology and Damage: The adult, which is about 4 mm long and striped longitudinally with white and light brown markings, attacks young cowpea seedlings by feeding on newly emerged leaves, mostly at the margins (Plate 6). Eggs are laid in the soil, where the larvae and pupae develop. Other beetles, which are minor pests of cowpea include *Lagria villosa* and the related *Chrysolagria nairobana.* Cowpea seedlings can withstand a substantial amount of defoliation by these beetles without effect on subsequent seed yield.

References: 42, 44.



FLOWER THRIPS

Megalurothrips sjostedti (= Taeniothrips sjostedti)

Distribution and Importance: Flower thrips are among the most important pests of cowpea. In West Africa, they are frequently responsible for total crop loss.

Biology and Damage: Adult thrips, which are shiny black, minute insects, are found feeding in flower buds and flowers (Plate 7). Severely infested plants do not produce any flowers (Plate 8). When the thrips population is very high, open flowers are distorted and discolored. Flowers fall early with the result that pods are not formed.

The entire life cycle takes 14-18 days. Eggs are laid in the flower buds and nymphs feed and do extensive damage. Pupae are produced in the soil. There are at least two other species of thrips found on cowpea in Africa. One, *Sericothrips occipitalis,* is a minor foliage pest of cowpea seedlings mostly under drought stress conditions. Adults are a pale color with a black band around the abdomen. The other, *Frankliniella schultzei* is found associated with cowpea flowers. It is a brown insect with a slightly yellowish head. Cowpea cultivars moderately resistant to *M. sjostedti* have been identified. When combined with a few insecticide applications, effective protection is provided.

References: 42, 43, 44, 51

LEGUME POD BORER

Maruca testulalis

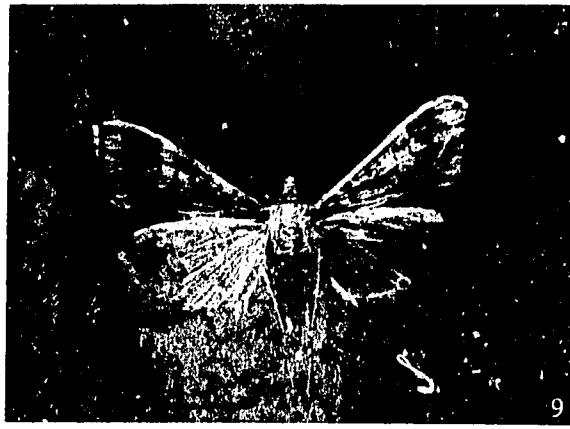
Distribution and Importance: *Maruca* is widely distributed throughout the tropics and sub-tropics where it may cause extreme damage. It is a major cowpea pest in Africa and Southeast Asia.

Biology and Damage: The adult is a nocturnal moth, light brown with whitish markings on its forewings (Plate 9). The larva is light brown with irregular brown-black dorsal, lateral and ventral spots and a black head (Plate 10).

Adult moths, which live for up to a week, lay eggs on leaf buds, flower buds and in flowers. Eggs hatch in about 5 days and the larvae feed on tender parts of the stem, peduncles, flower buds, flowers and pods (Plate 11). The characteristic signs of larval feeding are webbing of flowers, pods, and leaves and production of frass on pods (Plate 12). The spatial separation of pods is important; points of contact between pods, and between pods and leaves are especially prone to damage. About 150 eggs are laid per female. There are five larval instars which together last 8 to 11 days before pupae develop in the soil. The pupal stage lasts 5-7 days before adults hatch. Cowpea cultivars resistant to stem damage have been identified. Usually resistance is associated with long peduncles and widely separated pods that escape damage.

Some of the other lepidopterous pests found feeding on leaves, flowers, flower buds and green pods are *Spodoptera littoralis* and the lycaenid butterflies, *Euchrysops malathana* and *Virachola antalus*. *S. littoralis* adult moths are brown while the larvae are either green, dark grey or brown with pale longitudinal lines along the body. The larvae of the two lycaenids are dark green, flattened and sluglike in movement. Adult *E. malathana* is smalier, shiny and light brown; *V. antalus* is metallic purple.

References: 42, 43, 44, 50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12

COWPEA SEED MOTH

Cydia ptychora (= Laspeyresia ptychora)

Distribution and Importance: *C. ptychora* is a widely distributed and locally important pest of cowpea in tropical Africa. *Cydia* species also infest soybean and lima bean in Asia and Latin America as well as Africa.

Biology and Damage: The biology of the different *Cydia* spp. appears to be similar and they cause similar damage on different host plants. The adult moth of *C. ptychora* is tiny and dull brown or black (Plate 13). The females lay eggs mostly on the nearly mature peduncles or pods. The first instar larvae enter the pod and feed on the seeds remaining inside the pod. Early instar larvae are whitish, but later instars are pink to bright red (Plate 14). They pupate in the soil.

References: 42, 44

BLISTER BEETLES

Mylabris spp.

Distribution and Importance: A number of species of the genus *Mylabris* are found throughout Africa and Asia. *M. farquharsoni* and *M. bipartia* are common in Africa while *M. pustulata* is common in Asia. They feed on cowpea flowers leading to considerable crop damage. Large numbers of beetles in a field may result in total crop loss.

Biology and Damage: The blister beetles are elongated and narrow in shape. They are easily recognized by the bright-colored elytra with broad black yellow or red bands (Plate 15). The life history of these beetles is rather complex. They have hypermetamorphosis, with the different larval instars being quite different in form. The larvae are mostly beneficial and do not feed on plant material. The adult beetles are attracted to maize pollen. Cowpea fields near or intercropped with maize often suffer serious damage. It is difficult to control this pest with insecticide sprays as the beetles feed on flowers that only persist for a day.

References: 42, 44

POD SUCKING BUG

Anoplocnemis curvipes

Distribution and Importance: A major pest in tropical Africa; yield losses vary from 30 to 70 percent.

Biology and Damage: Full grown bugs are black and are about 3 cm long (Plate 16). Eggs are laid in chains and are grey to black. They hatch in about 7-11 days. There are five nymphal instars, and the early instars resemble ants. The total nymphal period varies from 29-54 days; the life of an adult from 24-84 days. Eggs are usually laid on leguminous trees or weeds, but seldom on cowpeas. Adults are strong fliers. They suck the sap from green pods, causing them to shrivel and dry prematurely with resulting loss of seed (Plate 17).

References: 42, 44, 49

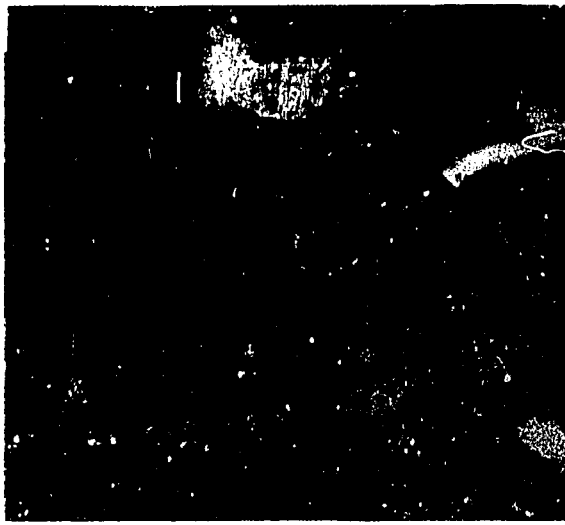
POD SUCKING BUG

Riptortus dentipes

Distribution and Importance: A serious pest in tropical Africa. Several coreids in the genus *Riptortus* (e.g. *R. fuscus, R. pedestris, R. linearis* and *R. pilosus)* are found in Asia as pests of cowpea.

Biology and Damage: The adult bug is cylindrical, light brown with characteristic white or yellow lines on the side of the body (Plate 18). Eggs are laid either in short rows or are scattered. They are mostly laid on leguminous trees and weeds but few are found on cowpeas. There are five nymphal instars. Adults are strong fliers and like *Anoplocnemis curvipes* (page 21) cause damage by sucking the sap from green pods.

References: 42, 44, 49



POD SUCKING BUG

Acanthomia spp.

Distribution and Importance: *Acanthomia tomentosicollis* and *A. horrida* are the two most common species in tropical Africa. Both do extensive damage and may cause yield losses up to 90 percent.

Biology and Damage: *A. tomentosicollis* is brown and *A. horrida* is grey (Plate 19). *A. horrida* is more cylindrical with longer spines on either side of the body. *A. tomentosicollis* has a more compact, "furry" body, with short spines on the abdomen. Eggs are laid on cowpea. Both adults and nymphs feed on pods by sucking the sap. They are not easily disturbed, and large numbers are found feeding together on a single pod. They cause similar damage to *Anoplocnemis curvipes* (page 21).

References: 42, 44, 49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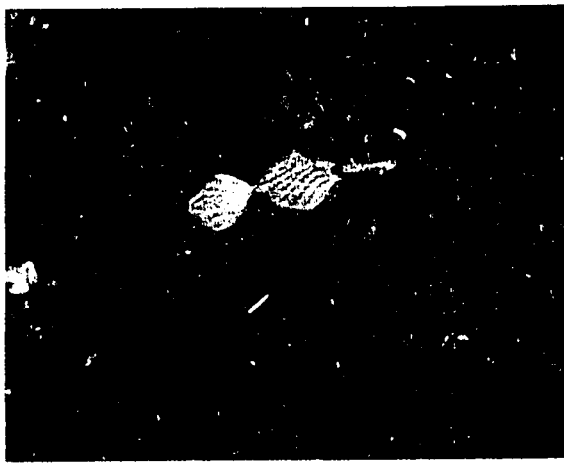
POD SUCKING BUG

Nezara viridula

Distribution and Importance: Commonly known as the green stink bug, it is widespread in the tropics and subtropics. It is primarily a pest of soybean, but also does extensive damage to cowpea crops.

Biology and Damage: Batches of 30 to 80 eggs are laid on the underside of the leaves. A single female may lay from 100 to 250 eggs in four to six batches. There are five nymphal instars. Nymphs are shiny with bright spots. Adults are green and triangular in shape (Plate 20). The entire life cycle may take 30 to 60 days. Both adults and nymphs suck the sap from the developing pods causing damage similar to that caused by *Anoplocnemis curvipes*.

References: 42, 44, 49



COWPEA STORAGE WEEVIL

Callosobruchus maculatus

Distribution and Importance: *C. maculatus* is a storage pest of worldwide importance. Severe infestations can lead to grain losses of up to 30 percent within six months of storage. *C. chinensis* is a minor cowpea storage pest.

Biology and Damage: The adult is a small square-shouldered beetle with dark markings on the wing cases (Plate 21). It is a field-to-storage pest. Adults live for 5 to 8 days. Eggs are laid on the seed surface. After hatching, the larvae enter the seed and complete their development within them. Adults emerge from the seed through characteristic holes made by the larvae. The holes make it easy to recognize infested seed (Plate 22). The entire life cycle takes about 35 days. A single cowpea cultivar with a moderate level of resistance in storage, and two cultivars with moderate levels of resistance to pod damage have recently been identified.

References: 5, 42, 43


2

ROOT KNOT NEMATODES

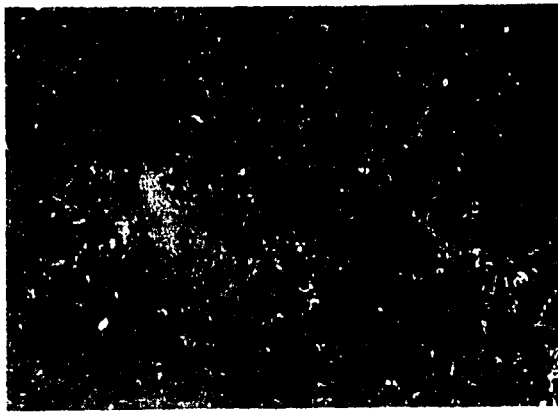
Causal agents: *Meloidogyne incognita, M. javanica and M. arenaria*

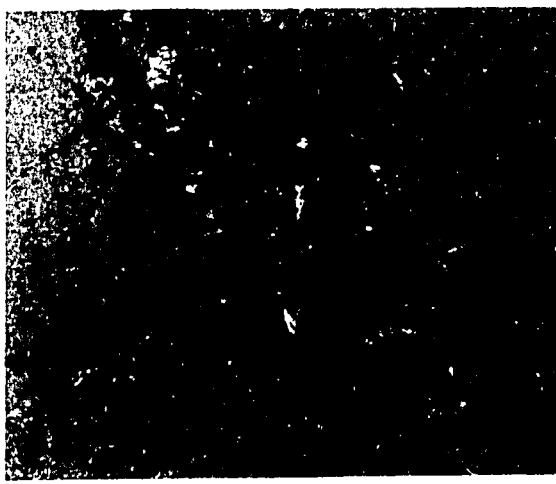
Distribution and Importance: All three species of nematode are widespread throughout the tropics. *M. incognita* can cause severe crop loss. *M. javanica* may make cowpea more susceptible to fusarium wilt (page 43).

Symptoms and Diagnosis: Affected plants die prematurely (Plate 23), as a result of extensive damage to the root system which may be heavily galled (Plate 24). Root knot galls are easily distinguished from the nodules containing *Rhizobium* which are usually small, spherical, and pink inside. Numerous species of non-gall-forming nematodes are parasitic on cowpeas throughout the subtropics and tropics.

Spread and Control: The nematodes survive in soil and on alternate hosts. Nematocides are available but uneconomic. Crop rotation may be effective but the host range may be wide. Sources of host plant resistance are available in cowpea but often are race specific.

References: 6, 18, 52, 53





SEEDLING MORTALITY

Causal agents: *Pythium aphanidermatum* and *Corticium solani* (= *Rhizoctonia solani* = *Thanatephorus cucumeris*)

Distribution and Importance: The causal fungi are ubiquitous. Seedling mortality has been investigated only in Nigeria but the disease probably occurs elsewhere. Seventy five percent mortality of cowpea seedlings has been obtained within 21 days after sowing. Disease incidence is highest during cool, wet, overcast weather.

Symptoms and Diagnosis: Both pre-and post-emergence mortality occur; in the latter case, symptoms can be observed on the hypocotyls (Plate 25). The reddish brown lesions caused by *C. solani* are usually limited to the collar region of the hypocotyl at which point the diseased seedling topples. *P. aphanidermatum*, however, moves rapidly up the hypocotyl giving it a grey-green, wet appearance and the seedlings undergo a watery collapse.

Spread and Control: These pathogens are abundant in the soils in the forest region of southern Nigeria where the humid environment is favorable for their activity. Seedling mortality is effectively controlled with chloroneb (= demosan) applied as a seed dressing (2g/kg of seed).

Reference: 62


25


26

ANTHRACNOSE

Causal agent: *Colletotrichum lindemuthianum*

Distribution and Importance: The pathogen is widely distributed, being present in almost all areas where beans *(Phaseolus vulgaris)* are grown. Isolates from cowpea have been obtained from Nigeria and other parts of Africa, India and Brazil. The disease is particularly severe in monocropped cowpeas in which it can cause up to 50 percent loss in yield.

Symptoms and Diagnosis: All aboveground parts can be affected but anthracnose is chiefly a stem disease in cowpea. Individual lesions are lenticular to sunken, and tan to brown in color. Lesion size and distribution depend on varietal susceptibility. Highly susceptible lines develop large spreading lesions which rapidly merge to girdle stems, branches, peduncles and petioles (Plate 26). Anthracnose can be distinguished from scab (page 80) by the presence of black setae, and from the related brown blotch fungi (page 78) by the shape of the conidia (Figure 1).

Spread and Control: Primary inoculum may come from seed (40 percent seed transmission) or from diseased plant debris. Secondary spread is rapid during cool, wet weather. The disease may be controlled by using clean seed, application of benomyl or mancozeb (0.2 percent a.i.) or by growing resistant varieties. Pathogenic variants occur.

References: 23, 29, 63

PYTHIUM STEM ROT

Causal agent: *Pythium aphanidermatum*

Distribution and Importance: Worldwide. In Nigeria, field incidence in cowpea normally ranges between 0.5 – 10.0 percent, although occasional incidences of up to 30 percent have been observed.

Symptoms and Diagnosis: *Pythium* stem rot is characterized by a grey-green water-soaked girdle of the stem extending from soil level up to and sometimes including the lower portions of the lower branches. During periods of high humidity copious growth of white, cottony mycelia occurs at the stem base (Plate 27). Infected plants quickly wilt and die.

The presence of oospores of the causal fungus in the stem cortical tissue distinguishes this disease from *Sclerotium* stem rot (page 40) and *Fusarium* collar rot (page 43) which superficially resemble it. Cowpea stem rot caused by *Phytophthora* spp., fungi closely related to *Pythium*, is of local importance in North America, Australia and India.

Spread and Control: Probably not seed-transmitted. Principally soil-borne. Bi-weekly applications of captafol effectively control the disease, but benomyl may increase its incidence.

References: 30, 58, 64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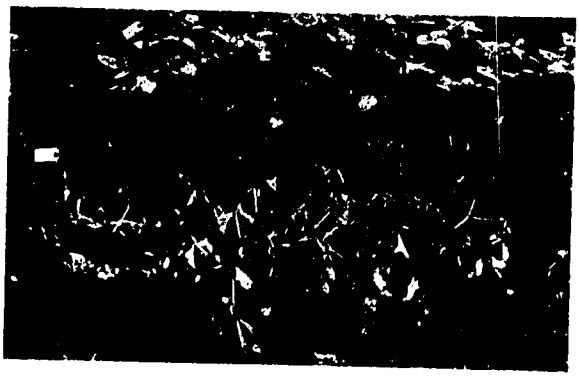


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SCLEROTIUM STEM ROT

Causal agent: *Corticium rolfsii = Sclerotium rolfsii)*

Distribution and Importance: The pathogen is widespread in moist tropics and warm temperate areas but the disease is of minor importance on cowpea.

Symptoms and Diagnosis: The causal fungus infects the bases of stems producing a fan of silky white mycelium and large round sclerotia (Plate 28) which are initially white and gradually darken. Infected plants wilt and die (Plate 29). The mycelium and presence of sclerotia serve to distinguish this disease from *Pythium* stem rot which it otherwise resembles. Occasionally, concentric leaf spots (Plate 30) are also induced by *C. rolfsii.*

Spread and Control: *C. rolfsii* is an unspecialised parasite capable of extensive saprophytic growth in surface layers of soil, persisting on crop residues and weed hosts. The sclerotia are disseminated by cultivation, wind and water, and occasionally as contaminants amongst seed. Control may be achieved by cultural means.

References: 25, 63

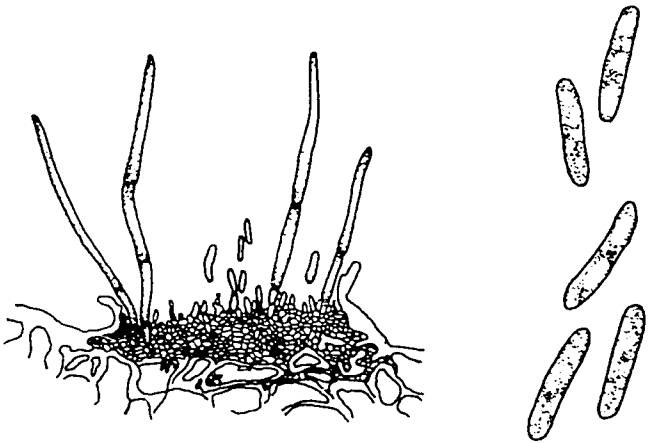

Fig. 1. *Colletotrichum lindemuthianum*, showing setae and oblong conidia.

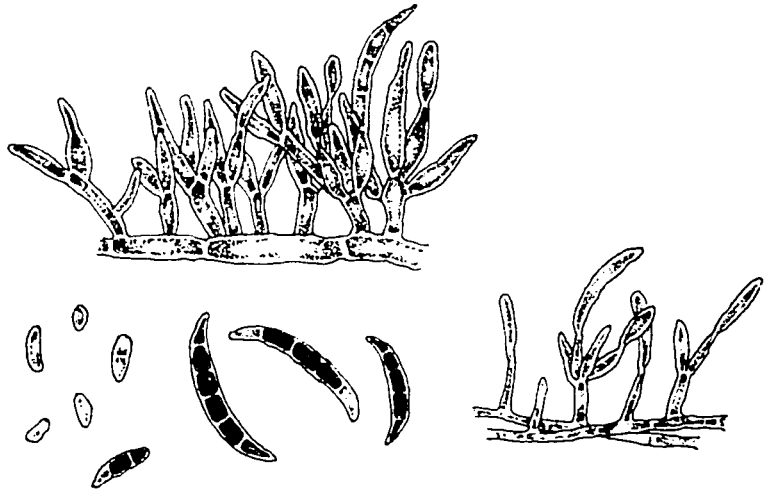

Fig. 2. *Fusarium oxysporum* showing septate conidia.

FUSARIUM WILT

Causal agent: *Fusarium oxysporum* f. sp. *tracheiphilum*

Distribution and Importance: Fairly widespread, being reported from North and South America, Asia and Australia. Reliably recorded in tropical Africa only from Nigeria and Uganda. Locally damaging. Hosts include cowpea and soybean.

Symptoms and Diagnosis: Leaves of infected plants are limp and yellowed and in young plants a rapid wilt leads to death. Older plants are stunted, leaves turn yellow and then fall and the plant gradually wilts. The vascular tissue is typically necrotic (Plate 31), and it is this symptom, and the presence of characteristic spores (Figure 2) which distinguish the disease from the stem rots. *Fusarium solani* causes a collar and root rot of cowpea in certain parts of tropical Africa and America while *Verticillium albo-atrum* causes a vascular wilt of cowpea in North America and Australia.

Spread and Control: The pathogen is soil-borne and probably also seed transmitted. Control is best achieved through growing resistant varieties. Three pathogenic races are recognized.

References: 14, 31


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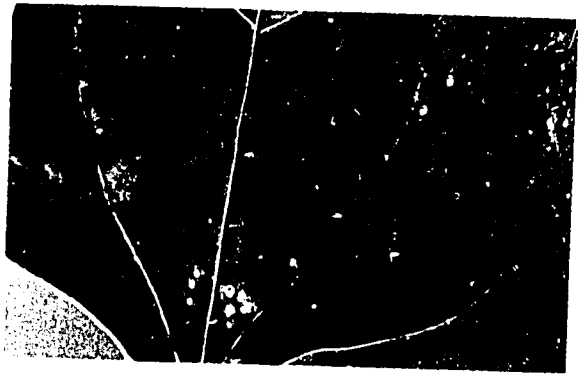


CERCOSPORA LEAF SPOT

Causal agents: *Cercospora canescens* and *C. cruenta*

Distribution and Importance: Both pathogens are widespread in warmer regions, occurring on various legumes. They can cause considerable leaf spotting of cowpea after flowering when defoliation can lead to yield losses of up to 20 percent *(C. canescens)* and over 40 percent *(C. cruenta)*. *C. cruenta* is the more important.

Symptoms and Diagnosis: *C. canescens* produces circular to irregular cherry-red to reddish brown lesions, up to 10 mm diameter (Plate 32). *C. cruenta* spots begin as a chlorosis (yellowing) on the leaf upper surface which becomes dotted with spots of dead tissue that enlarge until the whole lesion area is necrotic (Plate 33). On the lower leaf surface, *C. canescens* lesions are red (Plate 34) whereas the lower surfaces of leaves infected by *C. cruenta* have areas of profuse sporulation in which the masses of conidiophores (structures bearing spores) appear as downy grey-black mats. *C. canescens* lesions may be distinguished from those caused by *Septoria* (page 53) by microscopic examination of the leaf spots which bear characteristic conidiophores and conidia (Figure 3). Similarly, microscopic examination of *C. cruenta* leaf spot readily distinguishes it from

leaf smut (page 71), with which it may be confused in certain localities.

Spread and Control: Sources of primary infection are infected seed, alternate hosts and infected debris. Both fungi are controlled by use of clean seed, resistant varieties and application of benomyl sprays.

References: 11, 27, 39, 55, 57, 63

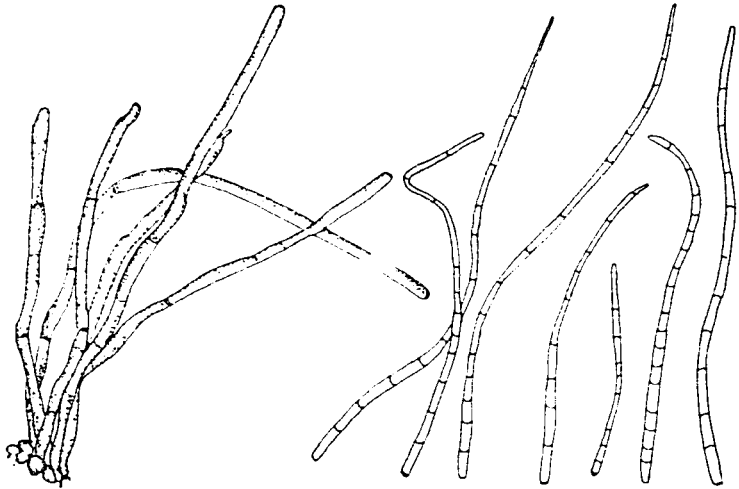


Fig. 3. *Cercospora canescens* showing dark conidiophores and filiform conidia.

TARGET SPOT

Causal agent: *Corynespora cassiicola*
(= Cercospora vignicola)

Distribution and Importance: Very widely distributed on numerous host plant species; especially abundant in the tropics. Of minor importance to cowpea on which it develops late.

Symptoms and Diagnosis: The lesions begin as dark reddish-brown circular spots, 1-2 mm diameter, which expand with narrow concentric banding to become large target spots, 15 mm diameter (Plate 35). Such leaf lesions are often associated with veinal necrosis. The fungus sometimes produces lesions on petioles and stems but these remain small (1-3 mm diameter) and do not show concentric banding. The early stages of target spot can be confused with *Cercospora canescens* infection, but the regular concentric banding of the lesions, and conidia and conidiophore characteristics (Figure 4) are diagnostic.

Spread and Control: The conidia are wind-dispersed. The fungus is seed-borne and survives on host debris for up to two years. Various fungicides effectively control the disease, and sources of resistance are known.

References: 8, 63

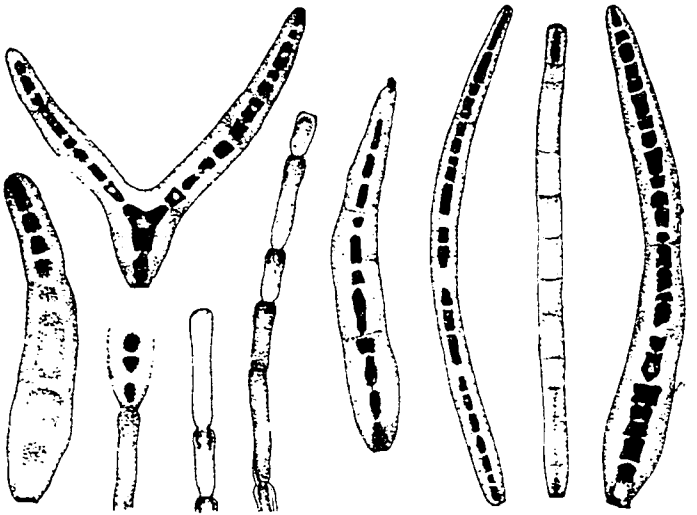


Fig 4. *Corynespora cassiicola* showing conidiophores and conidia

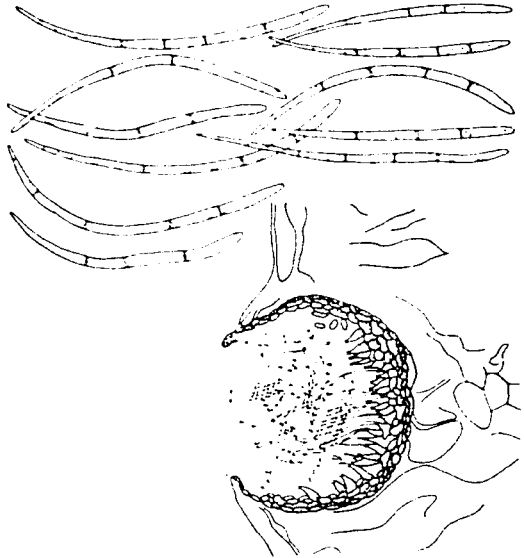


Fig. 5. *Septoria* sp. aff: *vignae* showing section of pycnidium and filiform conidia.

SEPTORIA LEAF SPOT

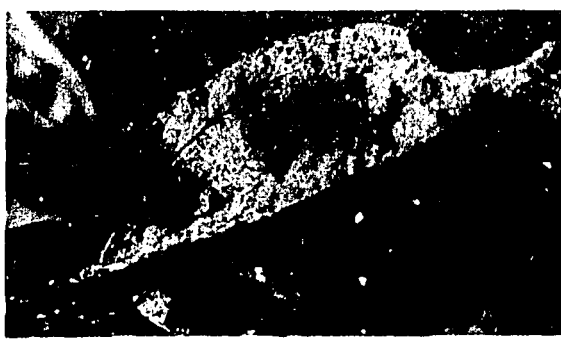
Causal agents: *Septoria vignae* and *S. vignicola*

Distribution and Importance: Though *S. vignicola* is recorded from eastern Africa and India it appears to be less widely distributed and less important than *S. vignae*, at least in the savannah zones of tropical Africa where *Septoria* leaf spot can be damaging.

Symptoms and Diagnosis: Lesions caused by *S. vignae* are dark red, circular to irregular, 2-4 mm diameter, appearing similar on both leaf surfaces (Plate 36). Spots are often concentric ringed, and sometimes raised, giving the leaf a freckled appearance. Black fruiting bodies (pycnidia) on the lesions contain septate (several celled), threadlike conidia (Figure 5). Species of the related *Chaetoseptoria* occur on cowpea leaves in North and Central America, while *Aristastoma* spp. in which the fruiting bodies bear bristles, cause pinkish grey, spreading, and freckled lesions on cowpea leaves in southern Nigeria (Plate 37).

Spread and Control: No information available. Likely to be seed-borne. There is evidence of varietal differences in susceptibility in northern Nigeria.

Reference: 63



DACTULIOPHORA LEAF SPOT

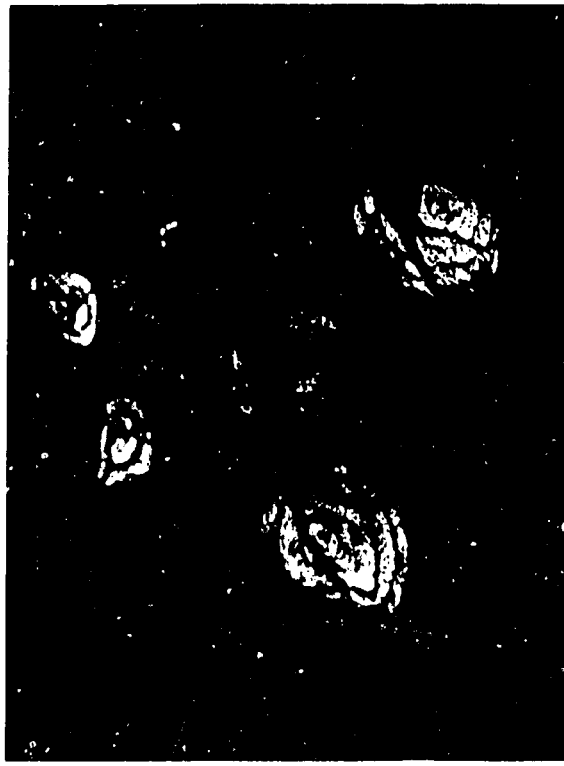
Causal agent: *Dactuliophora tarrii*

Distribution and Importance: A minor leaf spot, widely distributed in tropical Africa.

Symptoms and Diagnosis: Leaf lesions large (up to about 3 cm diameter), with concentric rings, and whitish on upper and often pinkish grey on lower leaf surfaces (Plate 38). Lesions bear sclerotia.

Spread and Control: No information.

Reference: 20



WEB BLIGHT

Causal agent: *Corticium solani (= Rhizoctonia solani = Thanatephorus cucumeris)*

Distribution and Importance: Worldwide; the pathogen is probably present in all arable soils. Web blight of cowpea is especially prevalent in the humid forest belt of West Africa where the disease can totally destroy the crop during periods of heavy rain.

Symptoms and Diagnosis: Initial symptoms on the leaves are small, circular reddish-brown spots which enlarge, becoming surrounded by irregular shaped water-soaked areas. Under humid conditions, the lesions develop rapidly and coalesce (Plate 39), and mycelium of *C. solani* can be clearly observed on the undersurface of leaves and on young stems. The initial discrete leaf lesions may be confused with those induced by *Cercospora canescens* (page 46), but the subsequent spreading lesions are characteristic of web blight.

Spread and Control: The pathogen survives as sclerotia in soil and on crop residues and weed hosts. Inoculum, which can be seed-borne, is primarily from soil splashed onto basal leaves during heavy rain. The use of clean seed and cultural methods (avoidance of dense plantings, and sowing timed to avoid

peak rainfall periods) offer the best means of control. Low levels of resistance occur but are insufficient alone to control the disease. Chemical control is feasible but uneconomic.

References: 24, 63

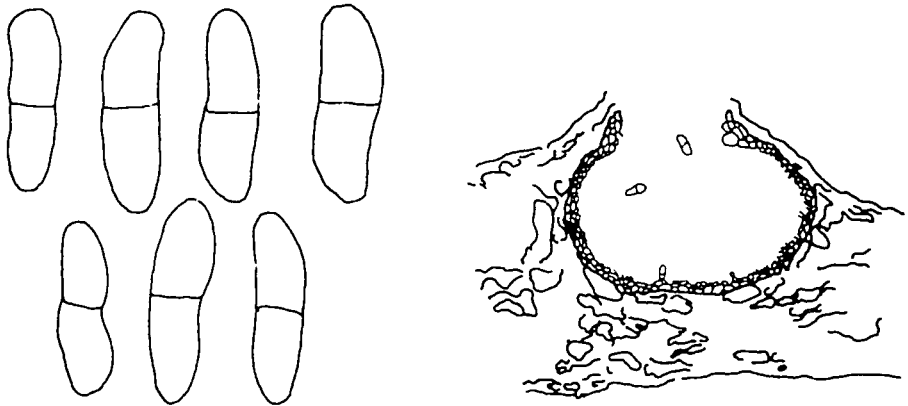


Fig. 6. *Ascochyta phaseolorum* showing section of pycnidium and 2-celled, ovoid conidia.

ASCOCHYTA BLIGHT

Causal agent: *Ascochyta phaseolorum*

Distribution and Importance: A major disease of cowpea (and many other legumes) under humid conditions at medium elevations in eastern Africa and in Central America. Often devastating, causing extensive defoliation.

Symptoms and Diagnosis: Young leaf spots are irregularly circular with grey to brown centers surrounded by a yellow halo. Such lesions become zonate and, under favorable conditions, spread rapidly causing extensive blighting of leaves, pods and stems. The large, concentrically ringed lesions are characteristic (Plate 40). Dark pycnidia are immersed in the host tissue; these contain 2-celled ovoid conidia (Figure 6).

Spread and Control: Seed-borne; and probably survives on infected plant debris. The disease spreads more rapidly in mono-culture than when inter-cropped with maize which may act as a barrier to spread. Though some cowpea varieties possess low levels of resistance, the use of clean seed and cultural practices such as rotation are recommended control measures.

References: 2, 22, 47

BROWN RUST

Causal agent: *Uromyces appendiculatus (= U. vignae = Aecidium caulicola)*

Distribution and Importance: Worldwide. Highly susceptible lines can be almost completely defoliated by mid-flowering time so that yield loss is probably severe.

Symptoms and Diagnosis: Pustules develop on both leaf surfaces, releasing powdery, reddish-brown uredospores (Plate 41). The pustules may be surrounded by yellow haloes, then by rings of secondary pustules. The color of the pustules becomes black as the pigmented teleutospores develop. The aecidial (fruiting) stage occasionally causes a basal stem rust disease.

Spread and Control: Rust is not seed-borne. The dispersal of rust is favored by cloudy, humid weather with heavy dew and temperatures of 21-27°C. Uredospores are disseminated principally by wind. Teleutospores may play a role in survival. Although some control of rust may be achieved by benomyl sprays, the use of resistant varieties is the best control measure, though the presence of numerous pathogenic races complicates resistance breeding.

Reference: 19

PINK RUST

Causal agent: *Phakopsora pachyrhizi*

Distribution and Importance: *P. pachyrhizi* is widely distributed in Africa and Asia and the Caribbean on soybean, cowpea and other legumes. Apparently of minor importance on cowpea, though early infection causes premature defoliation. The disease is more damaging during the rainy seasons in southern Nigeria.

Symptoms and Diagnosis: Lower leaf surfaces bear numerous pinkish tan colored, conical, protruding pustules which contain the colorless uredospores; angular lesions occur on upper leaf surfaces (Plate 42). Pink rust may be confused with bacterial pustule (page 84) in the field, and microscopic examination may be helpful. Pink rust lesions are neither greasy (like bacterial pustule) nor powdery (like brown rust).

Spread and Control: No information. Studies on *P. pachyrhizi* on soybean indicate that the pathogen survives on infected volunteer plants and on alternate hosts. *P. pachyrhizi* is probably not internally seed-borne. Various chemicals have been effectively used as sprays and seed treatments including benomyl, maneb, mancozeb and zineb. Varieties differ in susceptibility but *P. pachyrhizi* is pathogenically variable.

References: 16, 56


12


43

FALSE RUST (YELLOW BLISTER)

Causal agent: *Synchytrium dolichi*

Distribution and Importance: Widespread on cowpeas in tropical Africa and Asia. Of minor, local importance when it can be damaging (e.g. in Uganda). Usually develops late in the development of the crop.

Symptoms and Diagnosis: The first symptoms are pin-head yellow blisters, slightly greasy in appearance, which rapidly spread to cover leaves, petioles, peduncles, pods and stems. Later the blisters burst, releasing orange brown sporangia (Figure 7), ultimately leading to the development of raised warty orange brown scabs (Plate 43). The disease often causes considerable distortion of the plant.

Spread and Control: The pathogen is probably not seed transmitted. False rust may be controlled by destruction of crop residues, rotation and by mancozeb (= Dithane M45) sprays.

References: 26, 38

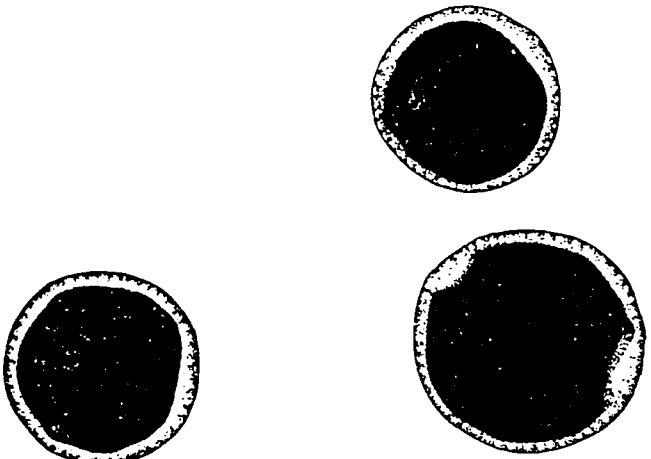


Fig. 7. *Synchytrium dolichi* showing thick-walled sporangia.

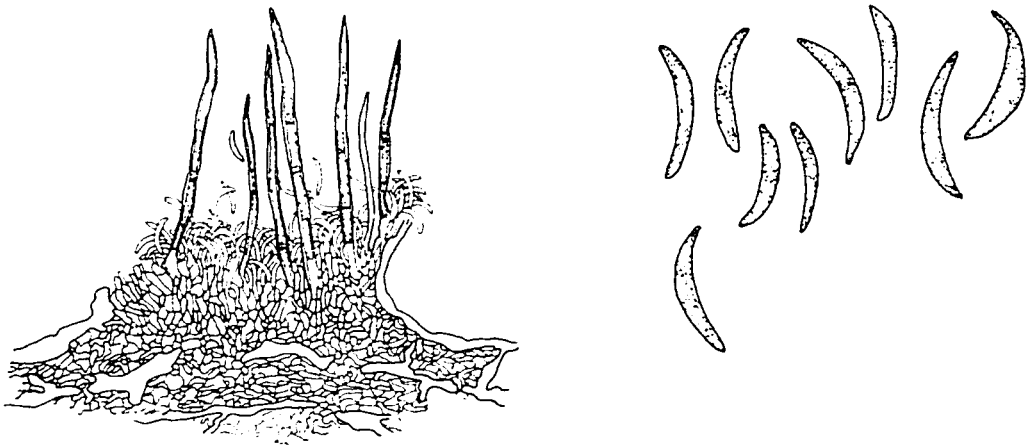


Fig. 8. *Colletotrichum truncatum* showing numerous setae and boat-shaped conidia.

BLACK SPOT (LEAF SMUT)

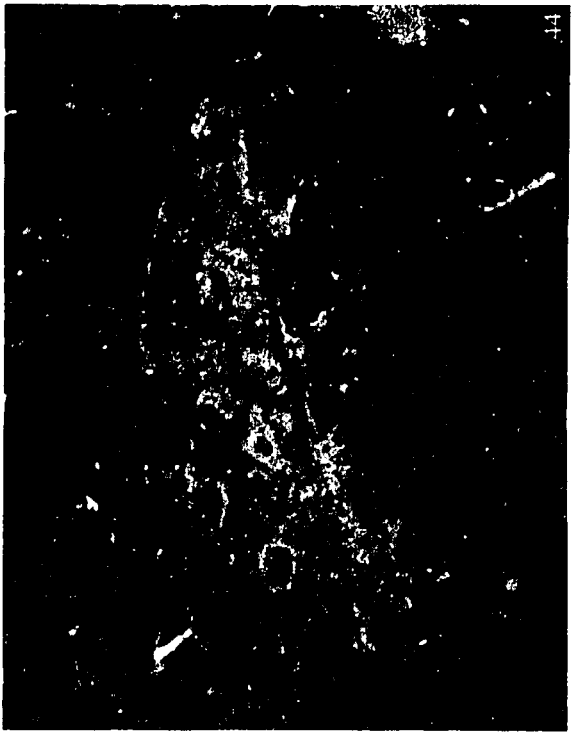
Causal agent: *Protomycopsis phaseoli*
(= Entyloma vignae)
The taxonomy of the causal fungus is controversial.

Distribution and Importance: *P. phaseoli* is widely distributed on cowpeas in tropical Africa and Jamaica, and on cowpeas, beans and other legumes in India and Nepal. The disease is of major economic importance on cowpea in Brazil where yield losses of 30-40 percent are reported.

Symptoms and Diagnosis: Dark ash-grey to sooty-black circular discrete leaf spots 6-8 mm diameter, surrounded by narrow yellow haloes (Plate 44). The leaf spots enlarge (to 10 mm or more), becoming greenish-grey, irregular and diffuse; severe infections cause premature defoliation. The presence of thick-walled, dark and warty chlamydospores in infected tissue is diagnostic.

Spread and Control: The chlamydospores survive in plant debris for at least two years but lose their viability when buried. The fungus is not seed-borne. Control measures would include rotation, destruction of crop residues, and the use of fungicides. Resistant varieties have been identified in Brazil.

References: 12, 13, 35, 37



POWDERY MILDEW

Causal agent: *Erysiphe polygoni (= Oidium* sp.)

Distribution and Importance: Worldwide; apparently of greater importance in tropical America and India than it is in Africa. Disease severity often greater under dry or shady conditions.

Symptoms and Diagnosis: Mycelium forms superficial, scattered, spreading patches, at first white turning greyish, on leaves and other plant parts (Plate 45). Unmistakable.

Spread and Control: Not known; not seed-borne. *E. polygoni* is known to be tolerant of low humidity. Survival possibly as mycelium, or as active infections on volunteer plants. Resistant varieties are available but races exist.

References: 45, 60


45

LAMB'S TAIL POD ROT

Causal agents: *Choanephora cucurbitarum* and *C. infundibulifera*

Distribution and Importance: Reported from Nigeria, India, U.S.A. and Brazil. Of occasional, local importance under humid conditions. Infection usually follows insect damage (e.g. cowpea curculio, *Maruca;* see page 13).

Symptoms and Diagnosis: Initial symptoms appear as water-soaked areas on pods, subsequently developing into a wet rot affecting both young and mature pods. Diseased pods bear luxuriant whitish growth of the causal fungus which produces black-headed pin-like sporing structures (Plate 46). The disease may affect also flowers and stems. *Botrytis* sp. causes a pod rot of irrigated cowpea in Brazil.

Spread and Control: Spread is favored by high humidity and pod borer damage. It is probable that timely planting and use of insecticides would control the disease.

References: 10, 36, 54, 66


46


47

COLLETOTRICHUM BROWN BLOTCH

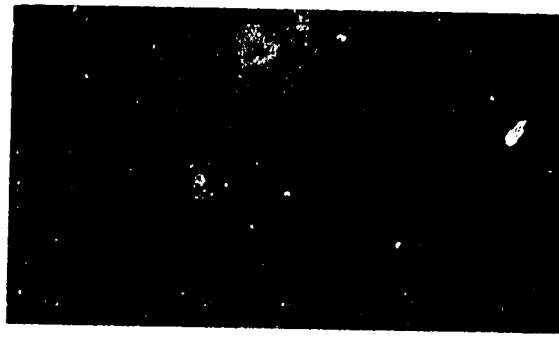
Causal agents: *Colletotrichum capsici* and *C. truncatum*

Distribution and Importance: The pathogens are widely distributed fungi in the tropics and sub-tropics. Brown blotch of cowpea is a newly recognized disease in Nigeria where it may cause singificant losses especially from pod infection. Brown blotch has also been observed in Upper Volta and Zambia.

Symptoms and Diagnosis: Purplish brown discoloration of petioles, leaf veins, stems, peduncles and, especially pods (Plate 47). Discoloration may be accompanied by cracking of stems. Pod infection leads to distortion and maldevelopment of pods which bear black fruiting bodies of the causal fungi. Symptoms first appear either at the stem base before flowering, or on pedicels (floral cushion) following flowering, the latter being characteristic. *C. lindemuthianum* (page 36) also occurs on cowpea pods but the brown blotch fungi differ in that their conidia are boat-shaped (Figure 8).

Spread and Control: The disease is seed-borne, and the pathogens probably also survive on infected plant debris. There is evidence that cowpea genotypes differ in susceptibility.

Reference: 9




49

SCAB

Causal agent: *Elsinoe phaseoli*

Distribution and Importance: Reported from East Africa and Central America; severe damage of cowpea in Surinam. A very similar disease, whose cause is presumed to be *Elsinoe*, causes extensive damage to cowpea crops in northern Nigeria. *E. phaseoli* also causes scab of lima bean and bean.

Symptoms and Diagnosis: Scab infections in Nigeria lead to development of silvery grey, circular to oval lesions on stems, petioles, peduncles and pods (the latter are especially damaging) (Plates 48, 49). In severe infections, such lesions coalesce, causing distortion. Leaves of diseased plants are often cupped and bear numerous small whitish scab lesions along the veins. The stem symptoms can be confused with anthracnose (page 36) but are greyish not tan-brown, and are more often circular. *Cladosporium vignae* also causes a scab of cowpea.

Spread and Control: The pathogen has been detected within the seed coat and on its surface; it survives on host debris and air dispersal is also suspected. Rotation, sanitation and seed treatment are control measures. Cowpea lines differ in scab susceptibility.

Reference: 46

BACTERIAL BLIGHT (CANKER)

Causal agent: *Xanthomonas vignicola*

Distribution and Importance: A widespread and important disease of cowpea in tropical Africa, America and India. Seedling mortality resulting from seed-borne infection may be up to 60 percent. Yield losses from field infection have not been estimated.

Symptoms and Diagnosis: The initial symptoms of bacterial blight are tiny water-soaked dots on leaves. These dots remain small and the surrounding tissue dies, developing a tan to orange coloration with a yellow halo (Plate 50). On heavily infected leaves the dead spots merge so that large areas of leaf are affected. The pathogen also infects the stem, causing cracking (stem canker), and causes water soaking of pods from where the pathogen enters the seed.

Spread and Control: The disease spreads rapidly during heavy rainfall, and during overhead irrigation. The pathogen is seed-borne, and probably survives on diseased crop residues. Methods of control include the use of clean seed and of resistant varieties.

References: 33, 40, 59, 63

BACTERIAL PUSTULE (BACTERIAL SPOT)

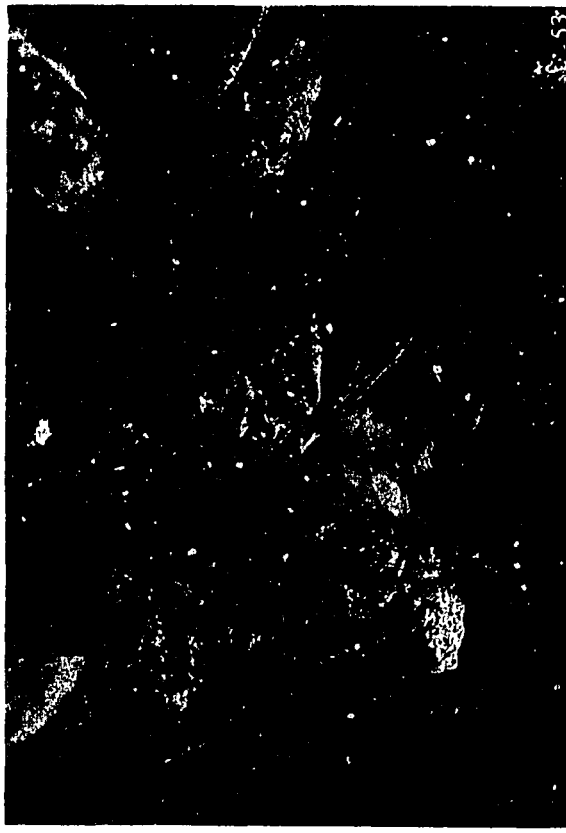
Causal agent: *Xanthomonas* sp.

Distribution and Importance: A widespread disease of both wild and cultivated cowpea in Nigeria. The disease occurs in Tanzania and apparently also in Brazil. Bacterial pustule appears to be less well adapted to the drier savannah regions of West Africa than is bacterial blight.

Symptoms and Diagnosis: The symptoms begin as tiny dark water-soaked dots on the undersurface of leaves. On susceptible varieties the dots enlarge to become circular spots (1-3 cm diameter) which, when young, appear as raised dark water-soaked pustules on the lower surface of the leaf (Plate 51) and as dark brown necrotic spots on the upper surface (Plate 52). Older, larger pustules become dry and sunken in the center, and water-soaked around the margin. Heavily infected leaves turn yellow and fall. Bacterial pustule is sometimes confused with pink rust (page 65) but careful examination (.eg. with a hand lens) reveals the conical, not greasy, pustules of the latter.

Spread and Control: The disease spreads rapidly during rainy weather and by overhead irrigation. The pathogen is seed-borne. Resistant varieties are available but there is evidence that some sources of resistance are race-specific.

References: 34, 63


53

VIRUS DISEASES

Causal agents: Numerous viruses cause mosaic diseases and mottle symptoms in cowpeas. Generally, the causal viruses cannot be identified from field symptoms; accurate diagnosis requires specialist knowledge and facilities (serology, electron microscopy). For this reason, and through confusion over virus names, records are often unreliable. Some of the more important cowpea viruses are described below; details of others are summarized in Appendix 2.

COWPEA (SEVERE) MOSAIC VIRUS (CSMV)

Distribution and Importance: Widespread in tropical and sub-tropical America. In Brazil, yield losses of 60-80 percent are caused by CSMV.

Symptoms: A range of mosaics (Plate 53).

Spread and Control: Sap, and seed-borne (10 percent) and transmitted by several beetles including *Ceratoma* spp.. *Phaseolus lathyroides* and other common weeds in tropical America may act as reservoirs of CSMV. Resistant cowpea varieties are available.

References: 1, 7, 21, 41

COWPEA (YELLOW) MOSAIC VIRUS (CYMV)

Distribution and Importance: Known from East (Kenya, Tanzania) and West (Nigeria, Togo) Africa; essentially an African virus though occasionally reported from America (Surinam, U.S.A.). CYMV causes yield losses of 80-100 percent; the earlier the infection the greater the yield loss.

Symptoms: Different virus isolates and different cowpea cultivars show different symptoms with systemic reactions ranging from none, or an inconspicuous green mottle, to severe mosaic, leaf distortion and blistering (Plate 54), and death of the plant.

Spread and Control: CYMV is readily sap transmitted and is seed-borne at a low level (1-5 percent); but little initial seed-borne infection rapidly spreads through entire crops through the activity of the chief vector, *Ootheca mutabilis* (page 7). Other beetles, grasshoppers and thrips are also reported to be vectors. Control is best achieved through growing resistant varieties.

References: 3, 61, 65

COWPEA APHID-BORNE MOSAIC VIRUS (CAMV)

Distribution and Importance: The most widespread cowpea virus. Reported from U.S.A., Europe, Africa, the south-west Pacific and Australia. Within Africa, CAMV is known from Kenya, Tanzania, Uganda, Zambia, Nigeria, Morocco, and Egypt. Yield losses of 13-87 percent are reported from Iran.

Symptoms: Various mosaics and mottling. Some strains of CAMV produce characteristic green-vein banding (Plate 55), but this is not sufficient for accurate diagnosis.

Spread and Control: Sap, seed (0-40 percent) and aphid-transmitted. Resistant varieties are available.

References: 4, 17, 18

57

COWPEA GOLDEN MOSAIC

Distribution and Importance: Nigeria; severe crop loss in susceptible cultivars. Similar diseases occur in Niger, Kenya, Tanzania and Pakistan, but their relationships are unknown.

Symptoms: In south eastern Nigeria, naturally infected plants are an intense yellow color, their leaves are distorted and blistered and plants are stunted (Plate 56). Less susceptible varieties exhibit varying degrees of chlorotic blotching and leaf distortion. Similar symptoms occur in Tanzania (Plate 57).

Spread and Control: Neither sap nor seed transmitted, but is spread by whiteflies (*Bemisia* sp.). Sources of resistance have been identified.

References: 15, 28

59

WITCHWEED

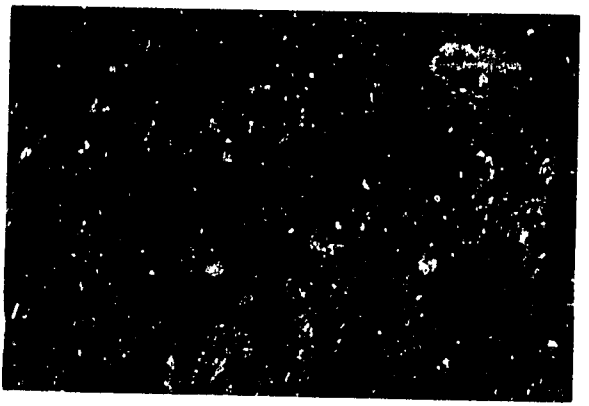
Striga gesnerioides

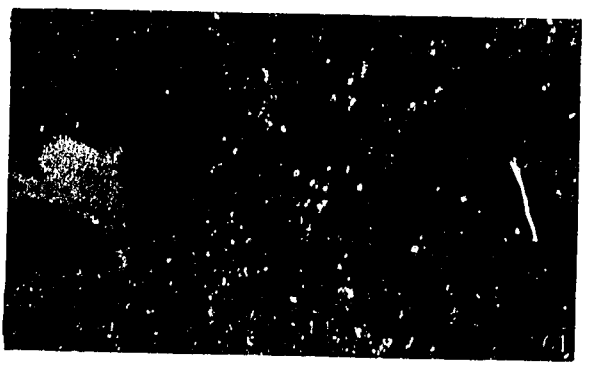
Distribution and Importance: Widespread and locally important throughout the Sudan Savannah zone of West Africa. Host range includes groundnut and tobacco (witchweeds of cereals belong to different species).

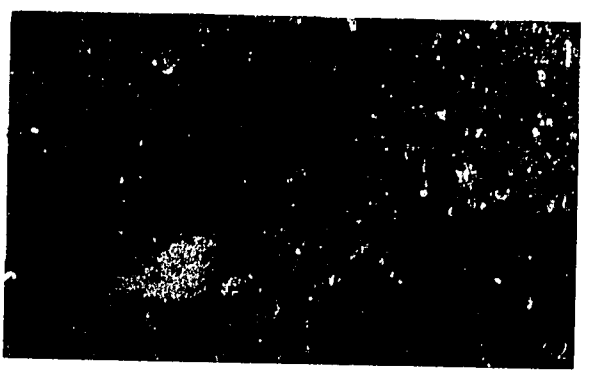
Symptoms and Diagnosis: This higher plant parasite (Scophulariaceae) has pink to mauve flowers (Plate 58). It causes yellowing between the veins of cowpea foliage, leading to premature wilting and collapse of plants, especially where soil moisture is limiting. Vascular tissues of affected plants are discolored (see *Fusarium* wilt, page 43). A related species, *Alectra vogelii*, with yellow flowers (Plate 59) also parasitises cowpea.

Spread and Control: Survives in soil and on alternate hosts. Cultural control involves crop rotation; trap crops are useful in the control of cereal witchweeds. Chemical fumigants are available but unlikely to be economic. The gall forming weevil, *Smicronyx* sp., may reduce *Striga* seed production thereby exerting a biological control in the absence of insecticide. Cowpea cultivars apparently differ in their susceptibility.

Reference: 32







CALCIUM DEFICIENCY

Occurrence: On acid soils (critical concentration = 2.5 mg/g D.M.)

Symptoms: Necrosis of leaf margins, crinkling of the youngest leaves (Plate 60), and petiole collapse.

MAGNESIUM DEFICIENCY

Occurrence: On acid soils, limed acid soils, and under high potassium fertilization (critical concentration = 1.0 mg/g D.M.)

Symptoms: Yellowing between veins of older leaves (Plate 61).
(c.f. chlorosis on *young* leaves caused by manganese deficiency, page 100).

SULPHUR DEFICIENCY

Occurrence: On savannah soils low in organic matter.

Symptoms: Young leaves become light green to purple in color (Plate 62).


64

PHOSPHORUS DEFICIENCY

Occurrence: On soils low in phosphorus, or high in phosphorus sorption (critical concentration = 2.0 mg/g O.M.). May be induced by aluminium toxicity.

Symptoms: Plants stunted, dark green (see under aluminium toxicity).

MOLYBDENUM DEFICIENCY

Occurrence: On acid soils

Symptoms: Youngest leaves light green, malformed ("Whip tail") (Plate 63).

IRON DEFICIENCY

Occurrence: On calcareous and alkaline soils, induced by excess manganese. (critical concentration = 70 ppm.).

Symptoms: Chlorosis of the youngest leaves (Plate 64).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-Mn

MANGANESE DEFICIENCY

Occurrence: On acid, sandy soils

Symptoms: Interveinal chlorosis of the younger leaves (Plates 65, 66). (c.f. chlorosis on older leaves caused by magnesium deficiency: page 96).

MANGANESE TOXICITY

Occurrence: On acid soils, soils acidified through bad management, use of acidifying fertilizers, such as ammonium sulphate, (critical concentration = 1500-2000 ppm).

Symptoms: Young foliage light green, becoming crinkled and necrotic; older leaves often bear brown spots (Plate 67).

ALUMINIUM TOXICITY

Occurrence: On strongly acid soils (pH 4.5 or less). Aluminium saturation 40 percent.

Symptoms: Plants dark green and stunted resembling phosphorus deficiency, showing interveinal chlorosis of older leaves (Plate 68). Root system compacted.

SUN SCORCH

Occurrence: On relatively fertile soils and especially leafy cultivars, when bright sunlight follows overcast conditions.

Symptoms: Purplish brown and sharply defined necrotic patches on lower surfaces of leaves which have become curled (Plate 69).

Appendices

Appendix 1.

Collection and Preparation of Plant Disease and Insect Specimens for Identification

Accurate identification is frequently impossible without good specimens for laboratory examination. Proper collection and preparation of specimens for dispatch to specialists is important; recommendations follow.

Collection and preparation of specimens affected by fungal and bacterial disease and pest damaged material.

Collect only the affected plant part. In the case of wilts and root rots, though the leaves show symptoms, the affected parts are the roots and lower stem and it is these that require examination. Collections should be generous; it is better to have too many specimens than too few. Collections should include a representative range of symptoms. The material should be pressed flat between sheets of newspaper and dried out (in the sun, or cool oven in humid climates), the paper being changed daily. *Do not use polythene bags unless the specimen will reach the laboratory within 24 hours.*

Collection and preparation of virus infected material

Collect specimens showing a range of symptoms from both young and mature tissue of several host plant varieties. Place each collection into a separate polythene bag and label it. To prepare for shipment, finely cut the leaves of each collection (isolate) and spread the pieces evenly over a nylon gauze covering a layer of anhydrous calcium chloride granules in a petri dish. Seal the dish with adhesive tape and keep

in a refrigerator at 5°C for at least a week (Bos*). The crisp leaf material may then be transferred to dry polythene bags for dispatch. If longer storage is required, the dried material may be placed in a test tube on a wad of cotton wool above $CaCl_2$. For periods of up to one week, virus diseased material can be kept fresh by wrapping in dry newspaper with silica gel, and enclosing the 'parcel' in a dry polythene bag.

Collection and preparation of insects.

All insects, except adult beetles, butterflies and moths which are dried, are best preserved in 70 percent alcohol in tubes. Insect collections should be made at dawn, dusk or mid-day, according to the species (leafhoppers, flies and foliage beetles -- early morning; parasites, predators and pollinators -- mid-day; pod- sucking bugs and adult lepidopterans -- at evening). Collection techniques include use of sweep nets, aspirators and light traps.

Dispatch of specimens.

Each specimen should be labelled, herbarium material packaged in envelopes, and accompanied by relevant information including name of host and variety, locality, date of collection and collector's name.

*Bos, L. $CaCl_2$ storage of virus-infected plant material. I.P.O., Wageningen (Mimeo).

Dead specimens (e.g. insects in alcohol) may be dispatched without restriction, but viable pathogens cannot be sent outside the country of collection without a special permit, for reasons of quarantine legislation. However, there are certain centers outside the tropics which operate an identification service (often for a fee); these include:

The Commonwealth Mycological Institute
Ferry Lane
Kew, Surrey
England (for fungi and bacteria)

The Commonwealth Institute of Entomology
British Museum (Natural History)
Cromwell Road
London, SW7
England (for insects)

The Commonwealth Bureau of Helminthology
103 St. Peter's Street
St. Albans, Hertfordshire
England (for nematodes)

No such service is currently available for viruses.

Appendix 2.

Other Cowpea Viruses

Name	Distribution	Importance (Crop loss, %)	Spread (Vector)	Spread (Seed trans., %)	Control
Cowpea mottle	Nigeria	50?	Beetle	3-10	Tolerant varieties
Southern bean mosaic	West Africa; America	?	Beetle	1-4	Resistant varieties
Cowpea chlorotic mottle	America	?	Beetle	0	?
Cucumber mosaic	Worldwide	?	Aphid	4-26	Resistant varieties
Cowpea ringspot	Iran	?	?	15-25	?
Cowpea banding mosaic	India	40	Aphid	15-31	Seed treatment?
Sun-hemp mosaic	Worldwide	56	?	4-20	?
Cowpea mild mottle	Africa	Negligible	?	90	?

* Singh, S.R. and Allen, D.J. Pests, diseases, resistance and protection in *Vigna unguiculata*. *Proc. Int'l. Legume Conf. Kew*, 1978 (in press)

Insecticides

Pest control in cowpea is best achieved through an integrated approach combining the use of insect resistant cultivars and appropriate cultural practices with minimum insecticide application. Currently effective pesticide chemicals, and the crop growth stage at which they should be applied, are as follows:

Foliage pests (including leafhoppers, aphids, foliage beetles and lepidopterans): Dimethoate, fenitrothion and endosulfan at preflowering stage.

Flower bud and flower pests (flower thrips, pod borers): Monocrotophos, methomyl, chlorpyrifos, surecide and synthetic pyrethroids at flowering.

Pod pests (pod borers, pod sucking bugs): Methomyl, surecide and synthetic pyrethroids applied post-flowering.

Storage pests *(Callosobruchus):* Phostoxin tablets, actellic and greundnut oil applied to seed post-harvest.

Dosages of insecticides are usually about 500g a.i./ha/application. Synthetic pyrethroids are applied at lower rates.

Sources of Host Plant Resistance*

Pest/Disease	Source
Leafhoppers	TVu's** 59, 123, 662, 1509; VITA-3 (foliage resistance).
Aphids	TVu's 310, 408-2, 410, 801, 2755, 3273; VITA-1 (foliage resistance).
Flower thrips	TVu's 1509, 2870, 6507, 7133 (flower bud resistance).
Maruca	TVu 946 and VITA-5 (stem and peduncle resistance).
Cowpea storage weevil	TVu 2027 (seed resistance) TVu's 625 and 4200 (pod resistance).
Anthracnose, rust, *cercospora* leaf spot, bacterial pustule + cowpea (yellow) mosaic	TVu's 310, 345, 347, 393, 410, 645, 697, 990, 1283, 1452, 1980, 2755, 3415, 3563; VITA's 1 and 3.
Cowpea (yellow) mosaic, cowpea mottle, cowpea aphid-borne mosaic, southern bean mosaic + cowpea golden mosaic	TVu's 493, 1185, 2755
Fusarium wilt	TVu's 109-2, 347, 984, 1000, 1016-1
Root knot	TVu's 264-2, 401, 857, 1560

*See reference number 16

**TVu (Tropical *Vigna unguiculata)* numbers, as used at IITA.

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