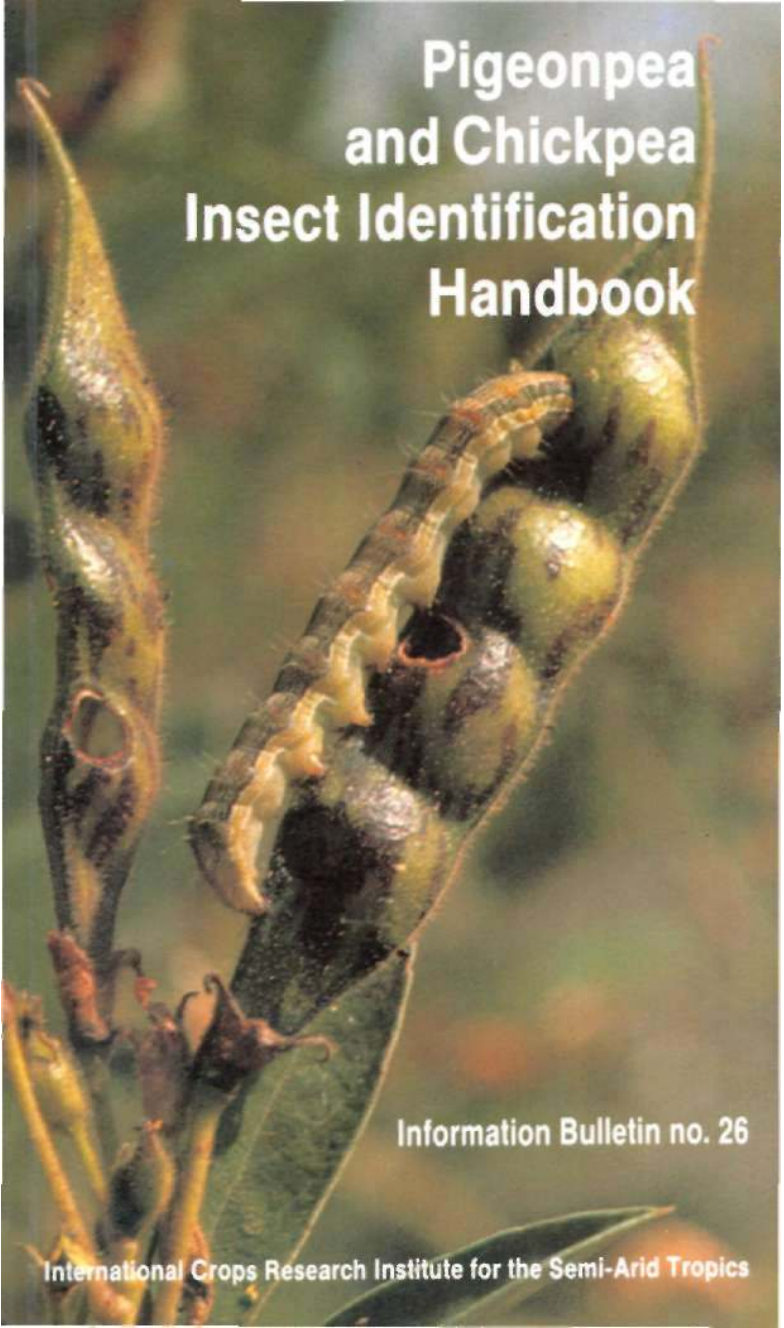
Pigeonpea and Chickpea Insect Identification Handbook



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Abstract

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Pigeonpea and chickpea are the two major pulse crops that are attacked by several insect pests at different stages of plant growth throughout the semi-arid tropics. Many of them cause severe yield losses in these crops. This bulletin provides a short description of these insects, their biology, distribution, and damage symptoms. It includes brief information on the options available to control these pests, as well as description and illustrations of several beneficial insects like parasites, predators, and pollinators. The text is supported by several color photographs to help identify the pests.

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Cover: *Helicoverpa armigera larva damaging pigeonpea pods.*

Pigeonpea and Chickpea Insect Identification Handbook

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ICRISAT

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Authors' Note

This handbook has been published to help agricultural scientists and students to identify the common insect and other animal pests of pigeonpea and chickpea. A number of insects found on these crops are not pests and many are even beneficial, because they feed upon the pest species. Illustrations of a few of these beneficial insects are given here, to emphasize that it is important to first determine the role of insects found on our crops rather than assuming that all insects are harmful and so must be eliminated! Brief descriptions of the distribution and biology of the pests are given, together with suggestions for control measures, where appropriate. Chemical control should only be used where essential and preferably with the advice of a plant protection specialist. It is not easy to identify insects, particularly from photographs. Our readers are therefore recommended to collect and preserve insects found on their crops, and to seek help from professional entomologists to identify them and to maintain specimen collections for future reference.

Acknowledgement

The authors gratefully acknowledge valuable assistance from several colleagues at ICRISAT and from the Commonwealth Institute of Entomology, UK.

Pigeonpea

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is an erect, woody, perennial shrub that is commonly grown as an annual. It is very important as a field crop in India, eastern Africa, and in the Caribbean region, but it is also grown as a backyard or hedge crop in most countries in the tropics and subtropics.

Its seed is harvested and eaten while green (mainly in Africa and the Caribbean) or when mature (mainly in India). The plants are also used for fodder, as fuel wood, for basket-making, and in construction. The crop is well known as a soil improver, for its roots penetrate deep, its nodules (containing rhizobia) fix nitrogen, and the shed leaves add a considerable quantity of organic matter to the soil.

Pigeonpea is most commonly grown as an intercrop, within a wide variety of short-duration companion crops (Fig. 1). Pigeonpea grows slowly during the early vegetative stage and does not compete with the companion crops but after these are harvested, the pigeonpea plants grow on to give a complete canopy. Long-duration plants can grow to a height of 3 m or more.

Pigeonpea is a host for many insects. Over 150 species have been reported to feed on it in India alone, and more will be found. However, most of these herbivorous insects are relatively rare or sporadic in their distribution and so are not regarded as pests. A small publication such as this cannot deal with all of them, so only the more important insects are illustrated.

Although many insects feed upon pigeonpea from the seedling stage, most of the economic damage is caused by pests that feed upon flowers and pods. Insects may cause considerable loss of leaves, but tests have shown that the plant can adequately compensate for defoliation during

Continued

Figure 1. A pigeonpea/sorghum intercrop.

Figure 2. It is difficult to spray tall crops.

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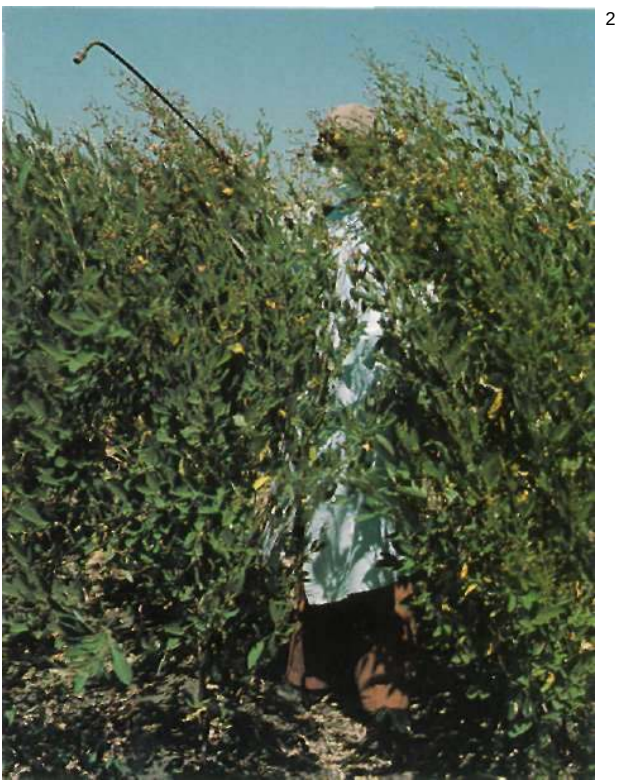

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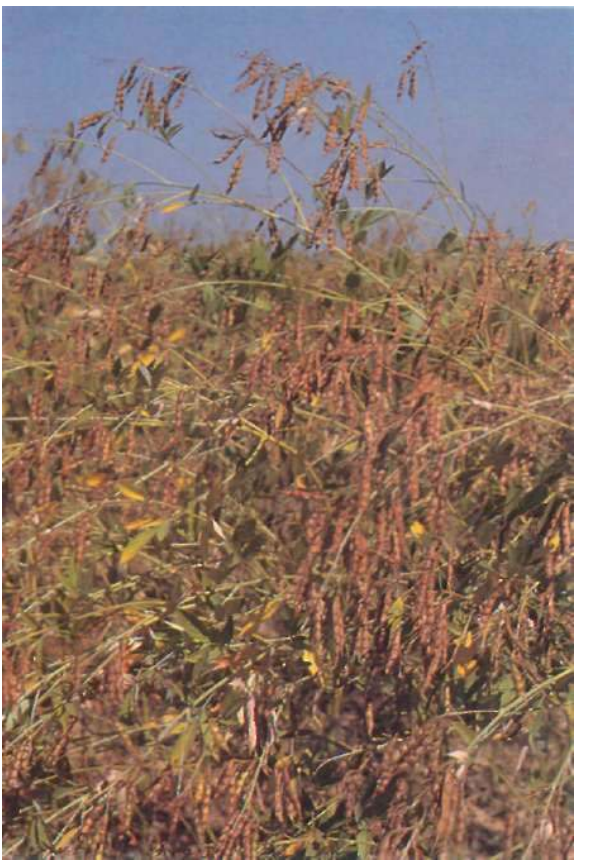

the vegetative stage, so that there is little reduction in seed yield. At the flowering stage, well-grown, medium- and long-duration pigeonpea is generally too tall and dense to be treated effectively by insecticides applied manually (Fig. 2). More attention is now being given to short-duration, sole crops of pigeonpea, which flower when about 1 m tall. Such crops can be conveniently treated with insecticides (Fig. 3). Short-duration, determinate genotypes with large, white seeds are particularly popular, but these are susceptible to insect damage and must be adequately protected. At ICRISAT, efforts have been made to identify sources of resistance to the major pests, particularly to *Helicoverpa armigera* and *Melanagromyza obtusa* and to incorporate these resistances into agronomically suitable cultivars. Most of these developed lines (Fig. 4) will produce greater yields in farmers' fields with no or minimal pesticide application.

Figure 3. Short-duration pigeonpea can be sprayed easily.

Figure 4. Pigeonpea genotype bred for pod borer resistance.

Pests Attacking Roots

Nodule-damaging Fly ***Rivellia angulata*** Hendel (Diptera: Platystomatidae)

Distribution. In India, this species has been reported to attack pigeonpea root nodules (Fig. 5), and there are similar reports from Africa. In the Americas, Africa, and Australasia, other species have been found to attack several legumes.

Symptoms. Damage occurs when larvae attack root nodules. The larvae penetrate the nodules, making them hollow, and feed upon the active, nitrogen-fixing portions (Fig. 6) Heavy attacks, usually in Vertisols, have resulted in the destruction of more than 90% of the nodules. The plants may show yellowing, indicating nitrogen deficiency and reduced growth.

Description and biology. The flies have black bands on their wings (Fig. 7), and lay their eggs on plants and in the soil. The larvae disperse to the root nodules where they feed and grow. The fully grown, cream-colored larva is 10 mm long. Pupation occurs in the soil. One generation can be completed in about 4 weeks.

Control. No control measures can be recommended. Application of large doses of insecticides to the soil has not been successful and is also not economic. Adding nitrogen fertilizer to the soil might alleviate the nutrient deficiency caused by nodule damage.

Figure 5. Nodules containing rhizobia fix nitrogen for the plant.

Figure 6. Nodule damaged by Rivellia angulata *larva.*

Figure 7. R. angulata *adult.*

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Termites ***Odontotermes*** spp
Microtermes spp
(Isoptera: Termitidae)

Distribution. Termites are common throughoutthetropics and subtropics.

Symptoms. In young plants, wilting and death of plants can sometimes be associated with a hole in the stem, just below the soil surface. When the stem and roots are split, small, white termites *{Microtermes* spp) are seen in tunnels. The stems of some large plants are coated or 'sheeted' with earth, under which the termites *(Odontotermes* spp) feed upon the stem surface (Fig. 8). Termites often attack plants that are damaged or dying due to disease or mechanical injury. It is unusual for termites to attack healthy pigeonpea plants in most soils and areas.

Description and biology. Termites, commonly known as white ants, are social insects that form colonies, usually in chambers below the soil surface. The 'workers' (Fig. 9), which are seen in and on plants, collect plant material and stock the 'fungus gardens' (food stores) in some of the chambers. The workers are small (4 mm) and have a soft, white body and a brown head. The 'soldiers', which protect the colonies, have a larger head and well-developed mandibles. The queen, which is cosseted in one of the underground chambers, can grow to several centimeters in length, with most of its body consisting of a distended abdomen.

Control. Seed treatment with aldrin or HCH is recommended in some areas where plant damage is common. Where termites form large mounds that hinder cultivation, nests can be poisoned by drenching them with solutions of these insecticides. In general, however, with adequate cultivation and rapid growth of healthy plants, termite damage seldom results in crop loss.

Figure 8. Plant damaged by Odontotermes *sp.*

Figure 9. Workers of Odontotermes *sp.*

Pests of Stem

Jewel Beetles

Sphenoptera indica Laporte & Gory
(Coleoptera: Buprestidae)

Distribution. This insect is fairly common, but in central and southern India it is sporadic. It feeds on several legumes including pigeonpea and groundnut.

Symptoms. The larva tunnels in the stem above and below the ground level. A prominent gall may form around the stem at ground level (Fig. 10), but similar galls are found when other insects, including weevil larvae, feed on the stem. Wilting and death is caused when young plants are attacked, but older plants may survive with little reduction in pod production.

Description and biology. The white, apparently legless larvae grow to a length of 20 mm or more, with a characteristic bulb at the head and thorax region. Pupation takes place in the tunnel in the root or stem. The adult beetle is dark but iridescent, with a jewel-like shine which gives this beetle its common name (Fig. 11). Little is known of its biology.

Control. No control measures are suggested. When damage is seen, it is too late to take remedial action, but destruction by burning old, infested stems may reduce attacks in the next season.

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Figure 10. Sphenoptera indica *larva and stem damage.*

Figure 11. S. indica *pupa and adult in split stem.*

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Figure 12. Seedlings damaged by Alcidodes *sp.*

Figure 13. Alcidodes fabricii *(right) and* A. collaris *(left).*

Stem Weevils ***Alcidodes fabricii*** (Fabricius.)
Alcidodes collaris (Pascoe.)
(Coleoptera: Curculionidae)

Distribution. Common in central and southern India.

Symptoms. Young plants are girdled by the adult so the upper portion of the plant wilts and dries; stem breakage may also occur (Fig. 12).

Description and biology. The adult beetle (6 mm long) of *A. fabricii* is dark red or brown with white longitudinal stripes, and *A. collaris* is black with white transverse bands on the elytra (Fig. 13). The eggs are laid on the stem, in which the white larvae develop.

Control. These pests seldom cause sufficient damage to merit any control measures. They may kill a few young plants but neighboring plants grow to fill the spaces.

Stem Flies ***Ophiomyia phaseoli*** (Tryo.)
Ophiomyia centrosematis (Meijere)
(Diptera: Agromyzidae)

Distribution. *Ophiomyia phaseoli* is common in Africa, Asia, and Australasia, feeding in the stems of several legumes, including pigeonpea; *O. centrosematis* has been reared from pigeonpea stems at ICRISAT Center, but may be rare on this crop.

Symptoms. The upper stems of young plants wilt, and the plants may die. Close examination of the stem at the base of the wilted portion will reveal a larva or puparium.

Description and biology. The shiny black fly, which is 2 mm long (Fig. 14), lays its eggson upper leaf surfaces. The white larva tunnels down a leaf vein into the stem where it feeds and pupates.

Control. This pest is seldom found in large numbers in pigeonpea to be of concern but it is a major pest in other legumes, including beans. On those crops, systemic soil insecticides such as phorate have been recommended for control.

Figure 14. Ophiomyia centrosematis *adult and damage caused by it's larva.*

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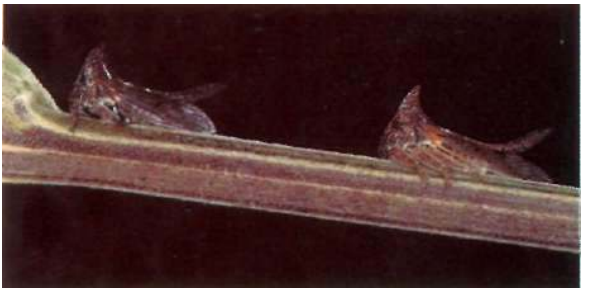

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Cow Bugs ***Otinotus oneratus*** W.
Oxyrachis tarandus F.
(Hemiptera: Membracidae)

Distribution. Common in central and southern India.

Symptoms. The bugs suck the green stems. Heavy infestations can result in the formation of corky calluses, wilting, and reduced plant vigor.

Description and biology. The grey-brown adult bugs (7 mm long), which have thorn-like projections on the thorax (Fig. 15), lay their eggs on the stems (Fig. 16). The nymphs exude a sugary (honey dew) liquid which is used by ants (Fig. 17), which in return may help to protect the bugs from natural enemies. The common name of cow bug is derived from this habit of providing 'milk' to the ants.

Control. No specific control measures are recommended. Insecticides used to control major pests, particularly dimethoate, will reduce the populations of this minor pest.

Figure 15. Oxyrachis tarandus *adults.*

Figure 16. Cowbug eggs.

Figure 17. Ants visiting areas infested by Otinotus oneratus.

Scale Insects ***Ceroplastodes cajani*** Maskell
Icerya purchasi Maskell
(Hemiptera: Coccidae)

Distribution. Several species, genera, and families of scale insects are known to feed upon pigeonpea stems in Africa and Asia.

Symptoms. The scale-like insects can be seen on stems and sometimes on leaves. Generally, these insects are not major pests when pigeonpea is grown as an annual, but they build up and attack perennials. One species, *Laccifer lacca* whose secretion provides us with lac, an important product, is sometimes cultivated on pigeonpea in Asia, but *Acacia* spp are more commonly grown as the host-plants of this insect.

Description and biology. Young nymphs are mobile and can be spread by wind. Adult females are sedentary and are usually found in colonies (Fig. 18). Scale insects are often protected from their numerous natural enemies by ants, which feed upon their secretions. *Ceroplastodes cajani* is the most common scale insect on pigeonpea in India. *Icerya purchasi* (Fig. 19), a polyphagous widely spread species, is one of the more colorful scale insects found on this plant.

Control. Scale insects can be controlled directly by the use of systemic insecticides, especially during the mobile-crawler stage. Alternatively, destruction of ant colonies will soon result in a buildup of the many natural enemies of the scale insects that will control them.

Figure 18. Ceroplastodes cajani.

Figure 19. Icerya purchasi.

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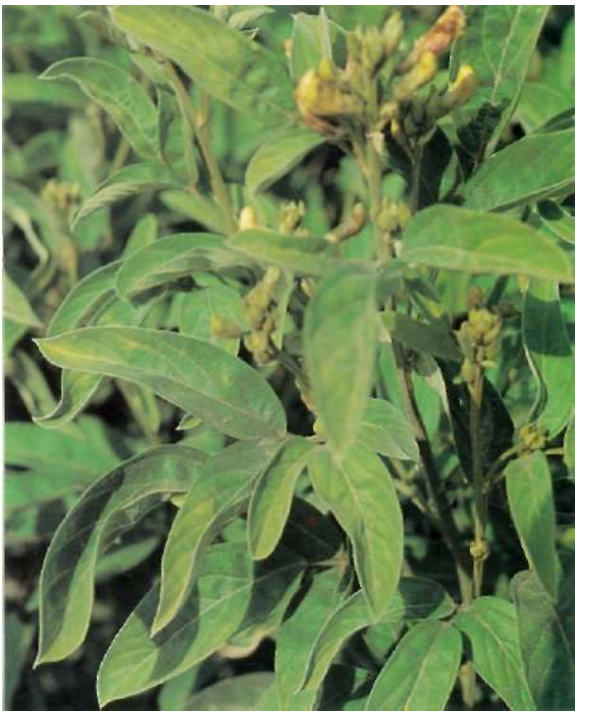

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Pests of Foliage

Jassids ***Empoasca fabae*** (Harris)
Empoasca kerri **P**ruth**i**
Jacobiasca lybica (de Beryeven)
(Hemiptera: Cicadellidae)

Distribution. Jassids have been found on pigeonpea in most areas where the crop is grown. They are not easily identified to the species level and assistance of specialists is usually needed. In India, *Empoasca kerri* is the species most commonly reported from pigeonpea and other legumes. *Jacobiasca lybica* has been reported from pigeonpea in Africa, and *Empoasca fabae* from the Americas and the Caribbean.

Symptoms. The attacked leaflets become cup shaped and yellow at the edges (Fig. 20). Heavy attacks result in the leaflets turning red-brown, with subsequent defoliation and stunting.

Description and biology. These small green insects (2.5 mm) feed by sucking on the leaflets. They are found on both upper and lower leaf surfaces. The adults fly when disturbed. The nymphs (Fig. 21) resemble the adults, but have no wings and run sideways when disturbed. The eggs are inserted in the veins on the underside of leaflets. One generation can be completed in 2 weeks under optimum conditions.

Control. Heavy infestations, sufficient to cause yield loss, have been seen in northern India and in Kenya. Several insecticides, including dimethoate and endosulfan have been found to adequately control this pest.

Figure 20. Jassid-damaged leaves.

Figure 21. Empoasca kerri *nymph.*

Aphids ***Aphis craccivora*** Koch
Aphis fabae Scopoli
Myzus persicae (Sulzer)
Macrosiphum spp
(Hemiptera: Aphididae)

Distribution. Several species of aphids have been reported from pigeonpea, but *A. craccivora* is the most common, both in Asia and Africa.

Symptoms. Aphids colonies are seen on young stems, leaflets, and pods. Young leaves of seedlings become twisted (Fig. 22) and the heavy infestation can cause wilting.

Description and biology. *A. craccivora* is common on several legume crops including pigeonpea (Fig. 23). The adults are black and shiny, up to 2 mm long and some are winged. The nymphs are similar to the adults but are smaller, with a light wax covering that makes them look grey and dull. *A. fabae* is similar, but the adults are less shiny and are a combination of dark brown and green rather than black. *M. persicae* and *Macrosiphum* spp on pigeonpea are usually green. All these aphids produce a new generation in a week, and infestations build up very quickly.

Control. Aphid colonies on pigeonpea seldom thrive for long, probably because of the natural enemy activity. Rain also results in a large reduction in infestation. Several systemic insecticides, including dimethoate adequately control aphids and can be used if needed.

Figure 22. Seedling affected by aphids and ladybird predator.

Figure 23. Aphids on pigeonpea.

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Eriophyid Mites

Aceria cajani Channabasavanna (Acarina: Eriophyidae)

Distribution. This mite has been identified only in India, where it is widespread and common. It is the vector of the pigeonpea sterility mosaic disease, the most damaging disease of this crop in India. However, disease symptoms that may indicate the presence of this mite have been reported from other countries also.

Symptoms. As a result of the transmission of the sterility mosaic disease, infected plants develop light green or chlorotic leaves which have mosaic patterns (Fig. 24). Most infected plants do not bear flowers, hence the name of the disease.

Description and biology. The mites (Fig. 25) are difficult to see with the naked eye. They are 0.2 mm long, light pink, spindle shaped, and are normally found feeding on the underside of leaflets. The eggs, which are milky white, are found on vegetative terminals. Many nymphs are found on young folded leaflets. Plant-to-plant infestation occurs by the wind dispersal of infective mites.

Control. It is best to prevent this mite, and the sterility mosaic disease by the use of resistant pigeonpea varieties. Several insecticides including dimethoate and phorate, and acaricides such as dicofol, help control these mites effectively.

Figure 24. Symptoms of sterility mosaic disease on pigeonpea plant and inset, close up of disease symptoms.

Figure 25. Electron micrograph of Aceria cajani.

Red Spider Mites

Schizotetranychus cajani Gupta
Tetranychus spp
(Acarina: Tetranychidae)

Distribution. Red spider mites are found on pigeonpea throughout India and eastern Africa. In India, *S. cajani* is the most commonly reported species.

Symptoms. Yellow or white spots appear on the upper surface of the attacked leaflets (Fig. 26). Heavy infestation results in partial defoliation. The mites can be seen with the naked eye. Most are found on the lower surface of the leaflets.

Description and biology. The adult mites (0.5 mm) are oval and velvety red (Fig. 27). The yellow eggs are laid on the undersurface of the leaflet and the nymphs are active, feeding on the undersurface, within the silk webbing that they produce. One generation is completed in less than two weeks under ideal conditions. Dispersion may be through wind-carried individuals.

Control. Red spider mite attacks on pigeonpea are seldom severe enough to merit control, except on plants grown in greenhouses. Most widely used cultivars appear to be relatively resistant to these mites. Several insecticides including dimethoate and most acaricides are normally effective in controlling these mites. However, some *Tetranychus spp* have developed considerable resistance to pesticides, particularly under greenhouse conditions.

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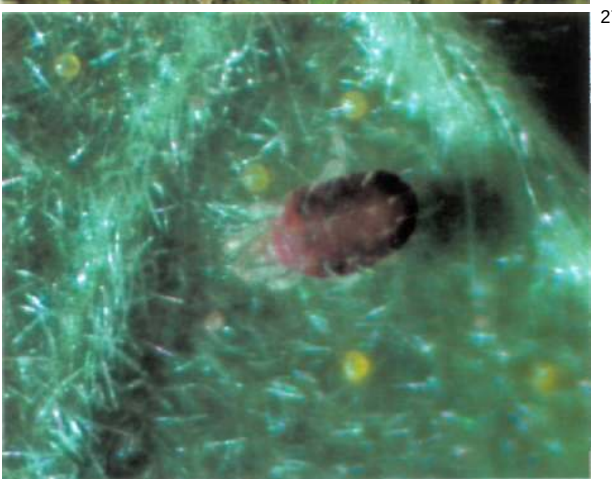

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Figure 26. Pigeon pea lea ves damaged by red spider mites and inset, closeup of damaged leaf.

Figure 27. Schizotetranychus cajani.

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Figure 28. Symptoms of yellow mosaic disease.

Whiteflies ***Bemisia tabaci*** (Genn.)
(Hemiptera: Aleyrodidae)

Distribution. These insects are common across the Americas, Europe, Africa, Australia, and Asia on many species of wild and domesticated host plants.

Symptoms. Whitefly is important as the vector of a virus that causes the yellow mosaic disease (Fig. 28) on pigeonpea in India.

Description and biology. The adults are small insects (1 mm) with white, wax-powdered wings. Eggs are laid on the undersurface of leaflets. The first instar nymph crawls about on the leaflet surface until it finds a suitable site for feeding. It then remains at that site, feeding by sucking and growing into a flat, oval shaped, scale-like 'puparium' fringed by wax filaments. One generation can be completed in less than 30 days.

Control. Whiteflies have not been recorded as being of sufficient pest status on pigeonpea to merit any control measures, even though the yellow mosaic disease is fairly common in postrainy-season pigeonpea in India. Several insecticides including dimethoate and monocrotophos are reported to control this insect.

Bud-sucking Bugs ***Campylomma*** spp
Creontiades pallidus (Rambir)
Eurystylus spp
Taylorilygus vosseleri (Poppius.)
(Hemiptera: Miridae)

Distribution. Several species of bugs have been recorded on pigeonpea. *Taylorilygus vosseleri* has been reported to feed on pigeonpea in eastern Africa, but this species is more damaging on cotton. Several other mirid species, including *Campylomma* spp, *Creontiades pallidus,* and *Eurystylus* spp, are common on pigeonpea in India.

Symptoms. The bugs suck the vegetative and flowering buds and may cause deformation of the leaves and abortion of flower buds.

Description and biology. *Campylomma* spp are small, green, elongate, and ovoid bugs. The adults are about 2 mm long. *Creontiades pallidus* adults are about 8 mm long and pale green (Fig. 29). *Eurystylus* spp and *T. vosseleri* are mottled brown bugs, about 4 mm long. The eggs are inserted into the soft tissue of the plants. One generation of these bugs can generally be completed in as short a time as 2 weeks.

Control. As most plants produce far more buds than are required, yield is rarely reduced by these insects. Specific control measures are not likely to be required for these bugs, but they can be controlled by most of the insecticides that are used to control major pests.

Figure 29. Creontiades pallidus.

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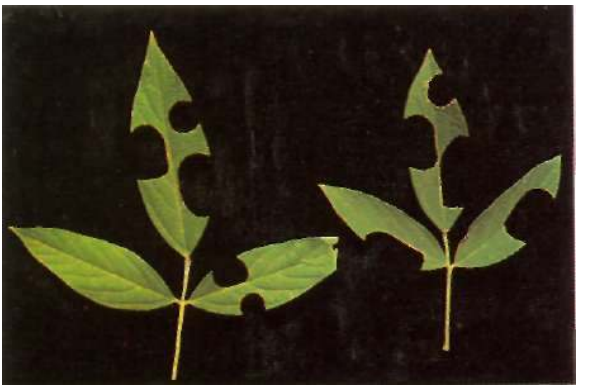

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Figure 30. Leaflets damaged by Megachile *sp.*

Figure 31. Megachile *sp bee.*

Leaf-cutter Bees ***Megachile*** spp
(Hymenoptera: Megachilidae)

Distribution. Widely distributed throughout the tropics.

Symptoms. Neat, semi-circular portions are cut from the leaflets of pigeonpea (Fig. 30) by several species of *Megachile*.

Description and biology. Female bees carry pieces of leaf to their nests which are formed in the soil, in rotten wood, or in crevices. The adult bees, which are of a range of colors and sizes, are among the more important pollinators of pigeonpea (Fig. 31). *Megachile* is not a social insect like the honey bee, but is 'solitary' for each female forms its own nest filling it with a paste of honey and pollen in which eggs are laid.

Control. Damage has never been reported to be extensive enough to merit control measures.

Grasshoppers and Locusts

Catantops erubescens Walk.
Colemania sphenerioides (Bolivar)
Cyrtacanthacris tatarica (L.)
Patanga succincta (L.)
Schistocerca gregaria Forsk.
(Orthoptera: Acrididae)

Distribution. Many genera and species of grasshoppers and locusts have been reported to feed on pigeonpea in Africa (*Phymateus* spp, *Zonocerus* spp, and *Schistocerca* spp) and in India, but few are of sufficient density and regular incidence to cause major concern. In India, several species including *C. tatarica* (Fig. 32) and the Deccan wingless grasshopper, *C. sphenerioides* (Fig. 33), feed on the leaflets, but the damage seldom results in noticeable yield reduction, except in locust outbreaks, where most plants including pigeonpea are defoliated.

Symptoms. Defoliation, in case of locust outbreaks as mentioned above. One grasshopper that causes unusual damage to pigeonpea is *Catantops erubescens* (Fig. 34a). It girdles branches of the pigeonpea plant which then wither and die (Fig. 34b).

Control. No control measures are normally required, as the densities of these insects seldom reach economic thresholds.

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34a

34b

Figure 32. Cyrtacanthacris tatarica.

Figure 33. Colemania sphenerioides.

Figure 34a. Catantops erubescens.

Figure 34b. Pigeonpea branches damaged by C. erubescens.

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Leaf-damaging Weevils

Myllocerus undecimpustulatus Faust
Nematocerus spp
Phyllobius spp
Systates spp
(Coleoptera: Curculionidae)

Distribution. *Myllocerus* spp and *Phyllobius* spp are widespread in India on pigeonpea and several other host plants. *Nematocerus* spp and *Systates* spp have been found on pigeonpea in Africa. Other genera and species of weevils are also reported to feed on pigeonpea leaves.

Symptoms. Adult weevils chew the leaflets, generally at the margins, causing a ragged effect (Fig. 35). Larvae live in the soil, where they feed mainly on roots.

Description and biology. The adults of *M. undecimpustulatus,* which are 5 mm long have 11 small black spots on their ash-grey bodies (Fig. 36), which gives them the common name ash weevil. The grubs are white, apodous, and stout. They pupate in the soil.

Control. The adults and larvae do not cause sufficient damage to pigeonpea to merit separate control measures. However, on other crops, particularly on some varieties of cotton, *M. undecimpustulatus* is a major pest in some localities, and insecticides, including monocrotophos, have been recommended for its control.

Figure 35. Leaf damaged by Myllocerus *sp.*

Figure 36. Myllocerus undecimpustulatus.

Other Leaf- and Flower-damaging Beetles

Cheilomenes spp
Epilachna spp
(Coleoptera: Coccinellidae)

Luperus spp
Monolepta spp
Podagrica spp
(Coleoptera: Chrysomelidae)

Oxycetonia versicolor **F.**
(Coleoptera: Cetonidae)

Holotrichia **s**pp
Adoretus spp
(Coleoptera: Scarabaeidae)

Distribution. Adult beetles of several genera other than weevils, also feed on pigeonpea leaves in India and in Africa. A few of these have been listed above.

Symptoms. Leaves are eaten. Some of the beetles are not seen on the leaves because they feed only at night and hide during the day.

Description and biology. The coccinellids, commonly referred to as ladybird beetles, are small and usually brightly colored with dark spots. The *Epilachna* spp are herbivorous, but *Cheilomenes spp* nymphs and adults are predatory on small insects including aphids. However, in the absence of their prey, *Cheilomenes* spp adults chew holes in leaves, possibly to obtain moisture. The chrysomelids are generally shiny, metallic beetles; *Podagricaspp* are flea beetles, so called because they jump. *Oxycetonia versicolor* (Fig. 37), a brilliantly colored and dorsally flattened beetle with a large scutellum feeds on pollen. *Holotrichia (Lachnosterna)* spp are larger beetles, and are important because their larvae (white grubs) considerably damage a range of crops by feeding on their roots. *Adoretus* spp are brightly colored, shiny beetles, whose larvae feed on roots.

Control. These beetles are seldom present in populations large enough to cause extensive damage to pigeonpea and so do not merit specific control measures.

Figure 37. Oxycetonia versicolor.

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Figure 38. Moths of (L to R): Amsacta albistriga, Amsacta collaris, Spilosoma obliqua, Acanthoplusia orichalcea, Chrysodeixis chalcites, Euproctis lunata, *and* Euproctis subnotata.

Figure 39. Amsacta albistriga *larva.*

Figure 40. Chrysodeixis chalcites *larva.*

Figure 41. Euproctis subnotata *larvae.*

Lepidopteran Defoliators ***Amsacta*** spp.
Spilosoma (Diacrisia) obliqua (Walker.)
(Lepidoptera: Arctiidae)

Chrysodeixis chalcites Esper
Acanthoplusia (Trichoplusia) orichalcea (F.)
(Lepidoptera: Noctuidae)

Euproctis spp
(Lepidoptera: Lymantridae)

Distribution. These polyphagous Lepidoptera (Fig. 38) are widely distributed in Asia and Africa. They feed upon the leaves, buds, and flowers of many plants.

Symptoms. The damage caused is obvious on pigeonpea, where the larvae feed upon leaves and inflorescence.

Description and biology. The *Amsactaspp* and *S. obliqua are* commonly known as 'hairy caterpillars' for they are densely covered with long hair (Fig. 39). *Chrysodeixis chalcites* (Fig. 40) and *Acanthoplusia orichalceaare* semi-loopers. The former is green and the latter is also green but with white lateral lines and black spines. *Euproctisspp* are 'tussock caterpillars' so called because they have prominent, compact tufts of short hair (Fig. 41).

The hair of these and other caterpillars cause skin rashes and irritation so care must be taken while handling them.

Control. Populations of these larvae on pigeonpea are seldom large enough to merit pesticide use. However, there are occasional reports of severe defoliation, particularly by *Amsactaspp.* Several insecticides including endosulfan normally give adequate control.

Leaf Webbers ***Grapholita (Cydia) critica*** Meyr. ***Leguminivora ptychora*** (Meyr.) (Lepidoptera: Tortricidae)

Distribution. *Grapholita critica* (formerly known as *Eucosma critica)* is common throughout the pigeonpea-growing areas of India and *Leguminivora ptychora* is common on several legumes, including pigeonpea, in eastern Africa.

Symptoms. Leaflets are webbed together with silk (Fig. 42a) and the larva feeds within the web. As the web often includes the terminal bud, further growth of that shoot is prevented. Infestations start at the seedling stage and may persist to the reproductive stage when the larvae feed inside flower buds (Fig. 42b) and in young pods.

Description and biology. *G. critica* is a small brown moth (Fig. 43) that lays its eggs on the leaf buds and young leaves. The cream-yellow larva ties leaflets together and feeds inside the web, reaching a length of about 10 mm before pupating in the web.

Control. Although leaf webbers make young pigeonpea crops look untidy, they apparently cause no yield loss. The plants produce side shoots to compensate for the loss of terminal buds. If insecticides are not used, the many parasites and predators soon bring this pest under control. The larvae inside the webs are well protected from contact insecticides. However, where necessary, systemic insecticides such as monocrotophos or one with some fumigant action such as dichlorvos can be applied.

Figure 42a. Grapholita critica *larva on webbed leaves.*

Figure 42b. Pigeonpea bud damaged by G. critica *larva.*

Figure 43. G. critica *moth.*

42a

42b

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Figure 44. Caloptilia soyella *larva and a rolled-up leaflet.*

Figure 45. Damage caused by Aproaerema modicella.

Other Leaf Webbers and Tiers

Other leaf webbers and tiers that feed on pigeonpea include *Maruca testulalis* (see page 70); the leaf tier *Anarsia ephippias* (Meyr.) (Lepidoptera: Gelechiidae)—a small brown larva that folds individual leaflets; the leaf roller *Caloptilia soyella* Van Dev. (Lepidoptera: Gracillaridae)—a green larva that rolls the leaflets from the tips (Fig. 44); and the groundnut leaf miner *Aproaerema modicella* Dev. (Lepidoptera: Gelechiidae), whose feeding produces white or light brown patches on the folded leaflets (Fig. 45). With the exception of *M. testulalis,* these larvae seldom, if ever, cause sufficient damage on pigeonpea to merit control measures.

Pests of Flowers and Pods

Thrips ***Megalurothrips usitatus*** (Bagnall) (Thysanoptera: Thripidae)

Distribution. Several genera and species of thrips have been recorded on pigeonpea. In India, the most common species appears to be *Megalurothrips usitatus,* which feeds on flowers (Figs. 46 and 47). In eastern Africa, other *Megalurothrips* species are common on pigeonpea and are considered important.

Symptoms. Heavy infestation of thrips can lead to shedding of buds and flowers.

Description and biology. The black adults (1 mm) and nymphs are easily seen with the naked eye, particularly when they are on yellow flower petals. One generation can be completed within 3 weeks.

Control. In India, the population build up of thrips on pigeonpea is generally not large enough to cause substantial damage and do not, therefore, merit specific control measures. In most cases, insecticides used to control major pests such as endosulfan or dimethoate also reduce thrips populations.

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Figure 46. Megalurothrips usitatus.

Figure 47. Electron micrograph of M. usitatus.

48b

48a

48c

Blister Beetles ***Mylabris pustulata*** *Thunberg*
Mylabris spp
Coryna spp
(Coleoptera: Meloidae)

Distribution. *Mylabris pustulata* and other *Mylabris spp* are widespread and common in India. Several species of *Mylabris* and *Coryna have* been recorded from pigeonpea in Africa.

Symptoms. Adult beetles feed on the flowers and greatly reduce the numbers of pods that are set.

Description and biology. *Mylabris pustulata* (25 mm) is one of the larger species, the adults having very obvious black and red coloration (Fig. 48a). Other genera and species are of varying sizes but most are conspicuously colored. Their name is derived from the blisters on human skin caused by the exudate (containing cantharidine), which is produced by the beetles when they are disturbed. Eggs are usually laid in the soil. The larvae of most species are generally beneficial because they feed upon insects in the soil.

Control. In locations where pigeonpea is grown over large areas, blister beetles cause little damage because they are spread across the crop. However, in small pigeonpea plots that are in the flowering stage during the period of peak adult activity (August-October in southern India), most of the flowers may be eaten by this pest and crop loss may be substantial. The beetles can be controlled manually by picking them by hand (Fig. 48b) or collecting them with an insect net (Fig. 48c) and crushing them, since they are slow moving, but care should be taken to protect the skin. Most insecticides are not very effective against these beetles, but synthetic pyrethroids work reasonably well.

Figure 48a. Mylabris pustulata.

Figure 48b. Handpicking of beetles.

Figure 48c. Collection of beetles using an insect net.

Bud Weevils ***Indozocladius*** **(Ceutorhynchus)** ***asperulus*** (Faust) (Coleoptera: Curculionidae)

Distribution. Widely distributed in peninsular India.

Symptoms. Larve feed and pupate inside the flower buds, making them hollow. In severe attacks, the number of flowers is reduced substantially.

Description and biology. The small (2 mm) brownish weevil (Fig. 49) lays its eggs on the buds and the white larvae develop singly inside the buds.

Control. This is generally a minor pest and so does not merit specific control measures.

Figure 49. Indozocladius asperulus.

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Figure 50. Apion benignum.

Pod Weevils ***Apion clavipes*** Gerstaecker
Apion benignum (Faust)
(Coleoptera: Apionidae)

Distribution. *Apion clavipes* is regarded as a major pigeonpea pest in some areas ot northwest India and in East Africa. *A. benignum* is occasionally found in southern India. In other areas, these weevils are relatively uncommon.

Symptoms. Larvae damage the green seeds in pods but the damage is usually noticed only after adults emerge, cutting their way out of the pod. The beetles also chew small holes in leaflets and flowers.

Description and biology. Adults are small black weevils (Fig. 50), larvae are creamy white, There does not seem to be any published information regarding the biology of these pests.

Control. There are no published reports of control measures but several pesticides including dimethoate, monocrotophos, and the synthetic pyrethroids can control these pests effectively.

Pod-sucking Bugs ***Anoplocnemis*** spp
Clavigralla gibbosa Spinola
Clavigralla scutellaris (Westwood)
Clavigralia tomentosicollis Stal.
Riptortus spp
(Hemiptera: Coreidae)

Piezodorus sp
Dolicoris indicus (Stal.)
Nezara viridula (L.)
(Hemiptera: Pentatomidae)

Distribution. *Anoplocnemis* spp and *Riptortus* spp are found on several hosts in Africa and Asia. *Clavigralla gibbosa* is the most important pod-sucking bug on pigeonpea in India; *C. (Acanthomia) tomentosicollis* is the most important in Africa; and *C. scutellaris* is common in Africa and Asia. *Nezara viridula* is found on many legumes and other hosts throughout the tropics and subtropics; *D. indicus* is common in India; and *Piezodorus* sp in southeast Asia and in Australia. Several other genera and species of Coreidae and Pentatomidae are also occasionally found on this crop.

Symptoms. All these bugs, suck developing seeds through the pod wall. The seeds become shrivelled with dark patches (Fig. 51). Such seed does not germinate and is not acceptable as human food.

Description and biology. The adults of *Anoplocnemis* spp, which are usually black or brown (Fig. 52), are the largest (30 mm) of these bugs. *Riptortus* spp (18 mm) are mainly brown and are smaller (Fig. 53). *Clavigralla* bugs are brown-grey; *C. scutellaris* (12 mm) is the largest and is broader than both *C. gibbosa* (Fig. 54a) and *C. tomentosi-*

Continued

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53

54a

54b

Figure 51. *Bug-damaged (left) and healthy seed (right).*

Figure 52. Anoplocnemis *sp.*

Figure 53. Riptortus *sp.*

Figure 54. Clavigralla gibbosa: *(a) adult and (b) eggs.*

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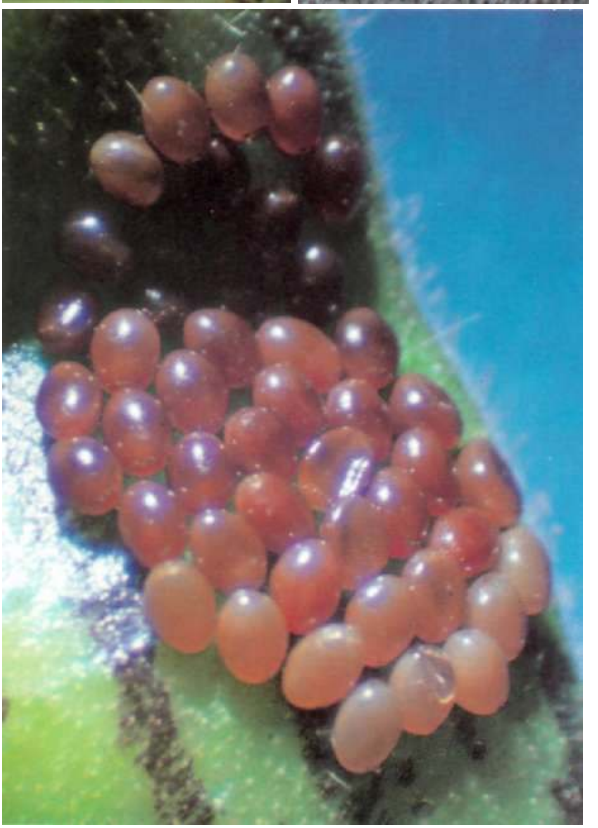

collis, both of which are about 10 mm long. *Nezara viridula* (15 mm) is normally green (Fig. 55), but can be completely yellow or green and yellow and *D. indicus* is brown with light mottling (Fig. 56). These bugs lay their eggs in clumps on the leaf and pod surfaces (Fig. 54b, 57). The young nymphs that feed by sucking the green tissue are usually found in groups. The large nymphs and adults can feed on seed through pod walls. One generation takes 4 weeks or more depending on the temperature.

Control. Insecticides, particularly those with some systemic action such as dimethoate and monocrotophos, are usually effective in controlling these pests. In eastern Africa some pigeonpea genotypes have been reported to have considerable resistance to the sucking bugs, so screening for resistance may be a useful strategy for the management of these pests.

Figure 55. Nezara viridula *adult.*

Figure 56. Dolicoris indicus.

Figure 57. Close up of N. viridula *eggs.*

Pod Borers

Helicoverpa (Heliothis) armigera (Hubner)
Helicoverpa zea (Boddie)
Helicoverpa punctigera (Wallengren)
Heliothis virescens (F.)
(Lepidoptera: Noctuidae)

Distribution. *Helicoverpa armigera* (Fig. 58) is widely distributed on many host plants throughout the tropics and subtropics but not in the Americas where it is replaced by *H. zea* and *Heliothis virescens.* In Australia, both *Helicoverpa punctigera* and *H. armigera* attack pigeonpea.

Symptoms. *Helicoverpa* spp destroy buds, flowers, and pods. If flowers and pods are not available, they feed upon leaflets (Fig. 59), leaving the veins. On pods, conspicuous holes are made by the entry of larvae. Usually developing and partly matured seeds are eaten completely. At times a portion of the seed and testa remain.

Description and biology. *Helicoverpa* spp lay their small white eggs (Figs. 60 and 61), usually singly, on the upper and outer surfaces of leaves, flowers, pods, and stems. The young larvae feed by scraping green tissue and

Continued

Figure 58. Male (left) and female (right) moths of Helicoverpa armigera.

Figure 59. H. armigera *damaging pigeonpea leaves.*

Figure 60. H. armigera *egg.*

Figure 61. Electron micrograph of H. armigera *egg.*

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Figure 62. H. armigera *damaging pods.*

Figure 63. Color range of H. armigera *larvae.*

Figure 64. H. armigera *pupa.*

the older larvae chew voraciously into buds, flowers, and pods, leaving characteristic round holes (Fig. 62). The large larvae (27 mm long) are yellow, green, pink, orange, brown, or black (Fig. 63), but all have characteristic light and dark stripes along each side. Pupation is normally in the soil or in plant debris (Fig. 64). One generation can be completed in just over 4 weeks under favorable conditions.

Control. Several insecticides, including endosulfan and synthetic pyrethroids, give good control, particularly if applied soon after the eggs hatch. However, considerable resistance to many insecticides has been reported in these insects in areas where crops have been sprayed intensively. *Helicoverpa* spp have many parasites and predators. In some areas these give adequate control and pesticide use may lead to an increase in *Helicoverpa* populations through the reduction of these natural enemies. Some pigeonpea genotypes have considerable tolerance to these pests, so host-plant resistance can be a useful method of avoiding damage.

Lablab Pod Borers ***Adisura atkinsoni*** (Moore) (Lepidoptera: Noctuidae)

Distribution. *A. atkinsoni* is widely distributed in southern India. It is a major pest of *Dolichos lablab,* and is often found in low numbers on pigeonpea. Two other species, *Adisura marginalis Wlk.* and *Adisura stigmatica* Warr. are also occasionally found on pigeonpea.

Symptoms. The larvae bore into buds, flowers, and green pods.

Description and biology. The green larva, 15 mm long, is very similar to *Helicoverpa armigera,* and is often confused with this pest in the field (Fig.65). It can be distinguished by its brown lateral stripes. Pupation takes place in the soil; the moth has yellowish brown forewings and white hindwings (Fig. 66). One generation is completed in about 4 weeks.

Control. Control is rarely needed because this pest is only found in low numbers on pigeonpea. However, insecticides used to control other major pests such as endosulfan can also control this insect.

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Figure 65. Larva of Adisura *sp.*

Figure 66. Adisura marginalis *moths.*

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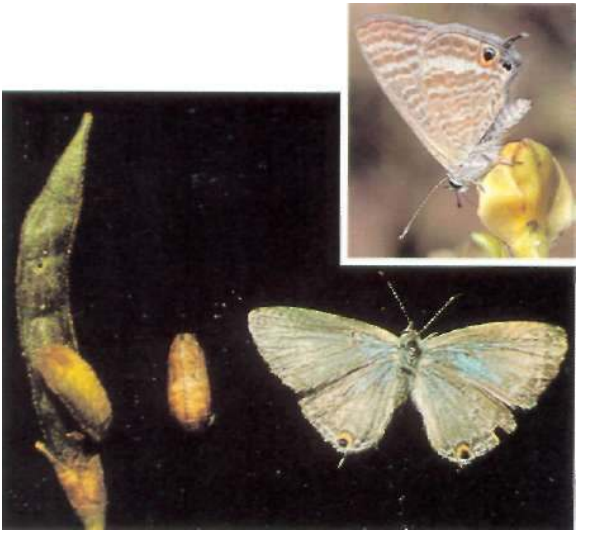

68a

68b

Figure 67. Lampides boeticus *butterfly larva, pupa, and butterfly, and inset, butterfly in action.*

Figure 68. L. boeticus; *(a) eggs and (b) larva.*

Blue Butterflies ***Lampides boeticus*** (L.)
Catochrysops strabo (Fabricius)
(Lepidoptera: Lycaenidae)

Distribution. Both these species are widely distributed in Asia and *L. boeticus* (Fig. 67) is common in eastern Africa. Larvae are found on several cultivated and wild legumes.

Symptoms. The larvae chew leaves, buds, flowers, and pods.

Description and biology. Small, blue, beautifully sculpted eggs are laid singly on buds (Fig. 68a). The larvae, which are 12 mm long, are green, oval, and flat (Fig. 68b). Pupation occurs in soil or in plant debris. One generation is completed in about 5 weeks.

Control. Although these butterflies are common and lay many eggs on the pigeonpea plants, relatively few larvae are found on the crop, probably because natural enemies reduce their numbers. Specific control for these insects is rarely required but endosulfan or other pesticides that control major pests can be used.

Legume (cowpea) Pod Borer

Maruca testutalis (Geyer)
(Lepidoptera: Pyralidae)

Distribution. Common on many legume species throughout the tropics and subtropics.

Symptoms. The larva webs together leaves, buds, and pods and feeds inside these webs (Fig. 69, 70a).

Description and biology. The moth (Fig. 71) lays yellow, oval eggs in small batches, commonly on terminals. The larva, 14 mm long, is whitish-green with rows of conspicuous black spots on the dorsal surface (Fig. 70a, b). However, the spots are not clearly seen on the yellow-green prepupae. Pupation takes place in the web or on the soil surface in a silk cocoon. In optimum conditions, one generation can be completed in less than 3 weeks.

Control. This is a major pest of pigeonpea and other grain legumes in many areas of Africa and central India. Several insecticides including endosulfan kill the larvae but as the webs protect them from contact insecticides, careful application is required. This pest is particularly destructive to determinate-type pigeonpea. As there are differences in genotype susceptibility, it may be possible to develop cultivars resistant to this insect.

Figure 69. Maruca testulalis *larva in a web of leaves and flowers, and inset, prepupa in silk cocoon.*

Figure 70a. M. testulalis *larva on webbed flowers and pods.*

Figure 70b. Close up of M. testulalis *larva damaging a flower.*

Figure 71. M. testulalis *moth.*

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70a

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70b

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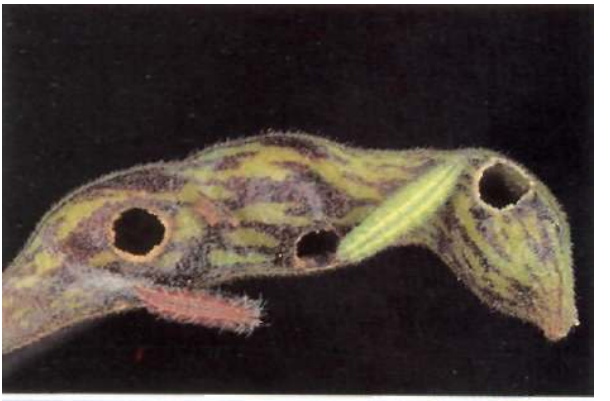

73

Figure 72. Larva (green) and pupa (red) of Exelastis atomosa.

Figure 73. E. atomosa *moth.*

Plume Moths ***Exelastis atomosa*** (Walsingham)
Sphenarches anisodactylus Wlk.
(Lepidoptera: Pterophoridae)

Distribution. Both these species are widely distributed in Asia and eastern Africa, but *E. atomosa* is generally more common on pigeonpea and is a major pest in several areas of India. *S. anisodactylus* is more common on lablab bean.

Symptoms. The larvae chew into the buds, flowers, and pods, and small holes are seen in the buds and tender pods.

Description and biology. The plume moth caterpillars are particularly numerous on postrainy-season pigeonpea and are generally considered as important pests. The green oval eggs of *E. atomosa* are laid singly on buds and pods. The larvae 14 mm long, are green or brown, spindle shaped, and covered with short spines and larger hair. The pupae, which look like the larvae, are usually found attached to the pod surface or on the pedicel (Fig. 72). The adults have brown, plume-like wings (Fig. 73). One generation can be completed in about 4 weeks.

Control. *E. atomosa* can be easily controlled by several insecticides, including endosulfan. Its many natural enemies prevent it from building up into large populations.

Lima Bean Pod Borer

Etiella zinckenella Treitschke
(Lepidoptera: Pyralidae)

Distribution. This species is widely distributed on several legumes in the tropics and semitropics.

Symptoms. The larva is generally found in maturing and dried pods. Infestations build up at the end of the pigeonpea season, particularly when temperatures are high. Faecal granules are found inside the damaged pods.

Description and biology. White elliptical eggs are laid in small groups on the developing pods. The young larvae are green, but turn red later (Fig. 74). They feed inside the pod, reaching a length of 14 mm. Pupation takes place in the soil. The moth has grey forewings but with a white costal margin and the hind wings are pearly and translucent (Fig. 75). One generation can be completed in 4 weeks under favorable conditions.

Control. In India, it is generally a minor pest on pigeonpea and will seldom merit specific control, but in southeast Asia, it is of some concern and can be controlled by systemic insecticides.

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Figure 74. Etiella zinckenella *larvae in damaged pods.*

Figure 75. E. zinckenella *moth.*

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Figure 76. Female fly of Melanagromyza obtusa.

Figure 77. M. obtusa *eggs inside the pod and inset, close-up of egg.*

Figure 78. M. obtusa *larva.*

Figure 79. M. chalcosoma *puparia.*

Figure 80. M. obtusa *larva, puparia, and seed damage.*

Podflies ***Melanagromyza obtusa*** Malloch
Melanagromyza chalcosoma Spencer
(Diptera: Agromyzidae)

Distribution. *Melanagromyza obtusa* is a widespread and major pest of pigeonpea in Asia, and extends to Australasia. Reports of this species in Africa are probably erroneous because the species usually found there is *M. chalcosoma,* a common pest in the pods of several legumes including pigeonpea.

Symptoms. There are no obvious external symptoms of podfly attack till the fully grown larvae chew holes in the pod walls leaving a "window" through which the flies emerge after pupation in the pod. Damaged seeds are of no value.

Description and biology. The small black fly (Fig. 76) lays eggs (Fig. 77) through the wall of the developing pod and the white legless larva, 3 mm long (Fig. 78), feeds inside the green seed. In the case of *M. chalcosoma,* twoor more larvae often develop and pupate in one seed (Fig. 79) but in *M. obtusa,* generally only one larva develops in one seed (Fig. 80). The brown puparium is formed inside the pod but outside the seed. One generation takes about 3 week under optimum conditions.

Control. As all stages of development take place inside the pod, only systemic insecticides such as dimethoate and monocrotophos are effective, but nonsystemic insecticides like endosulfan help in killing the adults. A closed season during which no pigeonpea pods are available should reduce infestation. It is best to avoid growing a mixture of cultivars of differing durations in an area because this will provide pods over a long period and allow several generations to develop. Some pigeonpea genotypes are much more susceptible to egg laying than others, so it may be possible to select resistant cultivars.

Pod Wasp ***Tanaostigmodes cajaninae*** LaSalle (Hymenoptera: Tanaostigmatidae)

Distribution. This pest is widely distributed on pigeonpea in India. It is common on research stations but it is rare in farmers' fields.

Symptoms. Young pods are attacked and either do not grow at all, or the locules that are not attacked may develop normally, while the attacked locules remain undeveloped (Fig. 81). The exit hole made by the emerging wasp is smaller than that of podfly.

Description and biology. The small wasp (2 mm long) lays translucent, flat, oval eggs on the flower and on the young pod. The white, apparently legless larva (2 mm long) feeds on the young seed and inner pod wall (Fig. 82). Pupation occurs in the same locules. One generation is completed in less than 3 weeks.

Control. This insect is promoted to pest status on research stations where a range of cultivars are grown, which provide pods over long periods, allowing the pest to build up over many generations in every year. The pest can be controlled by restricting the range of duration of cultivars growing in an area. The use of pesticides such as endosulfan appears to kill some of the natural enemies but not the pest itself. Systemic pesticides such as dimethoate, will reduce population densities since it is an internal feeder.

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Figure 81. Symptoms of damage caused by Tanaostigmodes cajaninae. *On the left is an undamaged pod.*

Figure 82. Larva, pupa, and adult of T. cajaninae.

83

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Figure 83. Callosobruchus *sp eggs and exit holes on pods.*

Figure 84. Callosobruchus *sp in and on damaged seeds.*

Bruchids ***Callosobruchus maculatus*** (F.)
Callosobruchus analis (F.)
Callosobruchus chinensis (L.)
(Coleoptera: Bruchidae)

Distribution. The bruchid, *Callosobruchus maculatus* is common on pigeonpea and some other grain legumes worldwide, both in pods in the field and in stored seed. Other species including *C. analis* (F.) and *C. chinensis* (L.) *are* also found in the stored seed, but are less common.

Symptoms. The pests attack nearly mature and dried pods. The round exit hole and the white eggs on the pod wall are conspicuous (Fig. 83). Infested stored seed can be recognized by the eggs on the seed surface and the round exit holes with the 'flap' of seed coat.

Description and biology. The mottled brown beetle, 3 mm long, lays its eggs on pods or seeds. The white larva burrows into the pod or seed through the base of the egg and then feeds and develops into a pupa inside the seed, from which the adult emerges through a neat cylindrical hole (Fig. 84). One generation takes 4-weeks or more, depending on the temperature and humidity. This pest can be destructive to stored seed.

Control. Pods should be harvested as soon as they mature and the seed sun dried before it is placed in a clean, beetle-proof storage container (metal, wood, earthenware, or plastic). Fumigation with a range of chemicals has been reported to control infestations in stored seed. A coating of edible oils or of inert clays can prevent further development of bruchids in the stored seeds.

Chickpea

Chickpea (*Cicer arietinum* L.) (Fig. 85), also known as Bengal gram (and has 30 other common names), has far fewer pests than pigeonpea. The relatively low occurrence of pests and other insects on this crop is probably caused by two major factors:

1. Chickpea is a 'cool season' legume commonly grown in temperate climates, sown immediately before or after winter. Its vegetative growth occurs during, or just after winter, when insect populations are generally low.

2. Chickpea is covered with glandular trichomes (club-shaped hair) that exude an acidic liquid (mainly malic acid) which evidently deters many potential herbivores from feeding on this crop (Fig. 86).

Two main types of chickpea are commonly grown (Fig. 87). The 'kabuli' type has large white seeds and is a popular human food in many countries, particularly in the Mediterranean area. The 'desi' type generally has smaller, colored seeds (yellow, brown, green, or black) and is most common in the Indian subcontinent and in Mexico. This type is used both as food by human beings and as feed for animals.

In general, the kabuli plants and seeds are much more susceptible to insect attack than the desi type.

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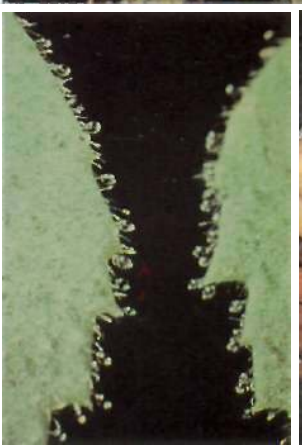

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Figure 85. Chickpea plant, Cicer arietinum *L.*

Figure 86. Acid exudate drops on leaflets.

Figure 87. Kabuli (light) and desi (dark) chickpea seeds.

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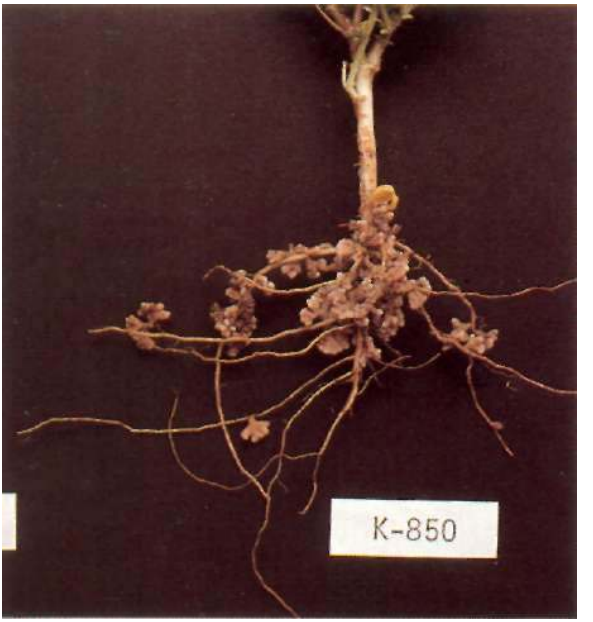

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Figure 88. Nodules containing rhizobia on chickpea roots.

Figure 89. Larvae of Metopina *sp damaging nodules.*

Pests Attacking Roots/Stems

Nodule-damaging Flies ***Metopina ciceri*** Disney (Diptera: Phoridae)

Distribution. Recorded only from peninsular India.

Symptoms. There are plenty of nodules containing rhizobia on chickpea roots (Fig. 88), which help fix nitrogen in the soil. At times small holes are seen in these nodules which when cut open are found to be extensively tunneled with varying degrees of decomposition.

Description and biology. The small white larvae (<1 mm long) and brown pupae can be seen in the tunnels in the nodule (Fig. 89). The tiny flies appear to be variable in their morphology. Very little is known of their biology.

Control. The crop loss resulting from such nodule damage has not been quantified but specific control measures may not be required. Soil insecticides may reduce the damage.

Sitona Weevils ***Sitona macularius*** (Marsham) (Coleoptera: Curculionidae)

Distribution. This pest is common in countries surrounding the Mediterranean.

Symptoms. The larvae feed mainly on roots and nodules of legumes, including chickpea. Heavy attacks lead to stunted, yellow plants. The adults feed upon leaves, cutting typical U-shaped notches from the edge of the leaflets.

Description and biology. The brown and white adults (4 mm long) (Fig. 90) emerge in winter and lay eggs in the soil. The cream-colored larvae feed mainly on nodules. There is only one generation per year.

Control. This weevil prefers lentil and seldom, if ever, damages more than 5% of chickpea plants or nodules in any field. Consequently, the damage to chickpea does not merit specific control measures.

Figure 90. Sitona macularius.

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Figure 91. Damage caused by Microtermes *sp.*

Termites ***Odontotermes*** spp
Microtermes spp
(Isoptera: Termitidae)

Distribution. Although these termites are widespread, they generally cause little damage to this crop but are important in some locations and soil types.

Symptoms. Plants attacked by *Microtermes* spp are wilted or dead and have a small entrance hole at or below the ground level (Fig. 91). The roots and stem are tunneled and the termites are found inside. *Odontotermes* spp cover the stems with earth sheeting under which they feed. Termite attacks are often associated with plants that have been weakened by disease or damaged mechanically.

Description and biology. The white, brown-headed, ant-like insects found in and around the plants are the 'worker' adults. They collect plant material and carry it to underground chambers where it is incorporated in 'fungus gardens', which provide food for the termite larvae.

Control. Damage is rarely serious enough to merit specific control measures, but dressing the seed with aldrin has been found to reduce attacks in some trials in northern India. Where termite mounds obstruct cultivation and other operations such as irrigation, nests can be killed by drenching with insecticides, before or after levelling.

Soil Beetles ***Gonocephalum*** spp
(False wire worms) (Coleoptera: Tenebrionidae)

Distribution. Widespread in India and Africa.

Symptoms. Attacked seedlings wilt or, some times are cut at ground level. Examination shows damage by feeding by the adult beetle, on the stem at or below ground level (Fig. 92). A search of the soil around the plants reveals the insects.

Description and biology. The beetles, 10 mm in length, are black and flat. Very little is known of the biology of these beetles.

Control. Although seedlings are killed by this insect, there has not been a report of infestations that kill more than a small percentage of plants in the field. If adequate seed rates are used, neighboring plants usually compensate for the loss of seedlings and no specific control measures are required.

92

Figure 92. Gonocephalum *sp adult damaging a seedling.*

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Figure 93. Seedling damaged by cutworm.

Figure 94. Agrotis ipsilon *moth.*

Figure 95. Cutworm larva.

Cutworms ***Agrotis ipsilon*** (Hufnagel)
Agrotis spp
(Lepidoptera : Noctuidae)

Distribution. *Agrotis ipsilon* is widespread and polyphagous throughout the tropics and subtropics. Other species of *Agrotis* are of localized importance.

Symptoms. Seedlings are cut through at or below ground level (Fig. 93). A search in the soil around such seedlings will reveal the larvae.

Description and biology. The large moths (25 mm long) of *A. ipsilon* have brown forewings and pearly hindwings with a brown margin (Fig. 94). The cream-colored eggs are laid singly on the plants or soil surface. Larvae feed on the foliage. The large larvae, 45 mm long, which are grey-black (Fig. 95), hide beneath the soil surface during the day and feed at night. Pupation takes place in the soil. One generation can be completed in 6 weeks.

Control. Although cutworms are not of widespread importance as pests of chickpea, they can be very damaging in some localities, killing more than 30% of the seedlings in some fields. Sprays of endosulfan, heptachlor, or aldrin have been reported to give adequate control, and poisoned bran baits have also been recommended for use in endemic areas. However, populations of these insects are usually heavily parasitized and so control is seldom needed. When damage is noticed it is usually too late to use insecticides economically.

Pests of Foliage and Pods

Aphids ***Aphis craccivora*** (Koch)
Acyrthosiphon pisum (Harris)
(Hemiptera: Aphididae)

Distribution. Both these species are widely distributed and found on a wide range of legumes in all regions where chickpeas are cultivated.

Symptoms. The aphids feed on stems, leaflets (Fig. 96), and pods (Fig. 97). The plants wilt when large colonies build up on them. However, stunt disease causes the most damage in chickpea (Fig. 98). This is caused by bean leaf-roll virus which is transmitted by these aphids. Stunt disease limits plant growth, and leaflets are small and reddish brown (yellow in kabuli types). Scraping the lower part of the stem reveals brown phloem which is characteristic of this disease.

Description and biology. *Aphis craccivora* (1.6 mm long) is a black shiny aphid while *A. pisum* (2 mm long) is grey-green. Winged parthenogenetic females are carried by the wind. Many that land on chickpea may be deterred and fly off or be killed by the acid exudate. Plants with colonies have little or no exudate. It is not known whether this is because the aphids feed on the exudate or whether colonies develop on plants that produce little exudate. The nymphs resemble the adults and one generation can be completed in less than 2 weeks.

Control. Aphids are seldom numerous enough on chickpea to merit control measures but stunt disease causes substantial losses in some years in some areas. Several chickpea genotypes are known to be resistant to this disease so the best means of combating it is by the use of resistant cultivars.

Figure 96. Aphis craccivora *on leaves.*

Figure 97. A. craccivora *on pods.*

Figure 98. Symptoms of stunt disease.

96

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98

Leafminers ***Liriomyza cicerina*** (Rondani)
Chromatomyia horticola (Goureau)
(Diptera: Agromyzidae)

Distribution. *Liriomyza cicerina* is common and causes damage in the chickpea-growing areas surrounding the Mediterranean. However, recent work has shown that many of the leaf mines occurring early in the season in these areas are caused by an unidentified species of *Agromyza. Liriomyza* sp has been reported to cause damage in Mexico. In India, leaf mines are occasionally seen on chickpea leaflets but these are reported to be caused by *C. horticola.*

Figure 99. Damage caused by Liriomyza cicerina.

99

Symptoms. The pale, serpentine mines in which the larvae feed can be clearly seen on the upper surface of the leaflets (Fig. 99). Heavy attacks lead to defoliation.

Description and biology. The adult flies (1.5 mm long) which are black and yellow, puncture the upper surface of the leaflets with their ovipositor and feed on the plant juices. This results in a stippled pattern on some leaflets. Small, white eggs are laid in some of these punctures. The egg hatches within 4 days and the yellow, maggot-like larvae tunnels through the parenchyma, forming a mine. The larva reaches full size (3 mm long) in about a week and pupates either in the leaf or, more commonly, in the soil. The life cycle is completed in about 3 weeks. It is suspected that the pupae survive the summer and winter in diapause.

Control. Heavy attacks by leaf miners can cause substantial defoliation and yield loss so control measures may be required in some areas. Low dosages of monocrotophos (0.025 kg a.i. ha^{-1}) have been found to give good control and should be applied during the vegetative stage to prevent buildup of infestations. Late-sown crops suffer most damage, so early sowing helps reduce losses. Deep plowing to reduce emergence from puparia has been suggested as a control measure. In some areas, parasites give adequate control of the leafminers, e.g., heavy parasitism of the first generation larvae has been reported from Spain. Differences in susceptibility to damage among genotypes has been reported, so screening and breeding for plant resistance may be profitable.

Armyworm ***Spodoptera exigua*** (Hiibner) (Lepidoptera: Noctuidae)

Distribution. *Spodoptera exigua* is a widely distributed polyphagous pest throughout most of the tropics and subtropics, but it is not reported from South America.

Symptoms. The green larvae feed mainly upon leaflets and occasionally on pods. Heavy infestations can defoliate plants.

Description and biology. The moths (13 mm) have greyish-brown forewings and opalescent hindwings with a dark edge (Fig. 100). Pinkish-white, oval eggs (0.5 mm long) are laid in clumps (of up to 150 eggs in each clump) on leaves of many plants, but rarely on chickpea. The larvae which feed on chickpea are generally found to have dispersed from egg masses laid on the weeds nearby. The green larvae hatch after two or more days and disperse (Fig. 101). They generally hide during the day but feed actively at night. The fully grown larva (25 mm long) buries itself in the soil where it pupates. One generation can be completed in less than 4 weeks under ideal conditions. When large populations of larvae are present in an area, they crawl across fields and destroy most green plants in their path.

Control. Although these larvae are common on chickpea in many parts of Asia, they seldom reach populations large enough to cause substantial damage and yield loss. This may be because they have a wide range of natural enemies. They are reported to be a major pest of chickpea in Mexico and have become resistant to several insecticides in that country. Synthetic pyrethroids may be most effective in controlling these insects.

100

101

Figure 100. Spodoptera exigua *moths.*

Figure 101. S. exigua *larvae.*

Figure 102. Species of Helicoverpa *and* Heliothis *moths recorded from chickpea.*

Pod Borers

Helicoverpa (Heliothis) armigera (Hubner)
Helicoverpa zea (Boddie)
Helicoverpa punctigera (Wallengren)
Helicoverpa assulta (Guenee)
(Lepidoptera: Noctuidae)
Heliothis virescens (Fabricius)
Heliothis viriplaca (Hufnagel)
Heliothis peltigera (Denis & Schiffermuller)

Distribution. *Helicoverpa armigera* is polyphagous and is widely distributed in the tropics and subtropics, but in the Americas, *H. zea* and *Heliothis virescens* are found. In Australia, both *H. armigera* and *H. punctigera* attack chickpea. In West Asia, *H. viriplaca* and *H. peltigera* (Fig. 102) are also found on the crop; *H. assulta* is occasionally reported from chickpea in India.

Symptoms. The larvae feed on all green parts and defoliate young crops in southern India (Fig. 103). Most damage is caused to the pods in which the large larvae cut round holes in the pod wall and devour the seed inside (Fig. 104).

Description and biology. *H. armigera* is a large brown moth (20 mm long) which is active at night. It lays eggs, usually singly, mostly on the undersides of leaflets (Fig. 105). Young larvae feed by scraping the surface of leaflets and the older larvae chew into leaflets, buds, flowers, and pods. Thefullygrown larva (40 mm long) may be of several shades of yellow, pink, red, brown, or black, but most of those found on chickpea are green. All larvae have characteristic and distinct light and dark bands along their sides. The fully grown larvae bury themselves in the soil or among plant debris to pupate. One generation can be

Continued

completed in as little as 4 weeks under optimum conditions. Other species have similar life histories.

Control. Some chickpea genotypes have considerable resistance to *Helicoverpa* spp and it is hoped that resistant cultivars will soon become available to farmers. Several insecticides, including endosulfan and synthetic pyrethroids give good control, particularly if applied when the larvae are small. However, considerable resistance to several insecticides has been reported in this species in areas where intensive insecticide use is common. As these pests have many natural enemies, pesticide use may lead to an increase in *Helicoverpa* and *Heliothis* populations through a reduction of the natural enemies. Insecticides should be used only on well-grown crops and only when the populations of larvae reach the 'economic threshold'. At ICRISAT, insecticide use appears to be profitable on good crops when two or more small larvae are found per plant. Insecticide dusts can be conveniently used on this crop, because the dust adheres to the exudate-covered plants.

Figure 103. Helicoverpa armigera *feeding on leaves.*

Figure 104. *Pod damage caused by* H. armigera.

Figure 105. H. armigera *eggs.*

103

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105

106

Figure 106. Semilooper damage to pods.

Semilooper ***Autographs nigrisigna*** (Walker) (Lepidoptera : Noctuidae)

Distribution. Several semiloopers have been reported to feed on chickpea, but the most important appears to be *A. nigrisigna* which is of some importance in northern India, particularly on Kabuli type chickpea.

Symptoms. The larvae feed upon leaflets and pods. When pods are attacked, much of the pod wall is eaten (Fig. 106). This is in contrast with the neat, round hole, characteristic of *Helicoverpa* damage.

Description and biology. The large, typically patterned moths lay their eggs in clumps (of 40 eggs or more in each clump) on the leaflets. The larvae, which are green semi-loopers, feed upon leaflets and on pods, reaching a length of 15 mm. Pupation takes place in the soil.

Control. Management of this pest is not very different from that of *H. armigera,* for the two species tend to occur in mixed populations. Endosulfan has been reported to give adequate control.

Pests of Stored Seeds

Bruchids ***Callosobruchus analis*** (Fabricius)
Callosobruchus chinensis (L.)
Callosobruchus maculatus (Fabricius)
(Coleoptera: Bruchidae)

Distribution. These pests are widespread, and are found in the stored seeds of several legumes, including chickpea, in most areas of the tropics and subtropics.

Symptoms. Bruchids are seldom found in chickpea pods in the fields, but they may infest the pods if they are left on the plants for several weeks after maturity. The white eggs are seen on the pods and the pod wall has a neat circular hole from where the adult would have emerged. These bruchids are very common in stored seed, where the eggs and the cylindrical emergence holes are obvious symptoms of infestation (Fig. 107).

Description and biology. The identification of these bruchids to the species level needs much expertise. Adults are small (3.0 mm long) brown beetles which lay their eggs on the seed surface (and rarely on mature pods in the field). The young larva hatches through the base of the egg and bores straight through the seed coat. The hatched eggs, therefore, seem to be intact. The white larva develops and pupates inside the seed. Populations build up quickly in stored seed because one generation is completed in 4-5 weeks and because each female lays more than 100 eggs.

Control. Stored seed can be protected from bruchids by keeping clean seed in pest-proof containers. Fortunately, chickpea growing in the field is rarely attacked, so freshly harvested grain is usually free from bruchids. Sun drying before placing the grain in a clean store should ensure that storage losses are minimal. It is possible to protect seed chemically, either by fumigation or by the admixture of insecticides, including malathion. Where small quantities of seed are to be used for sowing, as on research stations, moth balls (naphthalene) can be mixed with the seed to

prevent infestation. Another method of protecting seeds is to coat them with small quantities of vegetable oil or mix neem (*Azadirachta indica*) leaves or seeds in the stored grain. Some chickpea seeds are more susceptible to bruchid attack than others, kabuli types being particularly susceptible. In general, smaller seeds with rough seed coats are less susceptible, but as these characteristics are undesirable from the consumer viewpoint, breeding appears to offer little scope, except where the seeds are used as animal feed or consumed after removing the seed coat.

Figure 107. Callosobruchus *sp damage in stored seeds.*

107

108

109

110

Figure 108. Bird (parakeet)-damaged pigeonpea pod.

Figure 109. Bird (parakeet)-damaged chickpea pod.

Figure 110. Sown pigeonpea seed damaged by rats.

Other Animal Pests of Pigeonpea and Chickpea

Birds

Several species of birds attack both pigeonpea and chickpea, some at sowing and in the seedling stage, and others at the mature pod stage. In Syria, it has been reported that chickpea plants are damaged by birds pecking out the sown seed and the young seedlings. In many areas in India, parakeets particularly cause substantial damage to pods of both pigeonpea and chickpea (Figs. 108 and 109).

Control. Scaring away birds from fields at the seedling and maturity stages will reduce losses. However, several birds are insectivorous and are known to be important predators of *Helicoverpa* on chickpea, so bird-scaring will be counterproductive during the green pod stage when *Helicoverpa* infestations are present.

Rodents

Rats and other rodents damage chickpeas and pigeonpeas, both in the field and in the stores. Seeds are dug up and eaten by rats soon after sowing (Fig. 110). Green chickpea pods are taken from plants to the rats' burrows, the openings of which are often surrounded by discarded pod husks. Rodents also eat stored seeds, so rat proof storage is needed if the grain is to be stored for a considerable duration. Fumigation of rat burrows using zinc phosphide or other chemicals, and the use of baits containing rodenticides help reduce rat populations. However, care must be taken to ensure that other mammals, including man, are not harmed.

Beneficial Insects

Pollinators

Many insects including Hymenoptera, Diptera, and Lepidoptera visit pigeonpea flowers to feed on nectar and pollen (Figs. 111 and 112). Several of these carry pollen on their bodies and are likely to be involved in cross pollination.

The major pollinators are bees; both the social (*Apis* spp) and solitary bees (e.g., *Megachile* spp, Fig. 31).

In chickpea, relatively few insects visit the flowers and there is very little cross pollination.

Figure 111. Apis dorsata *pollinating pigeonpea.*

Figure 112. Xylocopa *sp pollinating pigeonpea.*

111

112

113a

113b

114

115

116

117

Natural Enemies

Many insect and animal species feed upon the insect pests on pigeonpea, and there are substantial numbers on chickpea also.

Insects and other animals that catch and eat these pests partly or wholly are known as predators. Animals that feed and develop on or in the bodies of other insects are known as parasites and those that kill their hosts are referred to as parasitoids. These natural enemies can be so abundant that the populations of insect pests are reduced to levels that cause little crop damage. In such cases, insecticides need not be applied.

It is not possible to illustrate all the natural enemies of these pests in a small publication like this, so a few representative examples have been given. It is essential that anyone attempting to conduct research on pest management or anyone involved in extension activities should be able to distinguish between pests and the beneficial insects found on these crops. A comprehensive record of different parasites and predators of these pests will be published in the near future.

Predators

Many predators (Figs. 113-122) feed on insect pests that attack pigeonpea and chickpea. For example, on ICRISAT farm we observed more than 20 species of insects that prey on *H. armigera* eggs and larvae. In addition to the predatory insects, several species of spiders, lizards, and birds have been observed to feed on *H. armigera* larvae.

Figure 113a. Ootheca, an egg case, of praying mantis.

Figure 113b. A praying mantis predator on pigeonpea.

Figure 114. Robber fly, a Helicoverpa *predator.*

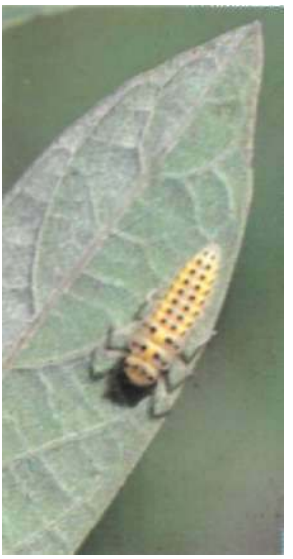
Figure 115. Dragon fly, a Helicoverpa *predator.*

Figure 116. A spider predator on pigeonpea.

Figure 117. The king crow or drongo, a Helicoverpa *predator.*

118

119



120a

120b

Figure 118. Chrysopa *sp., a predator on pigeonpea.*

Figure 119. A reduviid feeding on Helicoverpa *larva.*

Figure 120. Cheilomenes sexmaculatus, *an aphid predator; (a) grub and (b) adult.*

121

122

Figure 121. A mud wasp carrying a Helicoverpa *larva.*

Figure 122. A mud wasp's nest packed with Helicoverpa *larvae.*

Parasitoids

Several parasitoids have been recorded from among the pigeonpeaand chickpea pests. Forexample, morethan 25 species of insects have been recorded as being parasitic on *H. armigera* in southcentral India. All these are hymenopteran and dipteran; some examples are illustrated here (Figs. 123-125).

Nematodes also parasitize *H. armigera* larvae, especially during the rainy season. These nematodes, *Ovomermis albicans* (Fig. 126) grow to 10 cm or more. They coil up inside *H. armigera* larvae, and kill them before pupation by consuming and disrupting the internal organs of the host.

Figure 123. Life stages of Eucelatoria bryani, a Helicoverpa *parasite.*

Figure 124. Pupae of Apanteles *(wasp) parasite on pigeonpea.*

Figure 125. Pupa of Compoletis chlorideae *parasite, a major enemy of* Helicoverpa.

Figure 126. Ovomermis albicans, *a nematode parasite on* Helicoverpa *larvae.*

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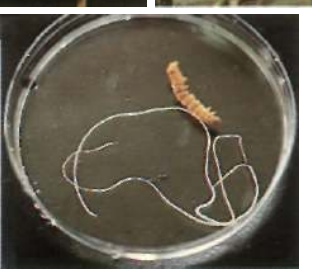
126



127a

127b

128

Figure 127a. H. armigera *larva infected by nuclear polyhedrosis virus on pigeonpea.*

Figure 127b. H. armigera *cadaver full of brown liquid containing virus particles.*

Figure 128. H. armigera *larva killed by nuclear polyhedrosis virus on chickpea.*

Insect Diseases

There are several disease-causing organisms including fungi, bacteria, and viruses, that infect and kill insects. However, such diseases are beneficial when they infect the insect pests.

An example of a beneficial viral disease that causes considerable mortality to a major pest is the Nuclear Polyhedrosis Virus (NPV) that infects *H. armigera.* This virus appears to be fairly common and widespread, for it has been reported to infect this pest in Africa, Asia, and Australasia. Infected larvae become sluggish, stop feeding, and eventually die. The infected larvae are often found hanging head downward from twigs (Figs. 127a, b, and 128). The cadavers are full of brown liquid which contains the virus particles (Fig. 127b). If such dead larvae are crushed and mixed with water, the mixture can be used as a cheap insecticide. This infects larvae that feed upon foliage or pods contaminated by the virus particles and thus controls the pest. However, infected larvae take a week or more to die and can cause substantial damage during that period. Also, the virus is inactivated by sunlight, so such sprays are not persistent unless mixed with some stabilizers.

Notes

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