concentration is toxic to some plant species. Moreover, development of resistance to insecticides is a major problem in the management of *S. exigua* because it attacks several crops. This results in frequent insecticide applications and a pest status as a secondary or induced pest in some crops. Insecticides have not been evaluated for control of *S. praefica* on chickpea, although they are used on other crops against damaging populations of this pest in the U.S. Pacific Northwest.

Integrated pest management. Improving the prospects for protecting chickpea crops from infestations by *Spodoptera* spp. requires the development of integrated pest management tactics. These should include monitoring of adults with pheromone traps, field sampling to estimate damaging populations, and the use of biopesticides and natural plant products that are compatible with natural enemies. In India, three insecticides (endosulfan, fenvalerate, and cypermethrin) can be used to control outbreaks of *S. exigua*. In the absence of integrated pest management programs for most of the grain legume insect pests in North America, including *S. praefica*, the only control strategy available is insecticides. The development and deployment of *Bt*-transgenic chickpea has received attention and could be a promising tool for protecting chickpea crops from damage by *Spodoptera* spp.

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(Prepared by R. Ahmad, P. Durai Murugan, P. Arjuna Rao, and S. L. Clement)

Black Aphid

The black aphid, *Aphis craccivora* (Hemiptera: Aphidiidae), also commonly known as the cowpea aphid, black legume aphid, groundnut aphid, bean aphid, lucerne aphid, black lucerne aphid, and African bean aphid, is an important pest of chickpea on the Indian subcontinent and an occasional pest in the Pacific Northwest of the United States. It is also important as a vector of chickpea stunt disease.

Geographic Distribution

The black aphid is distributed in Africa, Asia, Australasia, Central America, Europe, North America, the Pacific islands, and South America. It is widely distributed in the tropics, where it is one of the most common aphid species.

Host Range

A. craccivora has an extensive host range and damages several grain legumes including chickpea, lentil, cowpea, groundnut, alfalfa, and other legumes. It also infests *Glircidia* spp., *Capsella bursa-pastoris*, *Chenopodium album*, *Polygonum lapathifolium*, and *Rumex crispus*. *A. craccivora* is a key pest of lentil in Castilla La Mancha (central Spain).

Nature of Damage

Both nymphs and adults suck the plant sap from the tender leaves, stems, and pods and colonize mostly the young leaves and growing points, which become characteristically deformed (Fig. 187). Yield can be drastically reduced, and if infestations are early and severe, plants can be killed. Infestations during the bloom and early pod stages reduce yield and crop quality by removing plant sap, impairing pod appearance, and reducing seed fill and by the presence of aphid honeydew. Plants with high populations also have reduced ability to fix nitrogen. In many areas, *A. craccivora* is more important as a vector of viruses than as a direct plant feeder. While feeding, the aphid produces considerable amounts of honeydew, upon which sooty mold grows. The black sooty mold reduces photosynthesis and may make leaves unpalatable to livestock. The honeydew also makes the plants sticky, which causes problems during harvesting and threshing.

Life Cycle

A. craccivora is readily distinguishable from other aphids. It is a relatively small insect, and the adults are usually shiny black, while the nymphs are slate gray. The appendages are usually whitish with blackish tips. *A. craccivora* matures from nymph to adult in 8–10 days. The aphids are active throughout the year, and a female can produce over 100 nymphs in 15 days. There are several generations per year in the tropics. Winged, sexual forms of *A. craccivora* also occur in some regions, e.g., India, but not in others.

Management

Monitoring. Crops should be monitored regularly for aphid infestation, particularly when they begin to flower. Action thresholds are one to two aphids per leaf, two to three aphids per stem tip, or nine to 13 aphids per sweep, if a sweep net is used for sampling.

Cultural control. Early sowing leads to early canopy closure, which also helps in reducing the spread of viruses in chickpea. Aphid infestation is greater with wider spacing.

Biological control. *A. craccivora* is attacked by several parasites and predators. Ladybirds such as *Coccinella septempunctata*, *C. transversalis*, *C. nigritis*, *Cheilomenes sexmaculatus*, *Menochilus sexmaculatus* (Fig. 188), and *Brumus suturalis* and chrysopids such as *Chrysoperla* spp. are common aphid predators. Parasitoids such as *Trioxys indicus* and *Lipolexis scutellaris* are important natural enemies of *A. craccivora* in India. Although parasitism as high as 95% has been documented, aphid population levels can be so high that enough nonparasitized individuals remain to cause significant injury.

Biopesticides. Plant products such as azadirachtin, neem oil, and pyrethrins have shown some suppression of *A. craccivora* populations but do not provide effective control of the aphids.

Host plant resistance. A number of genotypes have been reported to be less susceptible to aphid damage. Chickpea cultivars

Fig. 187. Black aphid, *Aphis craccivora*, on chickpea (left) and lentil (right). (Courtesy ICRISAT [left] and W. Chen [right])

Fig. 188. Coccinellid beetles feeding on *Aphis craccivora* in chickpea (left) and lentil (right). (Courtesy ICRISAT [left] and W. Chen [right])

with low trichome density, those devoid of trichomes, and those with low acid exudates are highly susceptible to aphid damage.

Chemical control. Generally, there is no need for aphid control on chickpea in India, but chemical control may become necessary to prevent secondary spread of the chickpea viruses. A number of insecticides such as methomyl, oxy-demeton methyl, and monocrotophos are effective for aphid control. *A. craccivora* has developed resistance to some commonly used insecticides in India.

Integrated pest management. Aphids usually infest lentil crops only at later stages of development (podding), where no spray is necessary. However, if infestation occurs before pod maturity, insecticide sprays may be applied. Aphids are attacked by a number of natural enemies, especially predatory coccinellids, which have potential for management of aphids. Although the larvae and adults feed on aphids, the extremely fast reproduction rate of the aphids can prevent the coccinellids from sufficiently reducing infestation levels. Under heavy infestation, application of selective insecticides for aphid control may still be necessary.

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(Prepared by H. C. Sharma, M. K. Dhillon, and J. Romeis)

Black Cutworms

The black cutworm *Agrotis ipsilon* (Lepidoptera: Noctuidae) is a polyphagous pest on several field crops. The other two species, *A. flammatra* and *A. spinifera,* are of minor importance.

Geographic Distribution

Agrotis species are widely distributed worldwide and are pests of several crops in different agroecosystems. *A. ipsilon* is widely distributed in Australia, China, Europe, Hawaii, India, Indonesia, Japan, Myanmar, New Zealand, North Africa, Sri Lanka, and Syria. In Europe, it is found in almost all countries extending from Ireland and Portugal in the west to Bulgaria and Romania in the east and from Norway and Finland in the north to Sicily in the south. It is widespread and more damaging in the Northern Hemisphere than in the Southern Hemisphere. It annually reinvades temperate areas, overwintering in warmer or subtropical regions. Long distance dispersal of adults has long been suspected in China, Europe, and North America. The cutworms move north in the spring and south in the autumn. Studies in the United States demonstrate northward displacement of moths during the spring at approximately 1,000 km in 2–4 days when assisted by a northward wind. Similar displacement to the south and southwest has been documented in the autumn.

Host Range

The black cutworm feeds on chickpea, lentil, pea, potato, and other crops in northern India. It also damages alfalfa, artichoke, beet, cabbage, cauliflower, clover, cotton, cucurbits, grapevine, linseed, maize, mustard, pepper, poppy, rice, sorghum, soybean, strawberry, sugarcane, sunflower, sweet potato, tobacco, tomato, vegetables, wheat, and several weeds. Among weeds, suitable hosts for larval development are *Amaranthus retroflexus, Barbarea vulgaris, Chenopodium album, Poa pratensis,* and *Rumex crispus.*

Nature of Damage

The larvae feed on leaves, stems, and roots of many field crops, including chickpea and lentil. Up to 10% plant damage has been recorded at 40 days after crop emergence in chickpea. The older larvae cut the plant above the root crown (Fig. 189). Most of the plant is not consumed after cutting, and larvae move to another plant, leaving the earlier one to wither and dry. Some species feed on the upper leaves before moving to the soil surface (Fig. 190). Heavy damage by cutworms occurs in areas that remain flooded during the rainy season.

Life Cycle

The moths are gray brown with a wingspan of 40–50 mm (Fig. 191). The forewings are light brown, patterned with an ipsilon shape, and the hindwings are creamy white with brown edges. The moths appear in the plains in October and come out at dusk and fly until darkness sets in. After mating for 4–6 days, the female begins to oviposit at night and lays creamy white, dome-shaped eggs singly or in small groups on moist soil, weeds, or leaves of host plants. Oviposition continues for 5–11 days. The preoviposition and oviposition periods vary from 3.9–5.5 and 5.8–8.3 days, respectively. A female may lay 639–2,252 eggs.

Fig. 189. *Agrotis ipsilon* larva and damage on chickpea. (Courtesy ICRISAT)

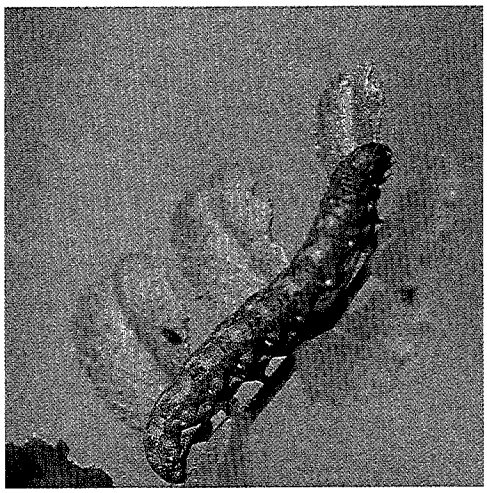

Fig. 190. *Agrotis ipsilon* larva feeding on chickpea foliage. (Courtesy ICRISAT)

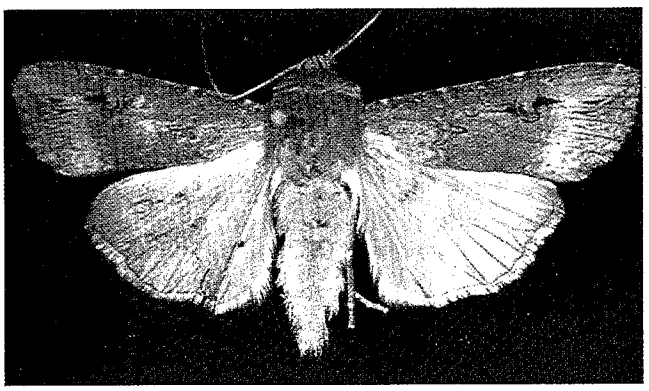

Fig. 191. *Agrotis ipsilon* adult. (Courtesy ICRISAT)