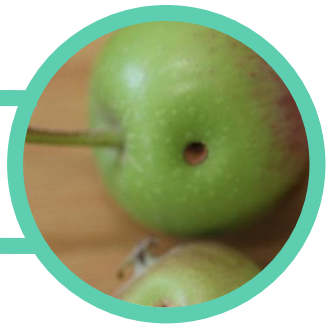
PEST FACT SHEET

African bollworm



Helicoverpa armigera

Common names: cotton bollworm, corn earworm, Old World bollworm, Afrikabolwurm, Amerikaanse bolwurm, katoenbolwurm
Higher taxon: Lepidoptera: Noctuidae
Synonyms: *Heliothis armigera*
EPPO code: HELIAR

African bollworm is a highly polyphagous and destructive pest which attacks over 180 plant species, including most of the cultivated crops in South Africa. In South Africa, it is most destructive to cotton and maize, but sporadic outbreaks on grapevines, deciduous fruit and citrus can be economically devastating.

African bollworm is a typical noctuid moth which is active at night. Adults feed on sugary substances and lay eggs on or near flowering plants. The larvae are the harmful stage as they target reproductive parts of the plant and bore unsightly holes which deem fruit unmarketable or severely reduce the vigour and yield of affected plants.

Monitoring for African bollworm is best accomplished through manual scouting for eggs and larvae in a standardized manner which varies from crop to crop. Economic action thresholds have been developed for many South African crops. Insecticides should not be applied unless action thresholds are exceeded, as African bollworm readily develops resistance to insecticides. For some crops, like *Bt*-cotton, genetically modified cultivars have been developed which prevent African bollworm infestation.

African bollworm, *Helicoverpa armigera*, adult.

African bollworm. Credit: R. Sugayama
https://gd.eppo.int/taxon/HELIAR/photos

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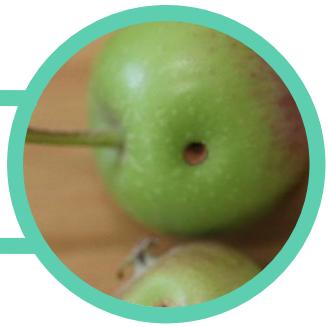

Helicoverpa armigera

BIOLOGY

Number of generations per year: 2-5
Length of generation: ~ 50 days, variable depending on host and environment
Threshold for development: 14º C (lower), 36º C (upper).

Life history of the African bollworm varies greatly depending on the host plant and environmental conditions. African bollworm moths are nocturnal, strong fliers which are most active from sunset until dark. During typical conditions, moths can travel up to 10 km during “non-migratory” flights. When conditions are suboptimal, such as low host availability or quality, moths have been known to fly as much as 250 km in “migratory” flights to find new hosts. Adults feed on nectar and other sources of sugar in the environment immediately upon emergence. Female adults must feed before ovarioles mature and they can begin laying eggs.

Reproduction is sexual and adults begin to mate 2-3 days after emergence. Adult females lay eggs singly on or near plant flowering parts or leaves of plants which will soon flower. Although this varies from country to country and crop to crop, each female lays an average of 730 eggs over a period of 10-23 days. Females prefer hairy surfaces as oviposition sites, as this is often correlated with time until bud burst and flower production in many host plants.

Eggs then hatch within 3-5 days and larvae immediately tunnel into plant reproductive parts such as cotton bolls, maize ears, or young apples. Larvae feed on internal plant tissue and leave characteristic holes and tunnels, sometimes filled with frass. The larvae moult 5 or 6 times during which they may be found within the plant, on the surface or within open flowers.

Pupation site depends on the host plant. On cotton, African bollworm pupates in silken cocoons on the plant or among dry leaves beneath the plant. In maize, however, final instar caterpillars drop to the soil and pupate at a depth of 3-15 cm within the soil. At this stage, the pupa may go through a facultative diapause which extends the pupal period. The lower the temperature, the longer the pupal period.

In South Africa, there is a small peak of adult emergence at the onset of spring between August and October, especially in places with cold winters. These are mostly adults which emerge from pupae which experienced diapause throughout the winter. In areas with mild winters, long summers and a succession of irrigated crops available, bollworm generations succeed each other continuously, with some overlap, throughout the season. Here, there tends to be a second, larger peak of adult emergence in February or March. Under optimal conditions, there may be two generations of adults within this short window.

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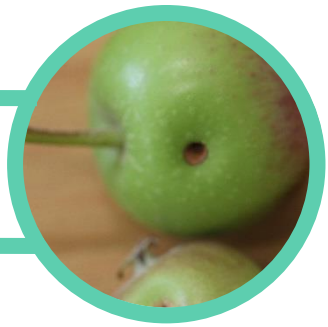

Helicoverpa armigera

IDENTIFICATION

Egg

Size: 0.4-0.6 mm long
Duration: 3-5 days
Spherical, shiny yellow or whitish, darkening closer to hatching. With approximately 24 longitudinal ridges and usually laid singly on leaves or other plant parts of plants in flower or close to flowering.

African bollworm eggs. Source: http://www.infonet-biovision.org/PlantHealth/Pests/African-bollworm

Larva

Final instar size: 30-40 mm long
Number of instars: 5-7
Duration: ~29 days
First and second instars are yellowish-white or reddish-brown with indistinct markings. Head, prothoracic shield and legs black and body spotted looking. Prolegs are present on the 3rd-6th and 10th abdominal segments. Later instars vary widely in colour – from shades of green to yellow, pinkish, reddish-brown or black – and have characteristic patterns of markings with a narrow dark band down center line of insect; on each side, a broad pale band then a broad dark band. The spiracles can be seen clearly on the light band. Underside is uniformly pale. Appearance of wavy or wrinkled longitudinal stripes along the dorsal pattern.

African bollworm larva. Source: http://www.africanmoths.com/pages/NOCTUIIDAE/HELIOTHINAE/helicoverpa%20armigera.htm

Pupa

Size: 14-18 mm long
Duration: 15.5 days but may enter diapause
Mahogany-brown with smooth surface. Pupa is rounded at both ends and posterior (abdominal) end has two tapering parallel spines.

African bollworm pupa. Source: http://www.infonet-biovision.org/PlantHealth/Pests/African-bollworm

Adult

Size: 3.5-4 cm wingspan; 14-18 mm long
Duration: males: 8.1 days; females: 11.4 days
Mean number of eggs laid by single female: 730
Stout-bodied moth which has a broad thorax which tapers toward the abdomen. Colour varies form dull yellow, pale brown to reddish-brown. A dark band is often present across edge of forewings, with a dark spot in the middle of the wing. Hind wings are paler, greyish-white with dark brown edges.

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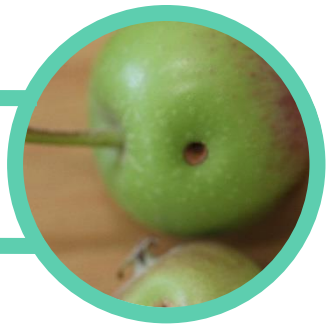

Helicoverpa armigera

ECONOMIC IMPORTANCE

The damage caused worldwide by African bollworm is estimated to be US$2 billion per year. Larvae feed mainly on flowers and fruit of high value crops, and thus even at low population densities, damage may be substantial economically. Feeding damage results in holes bored into reproductive structures and feeding within plants. Secondary fungal or bacterial infections may occur.

The pest status of African bollworm is exacerbated by its broad host range, feeding preference for reproductive parts of the plants, high fecundity, high mobility and ability to adapt to different climates by entering facultative diapause.

For example, on cotton, African bollworm begins by feeding on leaves, but then bores into flowers and bolls. The larva may move from boll to boll, causing bolls to fail to develop and severely effecting the quality of the lint.

African bollworm feeding damage to carnation flower heads. From: https://gd.eppo.int/taxon/HELIAR/photos

African bollworm feeding damage to French beans. From: https://gd.eppo.int/taxon/HELIAR/photos

HOST PLANTS

At least 180 plant species are known as hosts of African bollworm. It attacks almost all cultivated crops in South Africa as well as deciduous fruit, vegetables and ornamentals. It is also present on native vegetation and on weeds. Below is a partial list of some of the most important hosts in South Africa.

Common name	Scientific name	Family
Cotton	*Gossypium* spp.	Malvaceae
Apple	*Malus domestica*	Rosaceae
Grapevine	*Vitis* spp.	Vitaceae
Maize	*Zea mays*	Poaceae
Citrus	*Citrus* spp.	Rutaceae
Stone fruit (peach, plum, apricot)	*Prunus* spp.	Rosaceae

African bollworm feeding damage.

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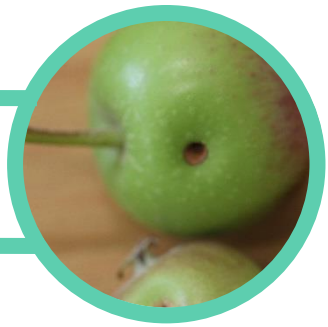

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MANAGEMENT

Monitoring

Light traps and pheromone traps (which attract males) can be used to observe the onset of an outbreak. However, trap counts do not correlate with damage. Instead, monitoring for larvae should be implemented in a standardized way depending on the crop. For instance, in apple orchards, 25 trees per block are selected for monitoring. At weekly intervals from just before blossom until just after petal fall, five fruiting spurs should be inspected for bollworm presence of eggs or larvae. No official threshold exists for apples, but sprays should target early instar larvae to be most effective. In cotton, the action threshold is five larvae per 24 plants of refuge (non-*Bt*) cotton or one egg per two plants in twice-weekly counts.

Prevention

Computer modelling has been used as a way to predict when, where, and to what extent bollworm infestations are likely to require control measures. This is effective in cotton in Australia and the USA but is not used widely in South Africa.

Control measures

Control measures vary from crop to crop, but integrated controls are always recommended with as little insecticide application as possible as African bollworm has been known to develop resistance.

Recommended integrated measures vary from careful monitoring and timing of chemical insecticide applications, to augmentation or introduction of natural enemies, to cultivation of genetically-modified crops which are resistant to damage by African bollworm, such as *Bt*-cotton.

African bollworm feeding damage to grape.

African bollworm feeding damage to apple.

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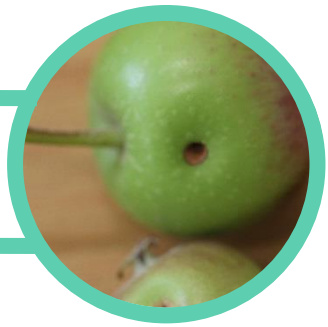

Helicoverpa armigera

MANAGEMENT

Natural enemies (biological control)

A vast number of natural enemies have been listed for African bollworm. Species of *Telenomus* and *Trichogramma* parasitic wasps are important egg parasitoids. There is at least one species in each of the Braconidae (wasp), Ichneumonidae (wasp) and Tachinidae (fly) families which are effective larval parasitoids. During the 1970s and 1980s several species of *Trichogramma* wasps were introduced into South Africa for the control of African bollworm. However, none of these became established.

Predators have also been identified as important in some regions and on some crops, particularly species of Anthocoridae (*Orius*-like bugs), Chrysopidae (lacewings) and Formicidae (ants) may feed on bollworm eggs or larvae. Entomopathogenic nematodes, bacteria (including *Bacillus thuringiensis*) and a virus specific to this species, Helicoverpa armigera nuclear polyhedrosis virus (HaNPV), have all shown promise as potential alternatives to chemical insecticides.

Attractants and trapping (pheromonal control)

A sex pheromone, (*Z*)-11-hexadecenal and (*Z*)-9-hexadecenal in a ratio of 97:3 has been isolated, commercialized and is known to attract male African bollworm. This pheromone is most effective when used in funnel or Texas traps rather than sticky traps. However, trap catches have been consistently found not to correlate with plant damage, so this pheromone trapping is used mainly to determine presence of African bollworm or onset of an outbreak. In order to time chemical applications, manual scouting for larvae or eggs must be applied.

QUARANTINE REGULATIONS

African bollworm is listed as an A2 quarantine pest by the EPPO. Although its current distribution probably already includes all areas which can possibly be infested, there is a concern that new infestations can disrupt northern European glasshouses.

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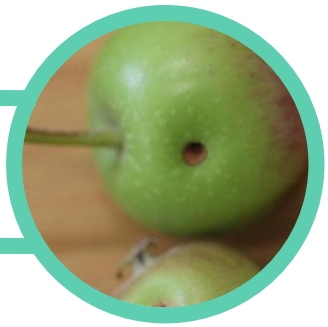

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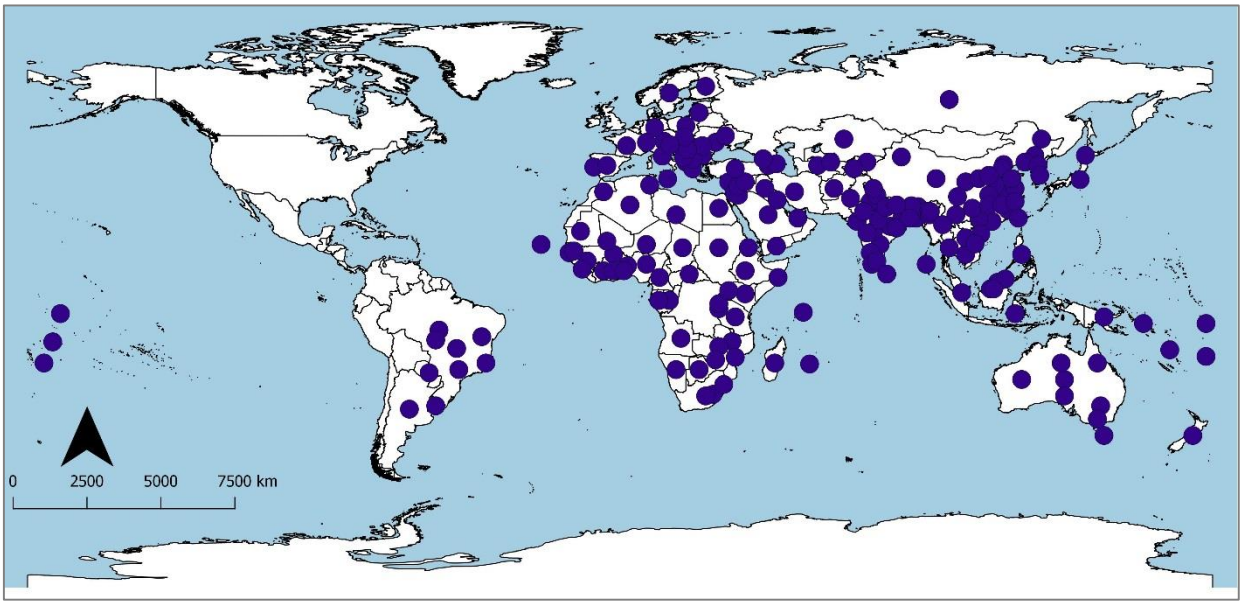
DISTRIBUTION

African bollworm is native to Africa but is also widespread throughout Europe, Asia and Australia. It also recently arrived in Brazil.



African bollworm, *Helicoverpa armigera,* distribution. Data from CABI (2017). Map drawn by C.S. Bazelet.

REFERENCES

1. Bennett A. (2015) Cotton. In: Prinsloo G.L., Uys V.M. (Eds.) Insects of cultivated plants and natural pastures in southern Africa. Entomological Society of Southern Africa, Hatfield, pp. 289-293.
2. CABI (2016) Data sheet report for *Helicoverpa armigera* (cotton bollworm). Crop Protection Compendium. Wallingford, UK: CAB International. www.cabi.org/cpc.
3. Cunningham J.P., Zalucki M.P., West S.A. (1999) Learning in *Helicoverpa armigera* (Lepidoptera: Noctuidae): a new look at the behaviour and control of a polyphagous pest. Bulletin of Entomological Research 89: 201-207.
4. EPPO (2017) Data sheets on quarantine pests: *Viteus vitifoliae*. European and Mediterranean Plant Protection Organization. https://https://gd.eppo.int/taxon/VITEVI.
5. Gerson U., Applebaum S. (2015) *Helicoverpa armigera* (Hübner). Plant Pests of the Middle East http://www.agri.huji.ac.il/mepests/pest/Helicoverpa_armigera/.
6. Pringle K.L., Heunis J.M. (2012) Bollworm management in apple orchards. South African Fruit Journal. February/March. 34-35.
7. Vermeulen J.B., Bedford E.C.G. (1998) American bollworm *Helicoverpa (=Heliothis) armigera* (Hübner). In: Bedford E.C.G., Van den Berg A.M., de Villiers E.A. (Eds.) Citrus Pests in the Republic of South Africa. Institute for Tropical and Subtropical Crops, Nelspruit, South Africa. 217-221.

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