EPPO Datasheet: *Helicoverpa zea*

Last updated: 2022-04-22

IDENTITY

Preferred name: *Helicoverpa zea*
Authority: (Boddie)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Lepidoptera: Noctuidae
Other scientific names: *Bombyx obsoleta* Fabricius, *Heliothis umbrosa* Grote, *Heliothis zea* (Boddie), *Phalaena zea* (Boddie)
Common names: American bollworm, American cotton bollworm, New World bollworm, corn earworm, cotton bollworm, sorghum headworm, soybean podworm, tomato fruitworm
view more common names online...
EPPO Categorization: A1 list
view more categorizations online...
EU Categorization: Quarantine pest ((EU) 2019/2072 Annex II A)
EPPO Code: HELIZE



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Notes on taxonomy and nomenclature

The genus *Helicoverpa* (Lepidoptera: Noctuidae) contains several polyphagous moths that cause severe negative impacts on agricultural crops worldwide during their larval development. *H. armigera* (Old World cotton bollworm) is the most widely distributed of these pests. *H. armigera* is closely related to *H. zea* (New World corn earworm), sharing external morphology, overlapping bioclimatic niche use, and host range and cannot be distinguished with the naked eye (Mitchell & Gopurenko, 2016). Hardwick (1965) referred to 17 species in the *Helicoverpa* species complex on the basis of differences in both male and female genitalia. Given the difficulty of distinguishing *Helicoverpa*/*Heliothis* species in the Heliothinae subfamily (with 381 species described) based on morphological characters (dissection of genitalia is required for identification), molecular markers are the best option for accurate detection of species in the *Helicoverpa* genus. In addition, *H. armigera* and *H. zea* can hybridize and produce fertile offspring (Nagoshi *et al.*, 2016, Cordeiro *et al.*, 2020), hence, *H. armigera* x *H. zea* hybrids might exist in the field, with unknown biological traits (e.g. resistance genes), and/or impacts in relevant crops. It is possible that *H. armigera* x *H. zea* hybrids could cryptically spread and avoid detection.

HOSTS

H. zea is regarded as being polyphagous in feeding habits but maize is a preferred host in North America, particularly when maize silks are present in early reproductive stages, in addition to sorghum. On both wild and cultivated hosts, *H. zea* prefers to feed on flowers and fruits. Most hosts are recorded from the Poaceae, Malvaceae, Fabaceae and Solanaceae families; in total more than 100 plant species are recorded as hosts.

The crops most frequently recorded as host plants are maize, sorghum, cotton, *Phaseolus*, peas, chickpeas, tomatoes, aubergines, *Capsicum*, *Vicia* and, to a lesser extent, *Trifolium*, okras, cabbages, lettuces, strawberries, tobacco, sunflowers and Cucurbitaceae. Damage to fruit trees has also been recorded. Buds and flowers of a wide range of ornamentals are attacked. Most infestations are of field and garden crops, but invasion of greenhouses, though rare, can occur, and protected crops are clearly at risk.

The expression of host preference depends upon a complex of factors including spatial and temporal availability of the hosts at the preferred stage of development. Maize and grain sorghum are preferentially attacked in most locations, although legumes are widely infested. Cotton is a crop which is particularly susceptible to damage by *H. zea* but is not a preferred (primary) host, because in many places it is only heavily attacked after alternative hosts have senesced or been harvested. *Trifolium* and other legumes are often important host plants in the spring before the annual crops are established.

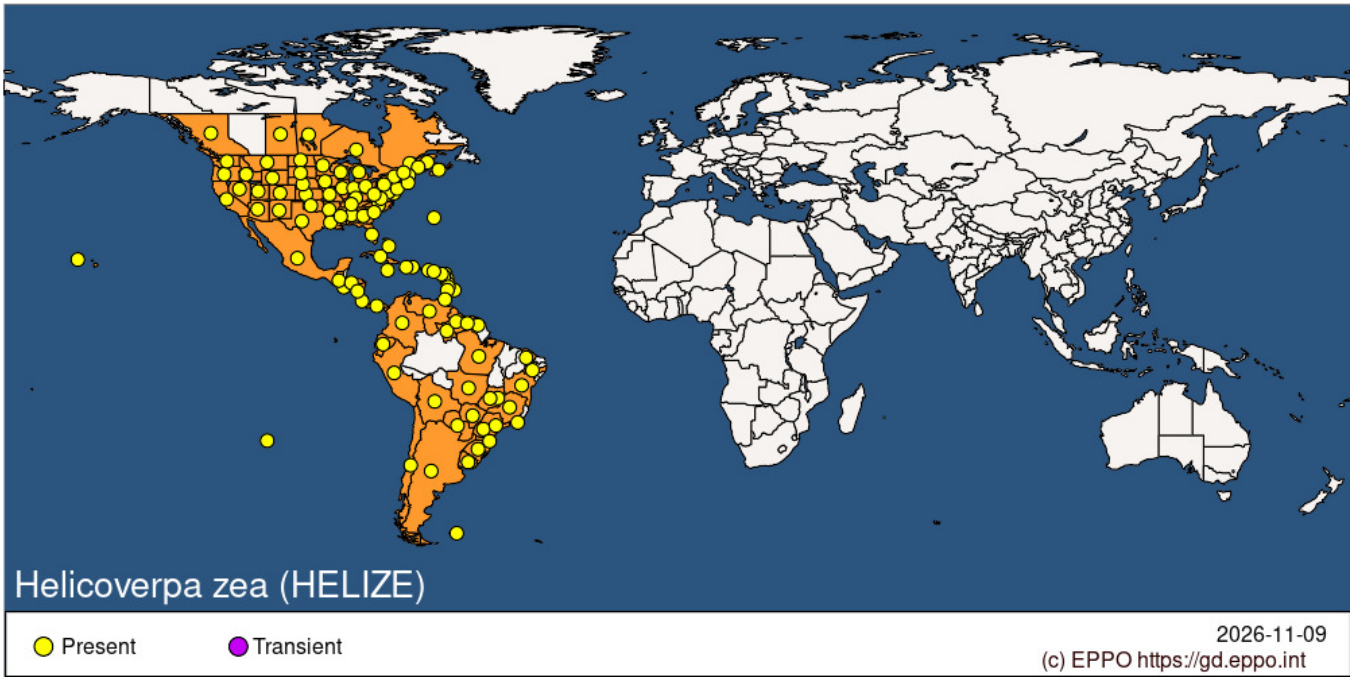
Many host crops for *H. zea* are available in the EPPO region, especially in the southern part. Many wild host species could act as sources of infestation of commercial crops. Further north in the region, glasshouse crops could be attacked.

For further information see Barber (1937), Neunzig (1963), Davidson & Peairs (1966), Matthews (1991), Cunningham & Zalucki (2014).

Host list: *Abelmoschus esculentus, Abutilon theophrasti, Acalypha persimilis, Amaranthus palmeri, Amaranthus, Apium graveolens, Arachis hypogaea, Avena sativa, Brassica oleracea, Cajanus cajan, Calendula, Canna indica, Cannabis sativa, Capsicum annuum, Cenchrus americanus, Chenopodium quinoa, Chenopodium, Cicer arietinum, Cichorium intybus, Citrullus lanatus, Citrus x aurantium var. sinensis, Citrus x limon, Coronilla varia, Cucumis melo , Cucumis sativus, Cucurbita pepo, Cynara scolymus, Datura stramonium, Digitaria sanguinalis, Erigeron canadensis, Erodium cicutarium, Fragaria chiloensis, Fragaria x ananassa, Galinsoga quadriradiata, Geranium dissectum, Gladiolus, Glandularia bipinnatifida, Glebionis coronaria, Glycine max, Gossypium hirsutum, Helianthus annuus, Hibiscus sabdariffa, Ipomoea cordatotriloba, Ipomoea purpurea, Lactuca sativa, Linum, Lonicera japonica, Malva neglecta, Malva parviflora, Malva pusilla, Medicago lupulina, Medicago sativa, Nicotiana repanda, Nicotiana tabacum, Nuttallanthus canadensis, Oryza sativa, Panicum dichotomiflorum, Phacelia , Phaseolus lunatus, Phaseolus vulgaris, Phaseolus, Physalis, Pisum sativum, Prunus persica, Prunus sp., Prunus, Pyrus communis, Rosa, Ruellia ciliatiflora, Ruellia runyonii, Saccharum officinarum, Secale cereale, Setaria italica, Sida spinosa, Solanum elaeagnifolium, Solanum lycopersicum, Solanum melongena, Solanum tuberosum, Sorghum bicolor, Sphaeralcea sp., Spinacia oleracea, Stachys bullata, Tagetes, Trifolium incarnatum, Trifolium pratense, Trifolium, Triticum aestivum subsp. aestivum, Urochloa texana, Vicia faba, Vicia, Vigna unguiculata, Vitis vinifera, Xanthium chinense, Xanthium strumarium, Zea mays*

GEOGRAPHICAL DISTRIBUTION

The more extreme northerly and southerly records are due to annual migrations. Hardwick (1965) regards this species as a seasonal migrant occurring regularly as far north and south as the 52nd parallels of latitude, from Saskatoon in the north to the Falkland Islands in the south.



North America: Canada (British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Québec, Saskatchewan), Mexico, United States of America (Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode

Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming)
Central America and Caribbean: Antigua and Barbuda, Bahamas, Barbados, Bermuda, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Montserrat, Nicaragua, Panama, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, Virgin Islands (US)
South America: Argentina, Bolivia, Brazil (Bahia, Ceara, Distrito Federal, Goias, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Para, Parana, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Roraima, Santa Catarina, Sao Paulo), Chile (Easter Island), Colombia, Ecuador, Falkland Islands, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela

BIOLOGY

Eggs are laid mostly on the silks of maize plants in small numbers (one to three), stuck to the plant tissues. On other key host plant species, eggs are laid on soybean on the abaxial side of leaves, on cotton on leaves or fruiting structures, and on leaves or the panicle of grain sorghum. Choice of oviposition site by the female seems to be governed by a combination of physical and chemical cues. Female fecundity can be dependent upon the quality and quantity of larval food, and also on the quality of adult nutrition. Up to 3000 eggs have been laid by a single female in captivity, but 1000 to 1500 per female is more usual in the field. Hatching occurs after 2-8 days and the eggs change colour from green to yellow then grey. The tiny grey larvae first eat the egg shell, and after a short rest they wander actively for a while before starting to feed on the plant. On maize, they usually feed on the silks initially and then on the unpollinated tip of the ear and kernels after entering the tip of the husk. By the third instar, the larvae become cannibalistic and usually only one larva survives per cob. Feeding damage is typically confined to the tip of the cob. Larval development usually takes 14-25 (mean 16) days, but under cooler conditions 60 days are required. In the final instar (usually sixth) feeding ceases and the fully grown larva leaves the cob and descends to the ground. It then burrows into the soil for some 3-12 cm and forms an earthen cell, where it rests in a prepupal state for a day or two, before finally pupating. Two basic types of pupal diapause are recognized, one in relation to cold and the other in response to arid conditions. In the tropics, pupation takes 13 (10-14) days; with males typically taking 1 day longer to emerge than females. Diapausing pupae are viable at latitudes up to 40°N in the USA.

Adults are nocturnal and emerge in the evenings. Flying adults respond to light radiation at night and are attracted to light traps (Hardwick, 1968), especially the ultra-violet type, as is the case for many other Noctuidae. Sex aggregation pheromones have been identified and synthesized for most of the *Heliothis/Helicoverpa* pest species, and pheromone traps can be used for population monitoring. Adult longevity is recorded as being about 17 days in captivity; they drink water and feed on nectar from both floral and extra-floral nectaries. The moths fly strongly and are regular seasonal migrants, flying hundreds of kilometres, for example from the USA into Canada. They migrate by flying at high altitudes with prevailing wind currents.

The life cycle can be completed in 28-30 days at 25°C. The number of generations varies from 1 in Canada to up to 10-11 generations per year in the tropics. All stages of the insect can be found throughout the year if food is available, but development is slowed or stopped by either drought or cold. In the Northern USA, there are only two generations per year.

For more information, see Hardwick (1965), Beirne (1971), Balachowsky (1972), Allemann (1979), King & Saunders (1984), Fitt (1989).

DETECTION AND IDENTIFICATION

Symptoms

Vegetative stage maize plants can have holes in the leaves following whorl-feeding on the apical leaf, although this type of feeding is generally rare. On maize plants at the reproductive stage, eggs can be found stuck to the silks. Young larvae feed on the silks as they move down the silk channel to feed on the ear. As the ears develop, kernels in the top few centimetres of the cobs can be eaten in addition to the unpollinated tip of the ear; usually only one large larva per cob can be seen.

Larvae feed on contents of seeds of sorghum heads after chewing holes. While feeding on leaves of legume plants can occur, more significant damage is caused by feeding on seeds in pods. Feeding holes can be seen in tomato fruits, cotton bolls, cabbage and lettuce hearts, and flower heads.

Morphology

Eggs

Subspherical, radially ribbed, about 0.52 mm high and 0.59 mm wide, stuck singly to the plant substrate, green when laid, turning yellow and finally grey before hatching.

Larva

On hatching, the tiny grey larvae have a blackish head; they grow through six instars usually, but five and seven instars can occur, and the final body size is about 40 mm long. The colour of larvae can vary substantially from green, brown, pink, to yellow. Longitudinal lines of white, cream or yellow are present, and the spiracular band is the most distinct. As the larvae develop, the pattern becomes more clearly defined, but in the sixth instar the colouration changes abruptly into a bright pattern, often pinkish, and with extra striations.

Pupa

A typical noctuid pupa, shiny reddish-brown, about 16 mm long, and with two distinct terminal cremaster spines, and normally not identifiable to species level.

Adult

A stout-bodied brown moth with a wing-span of 35-40 mm; forewing pale brown to greenish with darker transverse markings, underwings pale with a broad dark marginal band. The adults of both sexes are very similar in appearance, and both are indistinguishable based on their external morphology from *H. armigera*, but differ in several details in their genitalia (Hardwick, 1965); microdissection and slide-mounting are required for specific determination, and some aspects are comparative so that a series of closely related species are needed for comparison.

Detection and inspection methods

Feeding damage is usually visible and the larvae can sometimes be seen on the surface of plants but often they are hidden within plant organs (including flowers and fruits). Bore holes may be visible, but otherwise it is necessary to cut open the plant organs to detect the pest. Larvae show a feeding preference for the reproductive parts of the host plant, and the lower surface of the leaves is a common preferred oviposition site in addition to reproductive plants parts such as silks (maize) and flowers.

Sex-pheromone traps (species, or genus specific traps) have replaced light traps (non-specific species traps) as the former provide a more effective tool to monitor adult moths. These traps facilitate identification and monitoring of population levels to help with timing of insecticide applications. Bucket traps with a pheromone bait have been reported as the most efficient traps to catch *Helicoverpa* moths (Guerrero *et al*., 2014).

Identification of all stages in the EPPO region will be difficult in the field as they are very similar to *H. armigera* which is present in the EPPO region. Separation of the adult from similar species is most reliably done by reference to the male genitalia (Hardwick, 1965; Pogue, 2004) or using molecular tests. Protocols for DNA barcoding based on COI are described in Appendix 1 of EPPO Standard PM 7/129 and can be used to support the identification of *H. armigera* and *H. zea* specimens (EPPO, 2021). A multiplex real-time PCR test was also developed to distinguish *H. armigera* and *H. zea* (Gilligan *et al*. 2015). Given the known economic impact of the species worldwide, accurate identification is key to avoiding costly impacts in valuable economic crops.

The EPPO Diagnostic Protocol PM 7/19 focuses on the detection and identification of *H. armigera* (EPPO, 2003), but possible confusions with other species including *H. zea* are also covered.

PATHWAYS FOR MOVEMENT

H. zea is a facultative seasonal nocturnal migrant, and adults migrate in response to poor local conditions for reproduction, when weather conditions are suitable. Movement of *Helicoverpa* moths can be classified into three types: short-range, long-range, and migration. Short-range dispersal is usually within the crop and low over the foliage, and largely independent of wind currents. Long-range flights are higher (up to 10 m), farther (1-10 km), and usually downwind, from crop to crop. Migratory flights occur at higher altitudes (up to 1-2 km) and may last for several hours. The moths can be carried downwind hundreds of kilometres - 400 km is not uncommon for such a flight. Moths originating in Mexico and the Southern USA can migrate northwards in the early spring and summer (Westbrook JK & López 2010). Probably three generations are required to affect the annual displacement from Mexico up to southern Ontario.

In international trade, eggs and larvae of *H. zea* can be transported with host plants, cut flowers, fruit and vegetables (EFSA, 2020; Gilligan *et al*., 2019). *H. zea* is regularly intercepted on consignments of cuttings and cut flowers (e.g. dianthus, roses), fruit and vegetables (e.g. *Capsicum*, maize cobs, physalis).

PEST SIGNIFICANCE

Economic impact

In North America, *H. zea* was reported as the second most economically important pest species (preceded by codling moth) (Hardwick, 1965), and Fitt (1989) quoted the estimated annual cost of damage by *H. zea* and *H. virescens* together on all crops in the USA as more than 1000 million USD, despite the expenditure of 250 million USD on insecticide application. However, a decline in *H. zea* populations in some regions of the USA has been reported due to widespread planting of Bt maize in 1996-2016 compared to the pre-Bt era of 1976-1995; this suppression may provide benefits for many crops that are susceptible to *H. zea* feeding (Dively *et al*., 2018).

Reasons for the high impacts of this agricultural pest include its high fecundity (high number of eggs laid), polyphagous larval feeding habits, high mobility of both larvae locally and adults with their facultative seasonal migration, and a facultative pupal diapause.

Damage is usually serious and costly because of the larval feeding preference for the reproductive structures and growing points rich in nitrogen (e.g. sorghum heads, cotton bolls and buds), and has a direct influence on yield. Many of the crops attacked are of high value (cotton, maize, tomatoes). In sweet corn (*Zea mays* subsp. *saccharata*), *H. zea* is a major economic pest, though losses are mainly due to aesthetic reasons (Olmstead *et al*., 2016). Infestations of maize grown for silage or for grain are not of direct economic importance - losses are typically much less than 5% (and are often not detectable) and no control measures are taken (Bibb *et al*., 2018; Olivi *et al*., 2019), but these crops may serve as a focus, or reservoir of infestation. In many areas, the first generation is generally not regarded as a pest (often on wild hosts) and it does not become an economic pest on cultivated crops until the second, third or even fourth generation (Reay-Jones, 2019).

Control

Control of *H. zea* has been advocated in the USA since the middle of the 19th century, and measures used fall into two broad categories, those aimed at an overall pest population reduction, and others aimed at the protection of a particular crop. Integrated pest management (IPM) strategies can be used to promote more sustainable management programs (Bottrell, 1979, Swenson *et al*., 2013, Olmstead *et al.*, 2016). Various cultural practices can be used to kill the different life stages, including deep ploughing, discing and other methods of mechanical destruction to kill pupae in the soil, manipulation of sowing dates and use of trap crops. Use of resistant cultivars and topping of the crop to hasten ripening can minimize infestation levels and consequent damage. In many areas, natural control of this pest may be effective. Insect parasitoids attack the eggs (especially *Trichogramma* spp.) and larvae, and some predators can be important in reducing pest populations. Nucleopolyhedroviruses that are specific to Heliothines (including *H. zea* and the related species *Heliothis virescens*) can also be applied as biopesticides that infect larvae (Black *et al*., 2022). The prospects for long-term biological control of *Heliothis*/*Helicoverpa* spp. are discussed by King &

Coleman (1989) and Sithanantham *et al.* (2005), and clearly this should be an important component of any regional IPM programme. The use of pheromones to disrupt moth mating has also been investigated (Mitchell and Mclaughlin, 1982), though more research is needed to develop mating disruption as an effective management tool.

Chemical control of the larvae has been the most widely used and generally successful method of pest destruction on most crops, but it is not easy because larvae are difficult to reach with insecticides once they are protected within a plant. In sweet corn, insecticide applications should be timed to silk emergence to coincide with oviposition on silks. Once young larvae reach the ear, they are better protected from the insecticide, and control is more challenging. Sex-pheromone traps facilitate monitoring of population levels to help with timing of insecticide applications. The early history of chemical control of corn earworms is given by Hardwick (1965) and COPR (1983; p. 87). Pesticide resistance has been documented since the 1980s and is quite widespread (Fitt, 1989) especially on cotton crops.

Transgenic maize, cotton, and soybean that express insecticidal toxins from the bacterium *Bacillus thuringiensis* (Bt) can also provide control or suppression of *H. zea* and related crop damage. In maize, Bt hybrids are available in some countries for both field maize and sweet corn. Resistance to Bt in *H. zea* has been widely documented (Tabashnik and Carriere, 2017), though some Bt traits can help to reduce damage.

Phytosanitary risk

H. zea is a polyphagous pest which can attack many crops of economic importance in the EPPO region (e.g. maize, cotton, tomato, ornamentals). Considering its current distribution, *H. zea* could establish in most of the EPPO region, and is likely to cause similar damage as in the USA. It should be noted that the use of transgenic Bt crops is not authorized in most of the EPPO region.

PHYTOSANITARY MEASURES

Imported host plant material for planting should come from an area where *H. zea* does not occur or from a place of production where *H. zea* has not been detected during the previous 3 months.

Consignments of host plant products can be treated to kill larvae e.g. by irradiation (Hallman, 2016).

REFERENCES

A selection of sources is listed in this section. Bibliographies are included in the monograph by Hardwick (1965) (2000 titles on *H. zea*), and the reviews by Fitt (1989) (194 titles), and King & Coleman (1989) (159 references). Most of the basic research on *H. zea* was done in the early 1900s and published under early synonyms. Many references to *H. zea* are made in publications relating to the cultivation/protection of specific crops, e.g. Chiang (1978), COPR (1983), Pitre (1985), Swenson *et al.* (2013), Olmstead *et al.* (2016), Reay-Jones (2019).

Allemann DV (1979) Maize pests in the USA. *Maize (Technical Monograph)*, pp. 58-63. Ciba-Geigy Agrochemicals, Basle, Switzerland.

Balachowsky AS (Editor) (1972) *Entomologie appliquée à l'agriculture. Tome II. Lepidoptères. Deuxième Volume, Zygaenoidea - Pyraloides - Noctuidae*, pp. 1059-1634. Masson et Cie, Paris, France.

Barber GW (1937) Seasonal availability of food plants of two species of *Heliothis* in eastern Georgia. *Journal of Economic Entomology* **30**(1), 150-158.

Beirne BP (1971) Pest insects of annual crop plants in Canada. I. Lepidoptera, II. Diptera, III. Coleoptera. *Memoirs of the Entomological Society of Canada* **103** (supplement S78), 1-124.

Bibb JL, Cook D, Catchot A, Musser F, Stewart SD, Leonard BR, Buntin GD, Kerns D, Allen TW, Gore J (2018) Impact of corn earworm (Lepidoptera: Noctuidae) on field corn (Poales: Poaceae) yield and grain quality. *Journal of Economic Entomology* **111**(3), 1249-1255.

Black JL, Lorenz GM, Cato AJ, Bateman NR, Seiter NJ (2022) Efficacy of *Helicoverpa armigera*

nucleopolyhedrovirus on soybean for control of *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae) in Arkansas Agriculture. *Insects* **3**(1), 91. https://doi.org/10.3390/insects13010091

Bottrell DG (1979) Guidelines for integrated control of maize pests. *FAO, Plant Production and Protection Paper* No. 91, 18 pp. FAO, Rome, Italy.

Chiang HC (1978) Pest management in corn. *Annual Review of Entomology* **23**, 101-123.

COPR (1983) *Pest control in tropical tomatoes*. COPR, London, UK.

Cordeiro EMG, Pantoja-Gomez L, de Paiva JB (2020) Hybridization and introgression between *Helicoverpa armigera* and *H. zea*: an adaptational bridge. *BMC Evolutionary Biology* **20**, 1-12.

Cunningham JP, Zalucki MP (2014) Understanding heliothine (Lepidoptera: Heliothinae) pests: what is a host plant? *Journal of Economic Entomology* **107**, 881–896.

Davidson RH, Peairs LM (1966) *Insect pests of farm, garden and orchard* (6th edition). Wiley, New York, USA.

Dively GP, Venugopal PD, Bean D, Whalen J, Holmstrom K, Kuhar TP, Doughty HB, Patton T, Cissel W, Hutchison WD (2018) Regional pest suppression associated with widespread Bt maize adoption benefits vegetable growers. Proceedings of the National Academy of Sciences. 115(13), 3320-3325.

EPPO (2003) EPPO Standards. Diagnostic protocols for regulated pests. PM 7/ 19 *Helicoverpa armigera*. *EPPO Bulletin* **33**, 245-247. Available at https://gd.eppo.int/standards/PM7/

EPPO (2021) EPPO Standards. Diagnostic protocols for regulated pests. PM 7/ 129 DNA barcoding as an identification tool for a number of regulated pests. *EPPO Bulletin* **51**(1), 100-143. Available at https://gd.eppo.int/standards/PM7/

Fitt GP (1989) The ecology of *Heliothis* species in relation to agro-ecosystems. *Annual Review of Entomology* **34**(1), 17-52.

Gilligan TM, Tembrock LR, Farris RE, Barr NB, van der Straten MJ, van de Vossenberg BTLH, Metz-Verschure E (2015) A multiplex real-time PCR assay to diagnose and separate *Helicoverpa armigera* and *H. zea* (Lepidoptera: Noctuidae) in the New World. *PLoS One* **10**, e0142912. https://doi.org/10.1371/journal.pone.0142912

Gilligan TM, Goldstein PZ, Timm AE, Farris R, Ledezma L, Cunningham AP (2019) Identification of heliothine (Lepidoptera: Noctuidae) larvae intercepted at U.S. ports of entry from the New World. *Journal of Economic Entomology* **112**, 603-615.

Guerrero S, Brambila J, Meagher RL (2014) Efficacies of four pheromone-baited traps in capturing male Helicoverap (Lepidoptera: Noctuidae) moths in Northern Florida. *Florida Entomologist* **97**(4), 1671-1678.

Hallman GJ (2016) Phytosanitary irradiation of *Heliothis virescens* and *Helicoverpa zea* (Lepidoptera: Noctuidae). *Florida Entomologist* **99**(2), 178-181.

Hardwick DF (1965) The corn earworm complex. *Memoirs of the Entomological Society of Canada* **40**, 1-247.

Hardwick DF (1968) A brief review of the principles of light trap design with a description of an efficient trap for collecting noctuid moths. *Journal of the Lepidopterists' Society* **22**, 65-75.

Hardwick DF (1970) A generic revision of the North American Heliothidinae (Lepidoptera: Noctuidae). *Memoirs of the Entomological Society of Canada* **73**, 1-59.

King ABS, Saunders JL (1984) *The invertebrate pests of annual food crops in Central America*. Overseas Development Administration, London, UK.

King FG, Coleman RJ (1989) Potential for biological control of *Heliothis* species. *Annual Review of Entomology* **34**,

53-75.

Lingren PD, Westbrook JK, Bryant Jr VM, Raulston JR, Esquivel JF, Jones GD (1994) Origin of corn earworm (Lepidoptera: Noctuidae) migrants as determined by citrus pollen markers and synoptic weather systems. *Environmental Entomology* **23**(3), 562-570.

Matthews M (1991) Classification of the Heliothinae. *Bulletin of the Natural Resources Institute* No. 44. Natural Resources Institute, Chatham, UK.

Mitchell A, Gopurenko D (2016) DNA Barcoding the Heliothinae (Lepidoptera: Noctuidae) of Australia and utility of DNA barcodes for pest identification in *Helicoverpa* and relatives. *PLoS ONE* **11**, e0160895. https://doi.org/10.1371/journal.pone.0160895

Mitchell ER, McLaughlin JR (1982) Suppression of mating and oviposition by fall armyworm and mating by corn earworm in corn, using the air permeation technique. *Journal of Economic Entomology* **75**(2), 270-274.

Nagoshi RN, Gilligan TM, Brambila J (2016) Combining *Tpi* and *CO1* genetic markers to discriminate invasive *Helicoverpa armigera* from local *Helicoverpa zea* (Lepidoptera: Noctuidae) populations in the Southeastern United States. *Journal of Economic Entomology* **109**(5), 2115-2124.

Neunzig HH (1963) Wild host plants of the corn earworm and the tobacco budworm in eastern North Carolina. *Journal of Economic Entomology* **56**(2), 135-139.

Olivi BM, Gore J, Musser FM, Catchot AL, Cook DR (2019) Impact of simulated corn earworm (Lepidoptera: Noctuidae) kernel feeding on field corn yield. *Journal of Economic Entomology* **112**(5), 2193-2198.

Pitre HN (1985) Insect problems on sorghum in the USA. In: *Proceedings of the International Sorghum Entomology Workshop, July l984, Texas A & M University, USA* (Ed. by Kumble, V), pp. 73-81. ICRISAT, Patancheru, India.

Reay-Jones FPF (2019) Pest status and management of corn earworm (Lepidoptera: Noctuidae) in field corn in the United States. *Journal of Integrated Pest Management* **10**(1), 1-9. https://doi.org/10.1093/jipm/pmz017

Swenson SJ, Prischmann-Voldseth DA, Musser FR (2013) Corn earworms (Lepidoptera: Noctuidae) as pests of soybean. *Journal of integrated Pest Management* **4**(2), D1-8. https://doi.org/10.1603/IPM13008

Sithanantham S, Singh SP, Romeis J (2005) Biological control of *Helicoverpa*: Research status, constraints and opportunities, pp. 329-369. In HC Sharma (Ed.), *Heliothis*/*Helicoverpa* management – emerging trends and strategies for future research. Science Publishers, Plymouth, UK

Swenson SJ, Prischmann-Voldseth DA, Musser FR (2013) Corn earworms (Lepidoptera: Noctuidae) as pests of soybean. *Journal of integrated Pest Management* **4**(2), 1-8. https://doi.org/10.1603/IPM13008

Tabashnik BE, Carriere Y (2017) Surge in insect resistance to transgenic crops and prospects for sustainability. *Nature Biotechnology* **35**, 926-935.

Westbrook JK, López Jr JD (2010) Long-distance migration in Helicoverpa zea: what we know and need to know. *Southwestern Entomologist* **35**(3), 355-360.

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Datasheet history

This datasheet was first published in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2022. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', ‘Hosts’, and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

CABI/EPPO (1997) *Quarantine Pests for Europe (2nd edition).* CABI, Wallingford (GB).

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