EPPO Datasheet: *Keiferia lycopersicella*

Last updated: 2022-09-14

IDENTITY

Preferred name: *Keiferia lycopersicella*
Authority: (Walsingham)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Lepidoptera: Gelechiidae
Other scientific names: *Eucatoptus lycopersicella* Walsingham, *Gnorimoschema lycopersicella* (Busck), *Phthorimaea lycopersicella* Busck
Common names: tomato pinworm
view more common names online...
EPPO Categorization: A1 list
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EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: GNORLY

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Notes on taxonomy and nomenclature

Keiferia lycopersicella (Walsingham) has been the subject of considerable taxonomic confusion since the first specimens were collected on tomatoes in the Imperial Valley of California in 1923. Initially the specimens were misidentified as the eggplant leafminer, *Phthorimaea glochinella* (Zeller), and several early works treated the tomato pinworm under this name. In 1928, Busck described this pest as a new species, *Phthorimaea lycopersicella*, including material from Hawaii, California and Mexico in the type-series. He later synonymized all members of the genus *Phthorimaea* Meyrick with the genus *Gnorimoschema* Busck, thus giving the tomato pinworm the new combination, *Gnorimoschema lycopersicella* (Busck). In 1939, Busck moved *G. lycopersicella* and three other members of *Gnorimoschema* to the new genus *Keiferia* with *Phthorimaea lycopersicella* Busck (incorrectly given as *Gnorimoschema lycopersicella*) as the type species (Elmore & Howland, 1943). Hodges (1965) (cited by Oatman, 1970) reported that a study of the type of *Eucatoplus lycopersicella* (Walsingham, 1897), revealed that it is conspecific with *Phthorimaea lycopersicella* Busck, 1928. He further stated that Busck's 'lycopersicella' is the type-species of *Keiferia* Busck, so the correct combination for the Walsingham name is *Keiferia lycopersicella* (Walsingham).

HOSTS

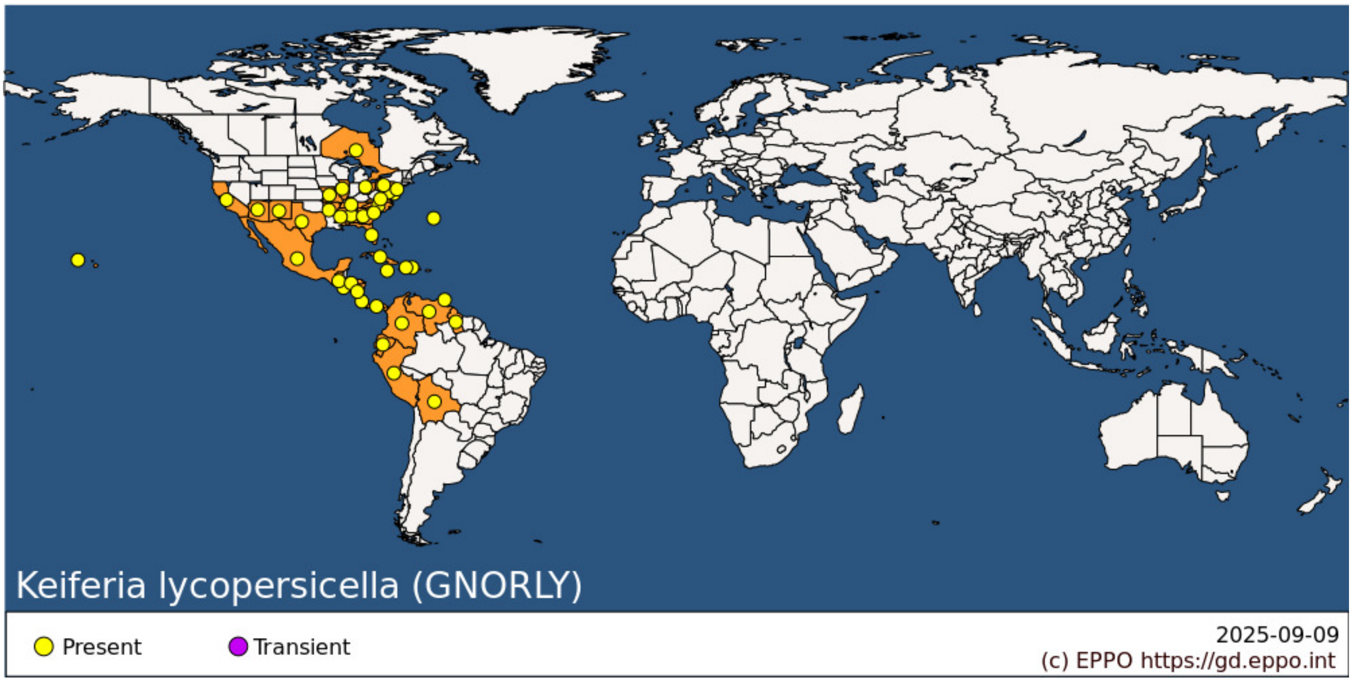
Keiferia lycopersicella attacks mainly tomato (*Solanum lycopersicum*), but can survive on at least 12 other solanaceous plant species. Occasional losses have also been reported for eggplant (*Solanum melongena*), and potato (*Solanum tuberosum*). Weed hosts include *S. americanum* var. *nodiflorum*, *Solanum bahamense*, *S. carolinense*, *S. dulcamara*, *S. elaeagnifolium*, *S. umbelliferum*, *S. viarum*, and potentially *Solanum nigrum* (Thomas, 1933; Zimmerman, 1978; Poe, 1999).

Host list: *Solanum americanum*, *Solanum bahamense*, *Solanum carolinense*, *Solanum dulcamara*, *Solanum elaeagnifolium*, *Solanum lycopersicum var. cerasiforme*, *Solanum lycopersicum*, *Solanum melongena*, *Solanum nigrum*, *Solanum torvum*, *Solanum tuberosum*, *Solanum umbelliferum*, *Solanum viarum*

GEOGRAPHICAL DISTRIBUTION

The tomato pinworm occurs in North, Central and South America, as well as in the Caribbean, mainly in sub-tropical and tropical tomato-growing areas where winters are mild. In the USA, it occurs in the tomato-producing areas of California, Florida (south of Tampa along the west coast and from Fort Pierce south along the east coast), and in the Rio Grande Valley of Texas. It has also been reported in greenhouses from other states (e.g. Delaware, Mississippi, Missouri, Pennsylvania, and Virginia) (Jiménez *et al*., 1988; Saunders *et al*., 1998; Poe, 1999). In Canada, it was first observed in 1946 when larvae of this pest were confirmed in field and greenhouse tomato crops in South-Western Ontario; however, the species did not establish. Isolated infestations were then reported: in 1970 in a greenhouse on Vancouver Island, and in 1975 in a greenhouse and surrounding home gardens at Kamloops, British Columbia. Eradication at both locations was accomplished by exposure to the elements and by planting cucumber, which is a non-host crop (Garland, 1989). In 1991, *K. lycopersicella* was reported again in Ontario in Essex County. Since then, it has spread throughout the Leamington area (Mason, 2002).

In Europe, an incursion of *K. lycopersicella* was reported in Italy in 2008 in a tomato field crop, but the pest did not establish, and no further detections were made (Sannino & Espinosa, 2009).



North America: Canada (Ontario), Mexico, United States of America (Alabama, Arizona, Arkansas, California, Delaware, Florida, Georgia, Hawaii, Illinois, Maryland, Mississippi, Missouri, New Jersey, New Mexico, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia)
Central America and Caribbean: Bermuda, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Trinidad and Tobago
South America: Bolivia, Colombia, Ecuador, Guyana, Peru, Venezuela

BIOLOGY

The female deposits the eggs on the leaves, both on the upper and lower side, with a preference for the upper leaf side. Eggs are deposited singly or in small groups of two to three, next to the veins of the leaves inside the grooves, which confers greater protection (Geraud-Pouey *et al*., 1997; Sierra *et al*., 2012). Oviposition in fruits usually occurs when infestation is very high and the foliage has deteriorated (Geraud-Pouey, 1997). Females oviposit from 50 to 200 eggs. Hatching generally occurs within 3.5 to 9 days (Swank,1937).

K. lycopersicella has four larval instars and larval development ranges from 9 to 17 days. The first larval instar drills the leaf epidermis initiating a gallery or mine inside the leaf mesophyll (Geraud-Pouey *et al*., 1997) leaving the lower and upper surface intact, forming a kind of reddish blister (Figueroa, 1950). The first instar larvae spin a tent of silk over themselves and tunnel into the leaf. Further feeding results in a blotch-like mine usually on the same leaf (Poe, 1999). Upon reaching the third instar, the larva leaves the mine and folds the tip of the leaf or joins two leaves together to create a space where it will remain for the third and fourth instar (Anaya, 1980; Morón & Terrón, 1988 cited by Anaya & Romero, 1999).

The fourth instar larva as it grows widens the mine in an irregular shape, depositing excrements at the initial end and subsequently rolls the leaves to form a shelter (Sierra, 2012).

Larvae usually drop to the ground to pupate (although occasionally they may pupate in fruits and folded leaves) (Anaya, 1980; Morón & Terrón 1988 cited by Anaya & Romero, 1999). After burrowing into the soil to a depth of 1–2 cm, the larvae spin a cocoon with silk and soil particles. Initially green, the pupae become increasingly brown as they age (Elmore & Howland, 1943). The pupal stage can last from 5 days to 38 days with temperature ranges from 10 to 26°C respectively (Sierra *et al.*, 2012; Elmore & Howland, 1943), on average, the stage lasts 16 days at 20°C (Poe, 1999), all developmental stages are temperature dependent.

The lower developmental threshold has been estimated at 11°C. This insect has no diapause, so sustained temperatures below 10°C generally prohibit population survival. Eggs will not hatch at temperatures above 41°C, but larvae will continue to develop at temperatures up to 44°C. Developmental time from egg to adult ranges from 18 days at 35°C to 118 days at 14°C. In the Mediterranean climate of coastal Southern California, there are about 8 generations per year. In Sinaloa, Mexico, warmer temperatures allow 10 or more generations per year. For additional information see Elmore & Howland, 1943; Weinberg & Lange, 1980; Lin & Trumble, 1985, and Schuster, 2006.

DETECTION AND IDENTIFICATION

Symptoms

The attack to the fruit is the most important part of the larval attack, as it damages the commercial part of the plant. Larvae can cause serious defoliation, and, consequently, fruits are marked by sunburn (Anaya & Romero, 1999). They damage the leaves, reducing the photosynthesis area and favouring the entrance of pathogens. They can also perforate the tomato fruit leading to rotting and loss (Guevara, 2000). Larvae hatched from eggs previously laid in the calyx or those migrating from leaves near the fruit can be found at the insertion of the peduncle with the fruit, but they rarely penetrate the fruit from elsewhere. The suppression of flower buds also decreases the number of fruits per plant (Figueroa, 1950).

Morphology

Eggs

Eggs are elliptical in shape; when freshly laid they are bright light yellow, gradually darkening and turning orange as the embryo develops (Geraud-Pouey *et al.*, 1997). Eggs are small, measuring less than 1 mm (0.36 mm long by 0.22 mm wide) (Sierra *et al.*, 2012; Figueroa, 1950).

Larva

The head capsule is dark brown; body yellowish-grey initially changing to grey with purple blotches or all purple. Newly hatched larvae average 0.85 mm in length and attain a maximum length of 5.8–7.9 mm. Typically, larvae have a pale prothorax notum.

Pupa

When the larva leaves the mine, it empties its digestive tract and weaves a cocoon and becomes a pupa (Geraud-Pouey *et al.*, 1997). When the pupa is newly formed it is brownish green and later becomes bright brown, the pupa in the soil is protected by an ovoid cell of grains of soil mixed with the salivary secretion of the glands of the larva, when it develops in the folds of the leaves, they remain protected only by these (Figueroa, 1950), after about 6 to 7 days the adult emerges (Geraud-Pouey *et al.*, 1997).

Adult

The adult is a brownish-grey moth approximately 5 mm long (Geraud-Pouey *et al.*, 1997), the female is larger than the male (Sierra *et al.*, 2012), with a wing spread of 9 to 12 mm (Figueroa, 1950). Labial palpi have a short-furrowed brush on the underside of the second joint, a terminal joint somewhat thickened with scales, and are compressed. The extreme tip is pointed. The head, thorax and wings are mottled brown. The forewings are elongate ovate; the hind wings are pointed and dilated at the tip of the costa in females. The abdomen is dark fuscous above with basal joints slightly ochreous, the underside is light ochreous sprinkled with dark fuscous spots. Adults are nocturnal, initiate flight and oviposition at dusk and continue ovipositing during the night if the temperature is approximately 15.5°C or higher. Activity is accelerated by an increase in temperature (Elmore & Howland, 1943), the moths rest in shaded areas of the plant during the day (Guevara, 2000), mating occurs within 24 to 48 hours after emergence (Elmore & Howland, 1943).

Detection and inspection methods

It is important to carry out surveillance activities to ensure the timely detection of the pest and to be able to implement appropriate control strategies and prevent its spread to other production areas. In production areas, both in protected cultivation and in open fields, delta traps with specific sexual pheromone (Z/E4-tridecadienyl acetate) can be used, with 1 to 2 traps per hectare (NAPPO, 2015; OIRSA, 2016). In homogeneous production areas, trapping routes should be established so that the largest number of traps can be efficiently checked. Traps should ideally be inspected every week and at most every 15 days. It is also important to survey high risk areas, and traps can usefully be placed in nurseries producing plants for planting, fruit markets, packing houses, as well as in ports, airports, and along highways where there is a passage of goods susceptible to carry the pest. In a monitoring programme, traps should be properly identified so that the information can be traced, as well as the record of the specimens captured. Suspicious samples should be sent to a diagnostic laboratory to carry out the identification. In susceptible sites where there are no traps, it is necessary to carry out a visual check to look for specific symptoms of the pest and detect any incursion (OIRSA, 2016).

Diagnosis is a very important tool that complements phytosanitary surveillance, however it is not possible to identify eggs and pupae using morphological characteristics. In the case of larvae and adults, identification is difficult as the species can be confused with other Gelechiidae feeding on Solanaceae (e.g. *Tuta absoluta*) and requires experience. For adults, the identification is made based on the morphology of the genitalia (OIRSA, 2016).

PATHWAYS FOR MOVEMENT

The main vehicle of dispersal to distant places or other countries is the transport of the insect in infested fruits. Plants for planting, as well as packaging material used for picking and packing fruit can also transport the pest. Over shorter distances, flight of adults, and movements of harvest residues can ensure further dispersal (Chavez, 1962).

PEST SIGNIFICANCE

Economic impact

Substantial and recurrent outbreaks of the tomato pinworm have been recorded in North America since the 1920s. Economic losses in the USA and Mexico cost millions of dollars (US) in the 1980s and early 1990s (Oatman, 1970; Trumble & Alvarado-Rodriguez, 1993).

While damage can be caused by foliar feeding, most economic losses result from fruit damage. In tomatoes destined for the fresh market, almost any penetration will result in fruit loss through secondary bacterial infection, cosmetic damage, or insect contamination. For processing tomatoes, the primary losses are to fruit shipments that are rejected because of larval contamination: the presence of any recognizable insect larvae or portion of a larva in food products is unacceptable to most consumers. Damage to potatoes can occur, but has been considered relatively minor throughout the current area of distribution. Damage to eggplant can be quite severe in the warmer areas of production (Mossler & Nesheim, 2010). In addition, pinworms are often seen on eggplant when growers use non-selective insecticides for management of whiteflies that reduce beneficial organism populations (Poe, 1999).

The economic impact of the introduction of *K. lycopersicella*, a pest of quarantine concern for many countries, is related to the increase in production costs. These costs would be due to the implementation of surveillance, monitoring, confinement, and integrated control of the pest with the objective of reducing the damage caused by the pest and avoiding the impact on production in order to protect domestic consumption and export markets.

Control

Initially, control was almost entirely based on frequent applications of multiple pesticides. More recently, populations have been effectively suppressed in tomato production areas in North America via a combination of mating disruption with pheromones and insecticides. Attempts to use host plant resistance have not been successful (Pena, 1983). However, a cultural technique establishing a tomato-free period in Mexico has proven effective at reducing pest pressure in a region where tomatoes can be produced year-round. Rapid destruction of tomato fields following the last harvest can reduce overwintering populations in areas where temperatures are moderate. The precautions include use of transplants that are free from eggs and larvae when set in the field, Populations may be controlled early during the first or second larval stages with several recommended insecticides; however, third or fourth instars are protected by leaf folds or fruit, making the control of older infestations difficult. Consequently, chemical control is contingent upon frequent and accurate observations of fields for pinworm mines (Poe, 1999). The same pheromones that have been used for several years as lures to monitor adult male populations have recently been used in large quantities for mating disruption. This technique provides control by saturating a field with sex pheromone so that male moths cannot find and mate with females. The pheromones can be integrated successfully into a management program, as long as the field is isolated from other infested fields and the pheromones are applied before populations build up (Jiménez *et al*., 1988).

In Canada, studies were conducted to evaluate the ability of six commercially available species of *Trichogramma* (Hymenoptera: Trichogrammatidae), to parasitize eggs of tomato pinworm. Of the six species, *Trichogramma pretiosum* and *Trichogramma brassicae* parasitized the highest proportion of eggs (40–50%) (Shipp *et al*., 1998). *Trichogramma* species, due to their high effectiveness, are widely used in many countries in biological control programs against lepidopteran pest species in Solanaceae, including *Keiferia lycopersicella*.

Phytosanitary risk

Keiferia lycopersicella is potentially a serious pest of tomato (and possibly eggplant) in the warmer parts of the EPPO region, both in the field and in protected conditions. In countries where measures are implemented against *Tuta absoluta* (e.g. screenhouses) the impact may be lower.

PHYTOSANITARY MEASURES

EPPO recommends (EPPO, 2012) that plants for planting and fruits of tomato and eggplant originating from countries where *K. lycopersicella* occurs should be free from the pest. Only new packaging should be used for those importations to avoid contamination of packaging by the pest.

In the OIRSA region (Belize, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama), it has been recommended that packaging and containers must be clean and free of soil and plant residues, and that the marketing of fruits in bunch and with peduncles should be prohibited (OIRSA, 2016). It is also recommended to prohibit the introduction and importation of substrates or soil samples from countries where the pest occurs. In addition, each country in the OIRSA region should develop specific surveillance plans to verify the absence of the pest and for its timely detection in case of an incursion, develop a communication campaign aimed at educating and raising awareness among the population most likely to spread the pest, strengthen the inspections at ports, airports and borders, in order to detect prohibited or risky materials (OIRSA, 2018).

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 2013, and revised 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.

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