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European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

EPPO Datasheet on pests recommended for regulation
Fiches informatives sur les organismes de quarantaine

Neoleucinodes elegantalis

Identity

Name: *Neoleucinodes elegantalis* (Guenée)
Synonyms: *Leucinodes elegantalis* Guenée
Taxonomic position: Insecta: Lepidoptera: Crambidae: *Neoleucinodes*: *N. elegantalis*
Notes on taxonomy and nomenclature: *Neoleucinodes elegantalis* (Guenée) was described as *Leucinodes elegantalis* Guenée and recorded as a South American species, attacking tomato in the states of Parana and Minas Gerais in Brazil (Capps, 1948). Capps (1948) argued that there was confusion in the literature regarding the type species of the genus *Leucinodes* Guenée, and indicated that Hampson (1896) cited the species *Leucinodes elegantalis* Guenée as the type species of the genus *Leucinodes* in his study on the moth fauna of British India. This information was again quoted by Hampson (1898) in his treatment of the subfamily Pyraustinae, and Klima (1939) in his catalogue of Lepidoptera (Capps, 1948). However, Capps (1948) noted that Walker (1859) had already designated the species *L. orbonalis* Guenée as the type species of the genus. Thus, Capps (1948) stated that under the principle of priority of the International Code of Zoological Nomenclature, the type species of the genus *Leucinodes* is *L. orbonalis* and not *L. elegantalis*, as erroneously indicated by Hampson (1896) and others that have cited this work. Capps (1948) regarded the New World *L. elegantalis* sufficiently different from other species in the genus known from the Old World, and created the genus *Neoleucinodes* in which he assigned the New World species as *Neoleucinodes elegantalis*.
Common names: tomato fruit borer, small tomato borer (EN), perforador del fruto, pasador del fruto de lulo, pasador del tomate, gusano rosado, barrenador del fruto del tomate, gusano perforador, gusano del tomate de árbol (ES), broca pequena do fruto, broca pequena do tomateiro (PT), petit foreur de la tomate (FR).
EPPO Code: NEOLEL
Phytosanitary Categorization: EPPO A1 list no 381.

Hosts

Neoleucinodes elegantalis is an oligophagous pest that attacks only fruits of plants belonging to the family Solanaceae. Some of these hosts are tropical fruits known for their exotic flavour, such as *Solanum quitoense* Lam., commonly known as lulo in Colombia or narajanjilla in Ecuador; tree tomato (*Solanum betaceum*), cocona (*Solanum sessiliflorum*), lulo del pacifico or luloeperro (*Solanum pseudolulo*) and vegetable crops such as tomato (*S. lycopersicum*), eggplant (*S. melongena*) and green and red pepper (*Capsicum annuum*). This insect pest also attacks a variety of wild solanaceous plants, mostly belonging to the *Leptostemonum* subgenus, including: *Solanum hirtum*, *S. crinitum*, *S. robustum*, *S. capsicoides*, *S. aethiopi cum*, *S. torvum*, *S. sisymbriifolium*, *S. acerifolium*, *S. atro purpureum, S. umbellatum*, *S. lycocarpum*, *S. paniculatum*, *S. viarum*, *S. palinacanthum.* Other wild hosts of *N. elegantalis* are *S. arboreum* of *Geminata* subgenus and *S. granulosun-leprosum* the *Brevantherum* subgenus.

It is noteworthy that in Colombia there are areas where the insect was not found on some host crop plants planted at certain altitudes above sea level. Also, a recent study on genetic diversity of populations of *N. elegantalis* in this country showed the formation of biotypes or host races. In Colombia, these biotypes or races are separated by the Andes mountain range. In Ecuador, the insect causes damage to *S. quitoense* and *S. betaceum* in some areas of its territory, but it has not been observed there on *S. lycopersicum* and *C. annuum*.

Geographical distribution

Neoleucinodes elegantalis is distributed in the Neotropics, but its exact distribution in this area is unknown and information on its host plants is also lacking. Some information about its current distribution is known for some countries such as Argentina, Brazil, Bolivia, Colombia, Ecuador, Honduras, Peru and Venezuela, where it is an important pest.
EPPO region: Absent.
North America: Mexico (Colima, Jalisco, Sinaloa, Tamaulipas, Veracruz). Adult specimens of *N. elegantalis* that were collected with light traps are stored in the U.S. National Collection located at the National Museum of Natural History, Washington, D.C. (M. A. Solis, pers. comm.).
Central America: Costa Rica (No records as a pest), Guatemala (No records as a pest), Honduras, Panama (No records as a pest),
Caribbean: Cuba (No records as a pest), Grenada (No records as a pest), Jamaica (No records as a pest), Puerto

Rico (Probably a misidentification). There are no *N. elegantalis* larval and adult specimens from Puerto Rico in the U.S. National Collection, National Museum of Natural History, Washington, DC (M. A. Solis, pers. comm.), Trinidad and Tobago (No records as a pest).

South America: Argentina, Brazil (Minas Gerais, São Paulo, Rio de Janeiro), Bolivia, Colombia, Ecuador, Guyana (No records as a pest), Paraguay (No records as a pest), Peru, Suriname, Venezuela.

Biology

The oviposition sites of *N. elegantalis* are different in each host plant. On tomato, the largest proportion of eggs (48%) are oviposited between the calyx (lower face) and fruit, 28% on the surface of the fruit, 20% on the calyx, 3% on the floral stalk and 1% on the flower buds; when the pest is present at high densities, eggs can be found on leaves and stem. Eggs are oviposited on young tomato fruit with a diameter of 2.5 cm. Oviposition occurs from 19:00 until dawn. Eggs are typically oviposited in groups of 3 eggs, but may be oviposited in larger numbers. Females oviposit from 3 to 133 eggs; the eggs have about a 75% fertility rate. Hatching generally occurs in 5.5 days after oviposition and shortly after dawn.

Larvae of *Neoleucinodes elegantalis* pass through 4 larval instars at 24° and 25°C and five larval instars at 15° and 30C°. Seven to 123 min after hatching, the newly emerged larvae begin boring into the fruit, and the time spent boring lasted for 21–202 min. This short time that the pest is exposed on the plant can reduce the effectiveness of contact pesticides. Newly hatched larvae secrete a silk thread and bore into the fruit following a perpendicular position to the fruit exocarp, using their thoracic legs to scrape the epicarp in order to reach the mesocarp leaving a completely circular entrance hole. Upon reaching the 3rd larval instar, the larva moves to the endocarp and may also feed on the seeds, completing the later instars inside the fruit. Later larval instars have a greater feeding capacity and produce large galleries, sometimes the last instar larvae ejects excrement outside the fruit and this excrement is often found just outside the dugout exit holes. Larval development ranges from 16.1 to 18.3 days.

The pupation site varies according to the host plant. Larvae of *N. elegantalis* pupate in the green leaves or dry leaves near the exit holes on the fruits. In tree tomato, the pupae are found on dry leaves on the soil surface. In lulo, the fruit borer pupates on leaves and dry flower buds in the aerial part of the plant, but can also pupate in the spaces between the fruits of a cluster and in plant debris accumulated in the axils of the plants. The pupal stage can last as few as 8.1 days, or as long as 11.1 days.

Adults typically survive between 4.3 to 6.1 days. Adult emergence occurs between 17:00 and 02:00, with peak emergence between 20:00 and 22:00. Adult *N. elegantalis* remain motionless throughout the day hidden under the leaves of weeds or crop hosts, with wings outstretched to the sides and the abdomen raised. The manifestation of the onset of activity by the moth is characterized by the extension of the abdomen, which is observed between 18:00 and 19:00, when the adult begins to move, whether walking or taking short flights. Females attract mates by emitting a sex pheromone. Mating occurs from 20:00 to 06:00, with a higher mating activity between 23:00 and 24:00.

The estimated critical temperature where development of *N. elegantalis* stops is 10.5°C. This species has no diapause. Developmental time from egg to adult is 25.6 days at 30.2°C, 34.7 days at 25°C, 50.9 days at 20°C and 124.1 days at 14.7°C. In Colombia, there are between 2 and 11 generations per year. In Southern Europe and North Africa the number of expected generations is 4–7 and in Northern Europe 1 generation per year. It should be noted that transient field populations may occur in Northern Europe in the summer time. However, it is unclear if and how the organism can survive the winter conditions in the EPPO region. In Colombia, the mean minimum temperature generally does not drop below the threshold development temperature of 10.5°C. In several areas in the EPPO region, the minimum temperature drops below the threshold development temperature in wintertime, such as in Verona, Italy. In southern and eastern Mediterranean areas, development of *N. elegantalis* is possible throughout the year, as e.g. in Haifa, Israel. In northern countries of the EPPO region, the expected number of generations in greenhouses (March-August) is 2-3 generations (Potting, 2013 unpublished information).

Detection and identification

Symptoms

After hatching, the larvae penetrate the small fruit, leaving a small entrance hole which heals over time (Fig. 1). As the fruit grows and develops, the moth larvae grow and develop simultaneously within it, feeding on the pulp and seeds (Fig. 2). When the larvae have completed their development, they open an exit hole to leave the fruit and build a shelter for pupation, using leaves near the fruit as a substrate.

In some countries the moths can be detected by using traps baited with the sex pheromone Neolegantol®. This *N. elegantalis* sex pheromone works in Venezuela, Colombia and in the State of São Paulo in Brazil, but does not work in Honduras, Ecuador and Bolivia (K. Jaffe, pers. comm.).

Morphology

Eggs

The eggs are flat, slightly textured. They are 0.5 mm long and 0.3 mm wide. Just-oviposited eggs are white, turning light yellow and prior to hatching they become brown.

Fig. 1 Entrance and exit holes of *Neoleucinodes elegantalis* on a tomato fruit. Photo courtesy of A Diaz Montilla, Corpoica La Selva (CO).

Fig. 2 Damage of *Neoleucinodes elegantalis* in a tomato fruit. Photo courtesy of A Diaz Montilla, Corpoica La Selva (CO).

After hatching, the chorion is transparent and is not consumed by the newly hatched larvae.

Larva

The mature larva is between 15 and 20 mm in length, Body colour from white to pink. Body pinacula without sclerotization and pigmentation. The colour of the pinacula is similar to that of the body; they are present as a slightly raised blister particularly on the meso- and meta-thorax. Prothoracic shield pale yellow with light-brown markings. Head slightly wider than long, pale yellow. In side view slightly rounded and not so flattened. Head with a darkened pigmentation a little wider at the posterior margin of head capsule.

Pupa

The pupa is obtect. The colour varies from light to dark brown, measuring 12–15 mm, with a cremaster. Dorsum of the abdominal segments smooth. The 2nd and 3rd abdominal segment with a protruding cover above each spiracle.

Adult

The adult is a moth with white wings, somewhat hyaline with dark brown or black scaly areas (Fig. 3). Dorsally the abdomen has a striking white band covering the entire 1st abdominal segment and part of the 2nd and 3rd segments, the rest of the segments covered by a mixture of dark-brown and black scales. The abdomen in ventral view, with the entire 1st abdominal segment and a large portion of the 2nd and 3rd segment white in colour, the other segments paler than the dorsum. Laterally, the abdomen has small tufts of scales of the same colour, often difficult to see in descaled specimens. There is a sexual dimorphism. In the females, the third labial palp is longer than in the males. The male wing expansion is 15–33 mm. and the female 15–30 mm.

Means of movement and dispersal

International movement could potentially occur on infested fruit. Packaging (e.g., crates, boxes used for picking and packing tomato, eggplant, paprika, lulo, tree tomato and cape gooseberry or other Andean solanaceous berry fruits may carry larvae.

Economic impact

This pest has a negative economic impact on Solanaceae production in Latin America; losses caused by *N. elegantalis* in tomato in Colombia are up to 60.3%, in Brazil 76.9%. In the State of São Paulo the losses caused were at least a thousand tonnes per year. In Venezuela the damage was 40.7% during the rainy season, in Honduras 1% and Peru between 4–5%. In tomatoes, eggplants and paprika destined for the fresh market, almost any insect making an entry or exit hole on the fruit will result in fruit loss through secondary bacterial infection, cosmetic damage, or insect contamination. For processing tomatoes, the primary losses are due to fruit shipments that are rejected

Fig. 3 *Neoleucinodes elegantalis* adult. Photo courtesy of M Alma Solis, USDA-ARS (US).

because of larval contamination: the presence of any recognizable insect larvae or portion of a larva in consumer products is unacceptable to most consumers.

Control

The success of good chemical control of *N. elegantalis* is based on the timing of insecticide applications considering the behaviour of the insect, it is best to make pesticide applications in the last hours of the afternoon or in early morning hours, applying the chemical to small fruit with a diameter of 2.5 cm. To improve the effectiveness of the application of the insecticides, it is recommended to apply some type of non-ionic surfactants or adjuvants, given that they increase wettability on fruits, intensify the dispersion and penetration of chemicals, avoiding also applying them in the rainy season. Newly hatched larvae are most susceptible to insecticides, so it is recommended to use active ingredients that act by ingestion and contact, the advantage of the former is that they can be combined with releases of *Trichogramma* spp. Egg parasitoids of the genus *Trichogramma* have been widely studied as a biological control agent of *N. elegantalis* in tomato crops, not only in Colombia, but also in Brazil and Venezuela (Berti and Marcano 1995, Cross 1996). The following species of *Trichogramma* have been reported in the literature to control *N. elegantalis*: *T. exiguum* Pinto & Platner, 1978 (Viáfara *et al.*, 1999; Noyes, 2004), *T. pretiosum* Riley, 1879 (Viáfara *et al.*, 1999 Blackmer *et al.*, 2001; Noyes, 2004; Parra & Zucchi, 2004) and *T. minutum* Riley, 1871 (Leiderman & Sauer, 1953; Noyes, 2004).

The following chemical insecticides are registered for control of this insect on tomato in Colombia include the following: Flubendiamide (Belt® SC) which acts by ingestion; Triflumuron (Alistin® 480 SC) and Lufenuron (Match® 50EC) which are chitin synthesis inhibitors. Others insecticides that act by contact and ingestion are: Thiametoxam + lambdacyhalothrin (Engeo SC 247); Emamectin Benzoate (Proclaim ®), Methoxyfenozide (Intrepid ® 25% WP), Spinetoram (Exalt® 60 SC), Clorantraniliprole (Coragen® SC), Imidacloprid + lambda-cialotrin (Geminis ®WP), Bifenthrin (Brigada®100 EC), Lamdacialotrin (Karate®Zeon CS), Lambda cyhalotrin, (Kaiso WG, Aikido® 50 EC), Clorpirifos (Lorsban® 4 EC, Vextertm® 4EC, Astro 450EWR). The economic threshold for the control of *N. elegantalis* is 5% of damaged tomato fruits, using abamectin 18 EC (Vertimec 18 CER) in a dose of 1 L/ha (Motta *et al.*, 2005).

Phytosanitary risk

Neoleucinodes elegantalis was listed as an EPPO A1 pest in 2014. This species is potentially a serious pest of tomato, eggplant, paprika, tree tomato and cape gooseberry or Andean berry. The climate in its current area of distribution is largely similar to that in the EPPO region. In northern areas of the EPPO region only transient field populations are expected, but permanent populations may establish in greenhouses.

Phytosanitary measures

EPPO recommends that fruits of tomato, eggplants, paprika, and tree tomato originating from countries where *N. elegantalis* occurs should be free from the pest. Exporting countries should implement post-harvest tactics for recognizing and separating the fruits that have the cicatricized entrance holes of the pest in order to guarantee healthy fruit. This tactic could be complemented by exporting fruit from areas where the insect does not exist, or its prevalence is low at certain ranges of altitudes above sea level. Alternatively as in experimental tests 100 and 200 Gy (gamma irradiation) were lethal doses to stages of eggs and larvae of *N. elegantalis* this could be recommended as a suitable quarantine treatment (Costa *et al.*, 2009).

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