EPPO Datasheet: *Epitrix tuberis*

Last updated: 2020-07-24

IDENTITY

Preferred name: *Epitrix tuberis*
Authority: Gentner
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Coleoptera: Chrysomelidae
Common names: tuber flea beetle
view more common names online...
EPPO Categorization: A1 list
view more categorizations online...
EU Categorization: Emergency measures
EPPO Code: EPIXTU



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Notes on taxonomy and nomenclature

Flea beetles are classified by some authors in a separate subfamily (Alticinae) of the family Chrysomelidae, but others place the group in a tribe (Alticini) of the subfamily Galerucinae. The genus *Epitrix* Foudras comprises 162 described species worldwide (Bienkowski & Orlova-Bienkowskaja, 2017). Most of the *Epitrix* species are native to the neotropics (Deczynski, 2016). In North America, the species *Epitrix tuberis* (tuber flea beetle) is the most damaging of a group of five *Epitrix* species that are associated with potato, which includes also the species *E. cucumeris* (potato flea beetle), *E. hirtipennis* (tobacco flea beetle), *E. similaris* (no common name), and *E. subcrinita* (western potato flea beetle). Because of the morphological similarity between these *Epitrix* species, *E. tuberis* was initially considered to be the same species as *E. cucumeris*, until it was described as a new species by Gentner, in 1944. Consequently, some of the earlier observations on hosts, distribution and biology reported for *E. cucumeris* may in fact relate to *E. tuberis* (Morrison *et al.*, 1967).

HOSTS

E. tuberis is associated with solanaceous hosts, as is the case for all other *Epitrix* species, the adults feeding on the foliage and the larvae on the roots (Doguet, 1994). The adults of *E. tuberis* may feed temporarily on plants from other botanical families when they do not have access to their solanaceous hosts (Hoerner & Gillette, 1928; Hill & Tate, 1942; Gentner, 1944; Hill, 1946; Neilson & Finlayson, 1953; Seeno & Andrews, 1972). No records exist on the possibility of larval development on non-solanaceous plants (Hill & Tate, 1942).

The most economically important host for *E. tuberis* is potato (*Solanum tuberosum*). *E. tuberis* has been recorded on other cultivated solanaceous plant species, such as tomato (*Solanum lycopersicum*), aubergine (*Solanum melongena*) and tobacco (*Nicotiana tabacum*), but damage on these plants is not important, and only leaves are affected (Deczynski, 2016). Other non-cultivated solanaceous host plants include common weeds such as black nightshade (*Solanum nigrum*), jimsonweed (*Datura stramonium*), buffalo bur (*Solanum rostratum*) and ground-cherry (*Physalis* sp.) (Gentner, 1944; Deczynski, 2016). All these secondary host plant species are important food sources for the survival of the tuber flea beetle populations when potato is not available. A list of confirmed solanaceous hosts of *E. tuberis* for the USA and Canada was established by Deczynski (2016).

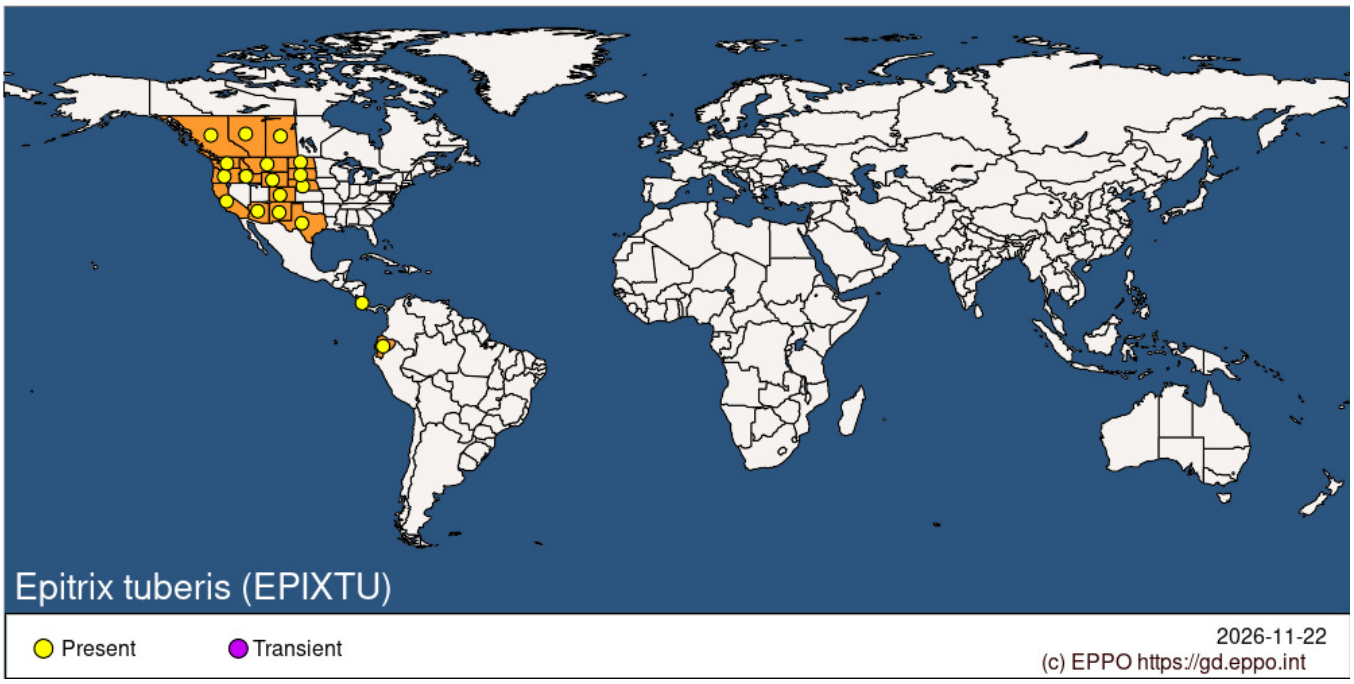
The species of host plants consumed by the females greatly affect their oviposition and life duration, as demonstrated by Hill (1946) in laboratory and field experiments. Among several plant species commonly fed upon by the overwintered flea beetles, potato promoted the highest egg production and the highest longevity.

Host list: *Alcea rosea, Amaranthus retroflexus, Ambrosia, Armoracia rusticana, Bassia scoparia, Beta vulgaris, Brassica oleracea, Capsicum frutescens, Chenopodium album, Citrullus lanatus, Cucumis melo, Cucumis sativus, Cucurbita maxima, Cucurbita, Datura innoxia, Datura stramonium, Descurainia pinnata, Helianthus annuus, Helianthus, Ipomoea sp., Iva xanthiifolia, Lactuca sativa, Lycium, Medicago sativa, Melilotus sp., Nicandra physalodes*

, Nicotiana alata, Nicotiana tabacum, Petunia, Phaseolus vulgaris, Physalis alkekengi var. franchetii, Physalis ixocarpa, Physalis lanceolata, Physalis lobata, Physalis longifolia, Physalis pruinosa, Physalis pubescens, Physalis sp., Physalis, Raphanus sativus, Ribes rubrum, Sinapis arvensis, Solanum americanum, Solanum carolinense, Solanum dulcamara, Solanum lycopersicum, Solanum melongena, Solanum nigrum, Solanum rostratum, Solanum triflorum, Solanum tuberosum, Solanum villosum, Spinacia oleracea, Taraxacum officinale

GEOGRAPHICAL DISTRIBUTION

E. tuberis is believed to be native to Colorado (USA), from which it expanded its distribution range to the western parts of the USA and Canada, alongside the development of the potato industry (Gentner, 1944; Morrison *et al.*, 1967). The species is also reported in Costa Rica and Ecuador.



North America: Canada (Alberta, British Columbia, Saskatchewan), United States of America (Arizona, California, Colorado, Idaho, Montana, Nebraska, New Mexico, North Dakota, Oregon, South Dakota, Texas, Washington, Wyoming)
Central America and Caribbean: Costa Rica
South America: Ecuador

BIOLOGY

Because of species misidentification, the biology of *E. tuberis* was studied under the name of *E. cucumeris* until 1944, when Gentner identified *E. tuberis* as a new species. These studies include those by Hoerner & Gillette (1928) in Colorado, by Hill & Tate (1942) in Western Nebraska, and by Jones (1944) in Eastern Washington.

The adults of *E. tuberis* feed on the leaves. On potato, the larvae feed on the roots, root hairs, stolons and tubers. In North America, *E. tuberis* normally completes two generations per year on potato (Hill & Tate, 1942; Fulton & Banham, 1962) but in Canada the species may occasionally undergo a third partial generation, depending on the length of the growing season and the date of emergence of the overwintered adults (Fulton & Banham, 1962). In autumn, the adults overwinter in and around the fields where they developed, buried in the soil or under leaf litter and other debris (Hoerner & Gillette, 1928). In spring, when the temperature warms up, the adults become active. They leave their winter refuges and start feeding on alternative host plant species available, until the potato plants develop (Hoerner & Gillette, 1928). Starting in mid-May, the overwintered adults emerge gradually, over a period of time which may extend up to 45 days, depending on the temperature (Hill & Tate, 1942). When they find a potato plantation, the overwintered adults settle on the potato plants, feed, and mate. They are able to mate shortly after

emergence (Hoerner & Gillette, 1928; Neilson & Finlayson, 1953). After a pre-oviposition period of 5-8 days (Neilson & Finlayson, 1953) the females lay the eggs singly below the soil surface, close to the stems of the potato plant, over a period ranging from 35 to 57 days (Hill & Tate, 1942), and die shortly after. In the laboratory, the overwintered females laid between 161 and 215 eggs (Hill & Tate, 1942). After incubating for 3-14 days (Hill & Tate, 1942), the eggs hatch and the larvae of the first generation move to the roots and to the small immature tubers of early-planted potatoes. When fully-grown, the larvae stop feeding, move away from the roots and tubers, and build a pupation chamber with soil particles in which they will metamorphosize into an adult. The larvae of the first generation develop in 2-4 weeks and the larvae of the second generation in 2-6 weeks (Hill & Tate, 1942). The larvae of the first generation develop on early-planted potatoes and those of the second generation in the late-planted potatoes (Hill & Tate, 1942). Pupation lasts 4-10 days (first generation) and 5-22 days (second generation) (Hill & Tate, 1942).

In Nebraska, the development time from egg to adult for the first generation of *E. tuberis* ranged from 27 to 50 days (average 30 days) and for the second generation from 30 to 85 days (average 40 days), and the two generations partially overlapped (Hill and Tate, 1942).

E. tuberis adults disperse by flight, jumping and walking. There are no data on the flight frequency or distances covered by the adults, but Hoerner & Gillette (1928) presumed that flight was the most important means used by the overwintered adults for locating potato fields which were up to 1.5 km from the potato fields where the pest was found the previous year. Very little flight occurs before noon and flight activity ceases completely on windy days, when the wind velocity is over 11 km/hour (Jones, 1944).

DETECTION AND IDENTIFICATION

Symptoms

Both larvae and adults have chewing mouthparts. The adults riddle the leaves with small circular holes (1.0-1.5 mm diameter) that produce the characteristic ‘shot-hole’ symptom in the potato foliage, which is common to all *Epitrix* species. The adult insects can be detected on the foliage and jump promptly when approached. On windy days, they are less active.

Different types of tuber injury are produced by the larval feeding. The larva may tunnel underneath the skin, producing winding superficial trails (‘worm-tracks‘) or may feed outside, penetrating only partially into the potato, almost at a right angle to the surface (Hoerner & Gillette, 1928), originating a pit which mostly penetrates up to 3 mm but may reach 6 mm, and later becomes filled with dark corky material, described as ‘slivers’ (Gentner, 1944; Wallis, 1953; Morrison *et al*., 1967). ‘Slivers’ may show on the tuber’s surface as a black point, or a raised rugose elevation in the skin (‘pimples’). The ‘worm-track’ type of injury is the most easily recognizable. Rough skin, deep cracks and scab-like lesions are sometimes associated with the larval attack. Tuber flea beetle lesions have been claimed to favour the penetration of different pathogens, and Schaal (1934) demonstrated that tuber flea beetle larvae could transmit the common scab fungus (*Streptomyces scabies*) from the soil into the tubers.

Morphology

The genus *Epitrix* is a group of small flea beetles with uniform appearance which can be recognized by the presence of characteristic rows of setae on the elytra (Deczynski, 2016). The morphological identification to species is made by specialists, on the basis of the *habitus* and *genitalia* of the adult insects. The identification keys and illustrations presented in EPPO Standard PM 7/109 (2) (EPPO, 2017) allow *E. tuberis* to be distinguished from the related potato species *E. cucumeris*, *E. papa* and *E. subcrinita*.

The immature stages and the adults have been characterized morphologically by Hill (1946) and by Neilson & Finlayson (1953) as follows:

Eggs

The eggs are elliptical, white, with a reticulate surface, approximately 0.5 mm in length and 0.2 mm in width.

Larva

The newly hatched larva is white in colour, threadlike, and approximately 1.0 mm long. The full-grown larva is white, with the head and thoracic shield light brown, averaging 5.3 mm in length and 0.8 mm in width.

Pupa

The pupa is white and approximately 2.5 mm long and 1.5 mm wide across the mesothorax.

Adult

The adults are small dull black beetles with rows of short white hairs across the elytra, 1.5-2.0 mm long, with brownish-yellow antennae. The hind femurs are enlarged, adapted to jumping.

Detection and inspection methods

Detection is made by visual inspection of the foliage of potato or other host plants, looking for shot-hole symptoms and adult flea beetles. On potato, the tubers are inspected visually for symptoms of larval injury (EFSA, 2019). The 'worm-track' type of injury is the most easily recognizable. The 'slivers' are best detected if the potato tubers are peeled with a knife.

The identification of the species requires the collection of insect specimens for analysis. Adult specimens may be collected with a sweep-net or with a mouth aspirator. The larvae are very difficult to detect and collect because of their small size and translucent colour, and also because of their feeding behaviour. When present at potato harvest, the larvae may be hidden inside the 'worm tracks', or may expose the terminal part of the abdomen protruding outside the tuber, while feeding.

The identification of all *E. tuberis* stages can be made reliably by non-specialists, using molecular methods (DNA barcoding on cytochrome c oxidase subunit I (COI) gene) (Germain *et al*., 2013; Mouttet *et al.*, 2019). The reference sequences of these species are available in EPPO-Q-bank and BOLD databases.

PATHWAYS FOR MOVEMENT

Adult *E. tuberis* can fly, and this is one of the main means for local dispersal of the species. The main pathway for long distance spread is through the commercial transport of potato tubers (seed or ware potatoes), when associated with soil and plant debris (EPPO, 2016; 2017).

When potatoes are harvested in an infested field, adults, pupae and larvae of *E. tuberis* may be present in the stubble, soil, and tubers. Adult beetles may be carried passively on the surface of potatoes, or with the soil adhering to potato tubers. This possibility would be higher in exports of seed potatoes, because potatoes are not washed. Larvae could be present inside the deeper 'worm-track' galleries. However, Fulton & Banham (1962) reported that the larvae left the tubers after these were dug up, and that these damaged tubers were not likely to spread the live pest.

The soil of host plants for planting could also contain and spread immature stages of the pest (EPPO, 2011).

PEST SIGNIFICANCE

Economic impact

The feeding lesions caused on the potato tubers by the larvae of *E. tuberis* are mostly superficial and do not affect tuber quality, but they have a marked negative visual impact for certain trade markets, and cause the commercial downgrading of the product (Gentner, 1944; Morrison *et al.*, 1967; Vernon & Herk, 2017). Furthermore, 'slivers', when present, oblige deeper peeling of the potatoes before consumption, causing additional losses. In Canada, a crop is commercially downgraded when more than 5% of the tubers present tuber flea beetle injury, as reported in a PRA

carried out by EPPO on tuber damaging *Epitrix* species (EPPO 2011).

The reduction of the leaf area by adult feeding should have a little impact on yield losses, because it is compensated by the fast growth of the potato plants, as demonstrated experimentally by Senanayake *et al.* (1993) for *E. cucumeris*.

In North America, in zones with an extended cropping season, control measures are necessary for preventing the build-up of the populations of *E. tuberis* and avoiding economical tuber damage. The related control costs represent an additional burden to the crop's production costs, in terms of monitoring, insecticide treatments, and cultural measures.

Control

There are no published records of efficient natural enemies of *E. tuberis* (Neilson & Finlayson, 1953; Vernon & Herk, 2017).

In Canada, the second-generation larvae, which develops on medium to late crops, is the most damaging one and is difficult to control efficiently with insecticides. For this reason, this generation is indirectly controlled with an IPM strategy targeting the overwintered adults, which oviposit on the early planted potato crops, and are thereby origin of the first-generation larvae (Vernon & Herk, 2017). The IPM strategy combines cultural measures, for reducing the population of overwintered adults, with insecticide treatments. The cultural measures include the destruction of overwintering places, the crop rotation with non-solanaceous plants, and the adaptation of planting schedules (Hoerner & Gillette, 1928; Vernon & Herk, 2017). In North America a 3-year potato rotation is recommended to avoid the on-site overwintering of the beetles (Vernon & Herk, 2017).

The need for insecticide treatments on potato is decided on the basis of weekly estimations of the population density of the adults on the plants (Vernon & Herk, 2017). The overwintered immigrant beetles tend to settle and feed initially on the border rows of the crop, and this behaviour creates an edge effect on the distribution of the beetles early in the season (Cusson *et al.*, 1990). This allows a simplification of the monitoring procedure, which can be carried out along the border rows and in two interior rows (Vernon & Herk, 2017). Monitoring begins at 10% crop emergence, and is done by visual counts of the adults on the foliage until the crop is 30 cm tall. Later on, counting adults on the larger plants is not reliable and adult monitoring is carried-out by sweep-net. Groups of potato plants are sampled at regular intervals (Vernon & Herk, 2017).

In Canada this program allowed a reduction of more than 90% spraying of the crops, and this reduction largely compensated for the costs associated with monitoring (Vernon & Herk, 2017). This high reduction was possible because the treatments could be directed to specific spots or rows infested by the beetles, avoiding spraying the entire crop. Early treatments, when necessary, are often sufficient to reduce oviposition from the overwintered females, eliminating the need for subsequent repeated sprays against the adults of the summer generations.

Phytosanitary risk

The present distribution of *E. tuberis* in North America and Ecuador indicates that the species would find suitable climatic conditions in the EPPO region. One could expect *E. tuberis* to develop one or two generations in many of the potato-growing areas of Central and Northern Europe (EPPO, 2011), and possibly also in southern regions. While *E. tuberis* could be controlled chemically, its presence could lead to a generalized use of insecticides on potato, rather than the occasionally targeted use against *L. decemlineata*, as at present in most EPPO countries. The problem would arise even more acutely in countries where *L. decemlineata* has not been introduced (EPPO, 2011). Furthermore, the control of *E. tuberis* would be critical in several EPPO countries, namely in a majority of the EU countries where insecticides used in North America are no longer authorized.

PHYTOSANITARY MEASURES

The import of seed potatoes from third countries is prohibited in several EPPO Countries, namely in the EU (EU, 2016), but sometimes authorized under derogation procedures, e.g. from Canada into the EU (EU, 2003).

Following the accidental introduction of the species *E. papa* and *E. cucumeris* in Portugal and Spain, *E. tuberis* is

subject, together with *E. cucumeris*, *E. papa*, and *E. subcrinita*, to measures by several EPPO countries to prevent their introduction and spread within the EPPO region.

Specific requirements related to *E. cucumeris*, *E. papa*, *E. subcrinita* and *E. tuberis* are recommended for seed potatoes (except micropropagative material and minitubers) and ware potatoes to be imported from third countries. According to EPPO Standard PM 8/1 (EPPO, 2017) seed potatoes should be washed or brushed so that they are free from plant debris with no more than 0.1% w/w of soil remaining; and where appropriate subject to transitional arrangements (pest-free area for *E. tuberis* and origin from a pest-free potato production and distribution system for the pest, according to EPPO Standard PM 3/61 (EPPO, 2019)). Ware potatoes should either (a) originate from a pest-free area for *E. subcrinita* and *E. tuberis* according to EPPO Standard PM 3/61 (EPPO, 2019) or (b) measures as described in EPPO Standard PM 9/22 (EPPO, 2016) for *E. tuberis* should be implemented to ensure that there is no risk of spreading this pest, or (c) there should be absence of plant debris with no more than 0.1% w/w of remaining soil.

Additional requirements are recommended for soil or growing medium attached to rooted host plants from countries where *E. tuberis* occurs (removal of soil and growing media, or production in a pest free area, or in a pest-free place under protected conditions, or production under screened greenhouse conditions with appropriate monitoring in the framework of a bilateral agreement) (EPPO, 2011).

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Datasheet history

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