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Pest survey card on *Tecia solanivora*

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Abstract

This pest survey card was prepared in the context of the mandate on plant pest surveillance (EFSA-Q-2017-00831), upon request by the European Commission. The purpose of this document is to assist the Member States in planning annual survey activities of quarantine organisms using a statistically sound and risk-based pest survey approach, in line with the current international standards. The data requirements for such activity include the pest distribution, its host range, its biology, risk factors as well as available detection and identification methods. This document is part of a toolkit that consists of pest-specific documents, such as the pest survey cards and generic documents relevant for all pests to be surveyed, including, the general survey guidelines and statistical software such as RiBESS+.

Keywords: plant pest, survey, risk-based surveillance, *Tecia solanivora*, Guatemalan potato tuber moth

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Introduction

The information presented in this pest survey card was summarised from the EFSA pest categorisation of *Tecia solanivora* (EFSA Plant Health Panel, 2018), the CABI Datasheet for *Tecia solanivora* (CABI, 2018), the European and Mediterranean Plant Protection Organization (EPPO) Diagnostic Protocol for *Tecia solanivora* (EPPO, 2006a), the EPPO Datasheet on *Tecia solanivora* (EPPO, 2006b), the EPPO Global Database (EPPO, 2018), International Standards for Phytosanitary Measures (ISPMs) and other scientific documents.

The objective of this pest survey card is to provide the relevant biological information that is needed to prepare surveys for *Tecia solanivora* in EU Member States (EFSA, 2018). This document is part of a toolkit that is being developed to assist and support Member States plan a statistically sound and risk-based pest survey approach in line with International Plant Protection Convention (IPPC) guidelines for surveillance (FAO, 2016). The toolkit consists of pest-specific documents and more general documents relevant for all pests to be surveyed:

i. Pest-specific documents:

a. The pest survey card on *Tecia solanivora*. [1]

ii. General documents:

a. The general survey guidelines (to be finalised in 2019)

b. The RiBESS+ manual available online[2]

c. The statistical tools RiBESS+ and SAMPELATOR which are available online[3] with open access after registration.

1. The pest and its biology

1.1. Taxonomy

Tecia solanivora (Povolný 1973)

Class: Insecta, **Order:** Lepidoptera, **Family:** Gelichiidae, **Genus:** *Tecia*

Junior synonym: *Scrobipalpopsis solanivora* Povolný 1973

Common name in English: Guatemalan potato tuber moth

1.2. EU pest regulatory status

In Annex II, Part A, Section I, the Council Directive 2000/29/EC[4] lays down that *Scrobipalpopsis solanivora* Povolný, shall be banned when present on tubers of *Solanum tuberosum* L. Furthermore, according to Annex IV, Part A, Section I, an official statement is needed that:

(a) the tubers originate in a country where *Scrobipalpopsis solanivora* Povolný is not known to occur; or

(b) the tubers originate in an area free from *Scrobipalpopsis solanivora* Povolný, established by the national plant protection organisation under relevant International Standards for Phytosanitary Measures.

[1] The content of this EFSA Supporting Publication is reproduced as a live document available at https://efsa.maps.arcgis.com/apps/MinimalGallery/index.html?appid=f91d6e95376f4a5da206eb1815ad1489 where it will be updated whenever new relevant information becomes available.

[2] https://zenodo.org/record/2541541/preview/ribess-manual.pdf

[3] https://websso-efsa.openanalytics.eu/auth/realms/efsa/protocol/openid-connect/auth?response_type=code&client_id=shiny-efsa&redirect_uri=https%3A%2F%2Fshiny-efsa.openanalytics.eu%2Fsso%2Flogin&state=d6f7f997-d09f-4bb0-afce-237f192a72d5&login=true&scope=openid

[4] Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. OJ L 169, 10.7.2000, p. 1–112. Consolidated version of 01/04/2018

Regulations on potatoes in general, not directly referring to the pest, are not listed here.

1.3. Pest distribution

In Europe, the pest was found in Spain with restricted distribution in 1999. Until 2014, the pest was present in the Canary Islands only: Tenerife island (in potato fields and in potato storage facilities), and the islands of La Gomera, Gran Canaria and Lanzarote (in potato storage facilities only; 1999). However, the pest was found in potato fields in mainland Spain, Galicia (NW Spain) in 2015 and furthermore in neighbouring Asturias in 2016. In 2018, the pest was under eradication (EFSA PLH Panel, 2018; EPPO, 2018).

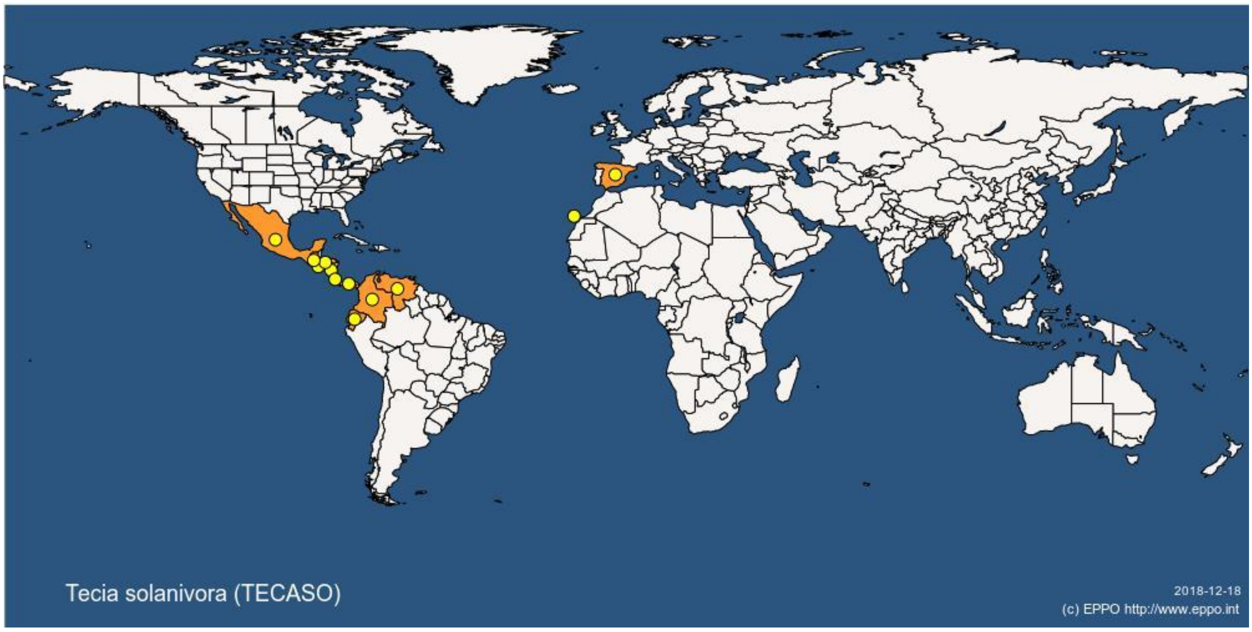

Figure 1: Distribution map of *Tecia solanivora*. The pest status in countries or states is reported as present (yellow dots) (Source: EPPO global database, www.eppo.int)

1.4. Life cycle

In Central America, *T. solanivora* has several generations per year, from two generations at 10°C to 10 generations at 25°C (Notz, 1996). Females lay usually just under 200 eggs, which develop in 5–25 days depending on the temperature (Notz, 1996). For example, if mean temperature is between 18.8°C and 22.1°C, eggs hatch in 6–7 days.

First instar larvae search for potato tubers either by burrowing into the soil or in potato storage facilities. Larvae mine into tubers creating galleries, both under the surface and the interior of the tuber (Figure 2). Feeding causes weight loss of tubers, and secondary pathogen infections via the galleries.

The four larval instars of an individual normally develop inside a single tuber (Hilje, 1994). Depending on the temperature, the larval stage can last from around 18 to 80 days (Notz, 1996). To pupate, larvae abandon the tubers. Pupation takes place in the soil, near the surface or, if in potato storage facilities, in sheltered areas (cracks or corners of building structures, potato sacks), and, rarely, also inside tubers (Povolný, 1973).

The life cycle lasts 95/91 days (females/males) under laboratory conditions at 15.5°C, and a relative humidity (RH) of 65.6%. The mean duration of developmental stages is 15 days for eggs, 29 days for larvae, 5 days for prepupae and 26 days for pupae. Adults live for 16/20 days (males/females). At 20°C, it is 57/54 days (females/males), and at 25°C, 42/41 days (females/males) (Torres et al., 1997).

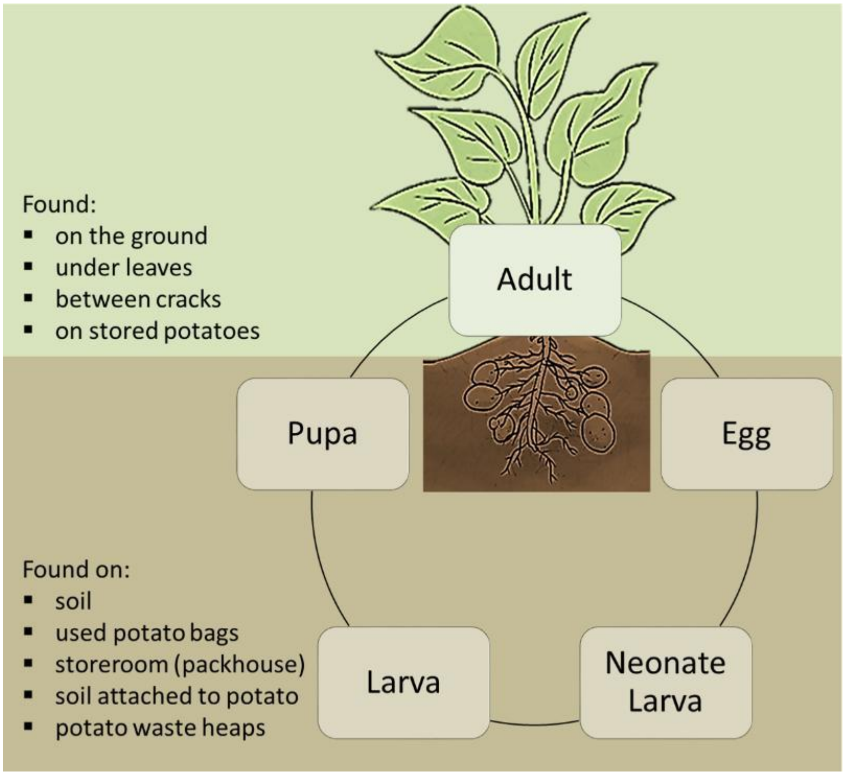

Figure 2: Life cycle of *T. solanivora* (based on information retrieved from EFSA PLH Panel, 2018; CABI, 2018; EPPO, 2006a, 2006b, 2018)

1.5. Host range and main hosts

Tecia solanivora feeds exclusively on *Solanum tuberosum* (EPPO, 2006b; CABI, 2018; Kroschel and Schaub, 2013). Therefore the survey activity will only be carried out on potato crops.

In the context of survey activities, two types of potatoes can be distinguished, the seed potatoes and the ware and starch potatoes as these two categories are subject to different (i) legislative requirements, and (ii) production processes.

Import of seed potatoes from non-member countries (other than Switzerland) is prohibited as laid down in Council Directive 2000/29/EC, Annex III Part A. Import of non-seed potatoes is also prohibited except from a limited number of Mediterranean and European countries.

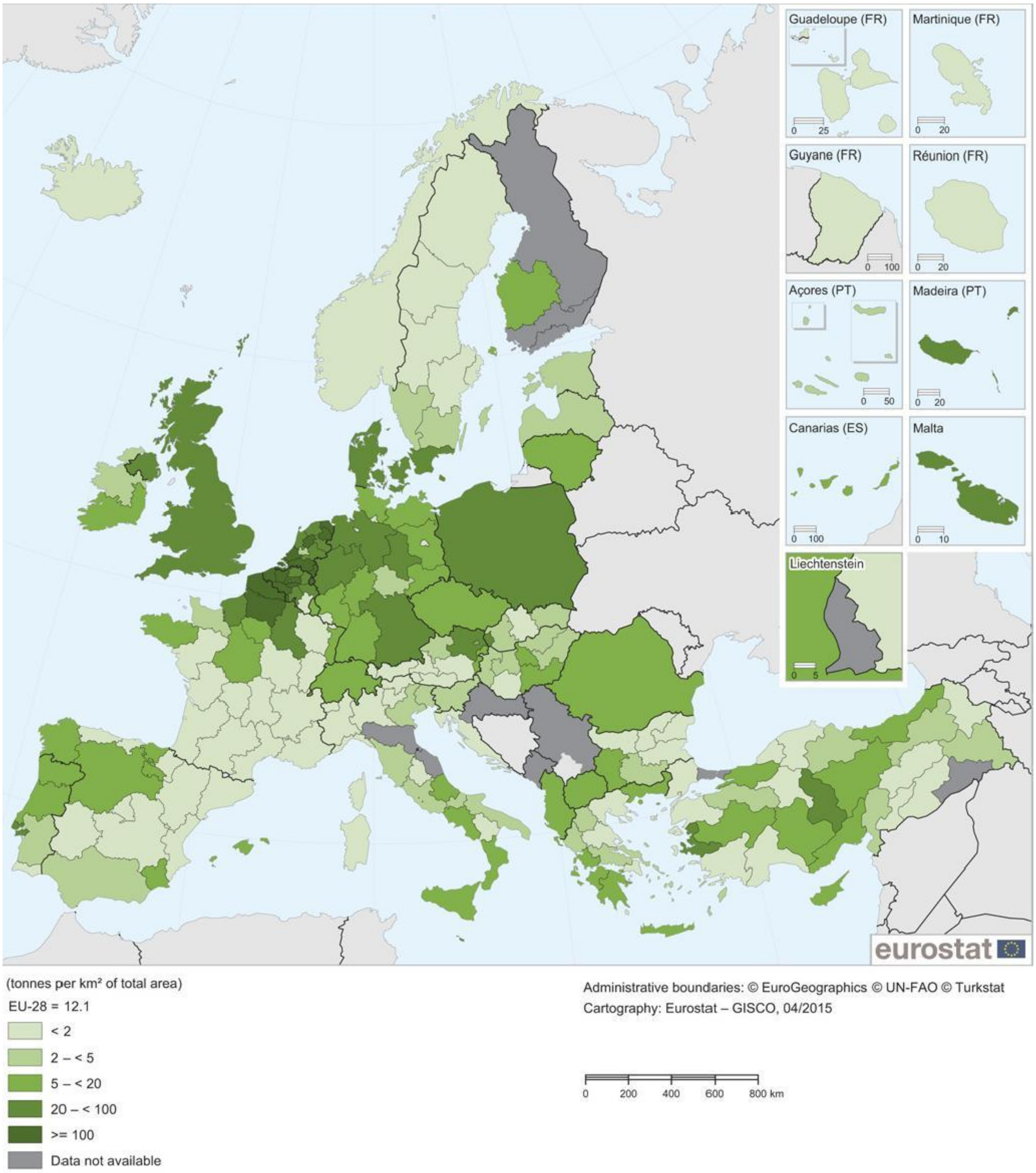

Figure 3: Harvested production of potatoes in 2013, by Nomenclature of Territorial Units for Statistics (NUTS) level 2 region in tonnes per km² of total area. Germany only available for NUTS level 1 regions. Czech Republic, Denmark, Poland, Romania, United Kingdom, Norway, Switzerland and Albania: only available at national level. Croatia: ratio calculated using land area and not total area. Norway, Albania and Turkey: 2012. Bulgaria: 2011. (Source: Eurostat Regional Yearbook 2015, ec.europa.eu/eurostat/documents/3217494/7018888/KS-HA-15–001-EN-N.pdf. Accessed 29 November 2018)

1.6. Environmental suitability

Tecia solanivora can be found in mountainous regions of Central and South America at altitudes between 1,000 m and 3,500 m above sea level (Torres et al., 1997), up to 600 m above sea level in the Canary Islands (EPPO, 2006b), but also below 400 m above sea level in Galicia and Asturias. Optimum temperature for population development seems to be around 25°C (Torres et al., 1997). *Tecia solanivora* does not survive below 7.9°C and above 30°C (Notz, 1996). Larval mortality at constant temperatures of 30°C is 100% (Povolný, 2004).

A pest risk assessment including a CLIMEX analysis (Sutherst and Maywald, 1985) by Germain (2002a, 2002b) as well as a global map entitled 'Establishment Risk Index' (ERI) (Kroschel et al. 2016, Schaub et al., 2016; Figure 4) suggest that regions outside the already infested areas of the EU, in particular coastal regions around the Mediterranean and the Atlantic coast of Portugal, would provide suitable conditions for establishment of *T. solanivora* and would allow multiple generations per year. Cold winters, where minimum temperatures are often below 7.9°C would not allow *T. solanivora* to establish outdoors in northern Europe.

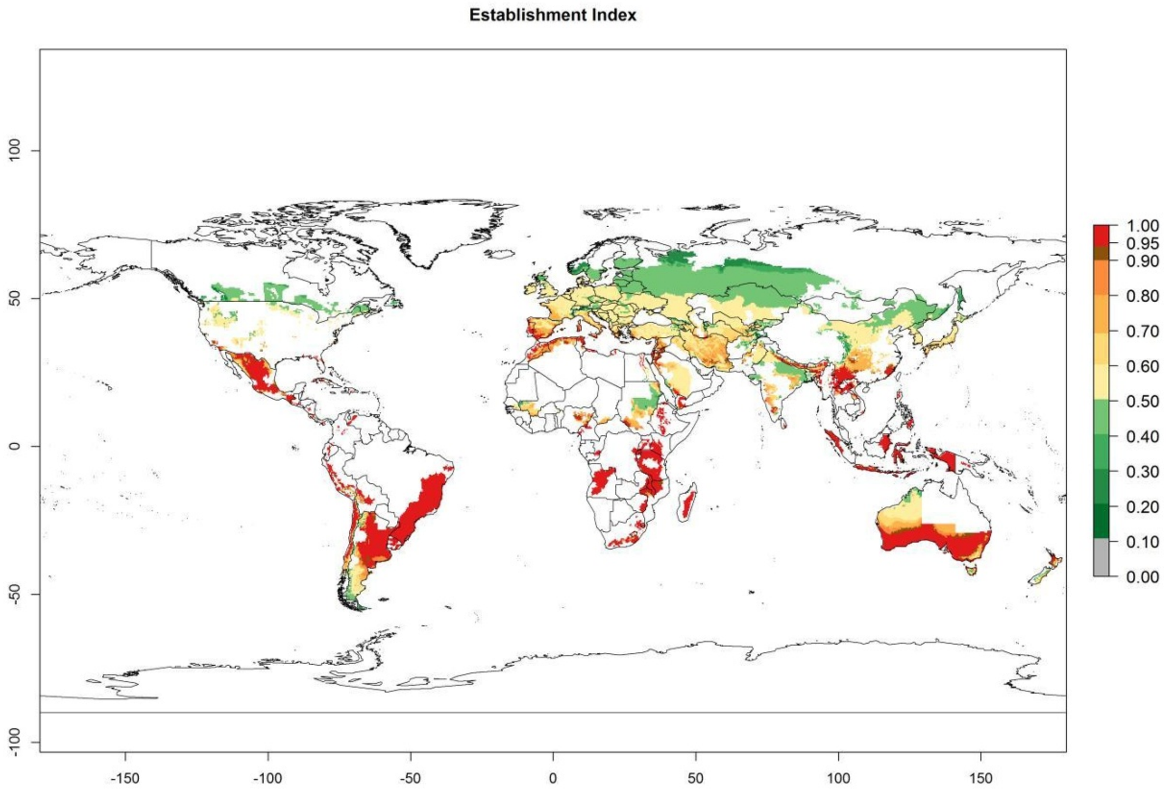

Figure 4: Establishment and potential distribution of *Tecia solanivora* in areas of potato production world-wide according to model prediction, shown here is the example for year 2000. If the establishment risk index (ERI) is >0.95 (see scale at right hand side), potential permanent establishment can be expected. For further details see: Schaub et al. 2016, http://nkxms1019hx1xmtstxk3k9sko-wpengine.netdna-ssl.com/riskatlasforafrica/wp-content/uploads/sites/4/2016/11/4.1.2-1.pdf (accessed 5 February 2019)

Therefore, the areas in the EU where the environment is most suitable for the pest to establish are the potato-growing areas in coastal regions around the Mediterranean and the Atlantic coast of Portugal.

1.7. Spread capacity

The spread of *T. solanivora* in Central and South America was due to movement of infested seed potatoes (Puillandre et al., 2008). In the Canary Islands the pest was introduced through the illegal movement of infested seed potatoes from South America (EPPO, 2006b).

Adults are weak fliers, but local spread is possible. They make short flights close to the ground during the night, and shelter in shady places on the ground, on bushes and weeds at the edges of fields, and under leaf litter or between potatoes in potato storage facilities at daytime. Adults can move from potato fields into potato storage facilities and back to potato fields (Povolný, 2004). When introduced into new areas in Central and South America, the moth spreads rapidly in potato-growing regions; facilitated by the trade in potato tubers and by local natural dispersal (Kroschel and Schaub, 2013).

In conclusion, the new introductions of the moth into non-infested potato-growing areas are mainly linked to the movement of seed potatoes. Once introduced the moth spread within the production area is the result of the combination of natural flight of the moth and movement of infested harvested potatoes.

1.8. Risk factor identification

A risk factor is a biotic or abiotic factor that increases the probability of infestation by the pest. The risk factors that are relevant for surveillance are those that result in different effects on different parts of the target population depending on its structure and its variability.

The identification of the risk factors and their relative risk estimation is essential for performing a risk-based survey. It needs to be tailored to the situation of each Member State. The proportion of the target population for each risk factor needs to be known or estimated by each Member State. This section presents examples of risk factors. Different Member States may have different risk factors.

For seed potatoes, considering the prohibition of import of seed potatoes (Annex III of Council Directive 2000/29/EC), the highest likelihood for introduction of the pest is linked to the movement from the areas where the pest has been reported in Spain, although under official control. Therefore, the seed potato pathway deserves special attention.

The high risk locations are premises (e.g. packing stations of potatoes): (1) where seed, ware and/or starch potatoes are handled, in particular where waste from potatoes is disposed; (2) where potato bags are transiting and from where they are sent for being reused; and (3) where the soil attached to the potato tubers is managed as both used bags and soil may carry eggs or pupae (EPPO, 2006b).

In southern MS – depending on the climate and the geography – altitude of the fields may be an additional risk factor (see Section 1.6).

<u>Example 1: Origin of seed potatoes</u>

The use of seed potatoes from areas (of countries) where the pest is present is a potential risk factor, particularly in MS where it is currently absent and where temperatures are not below 7.9 and not above 30°C (see Section 1.6 and Figures 3 and 4). Given that the origin of the seed potatoes is not always known (trade may vary in time, infestation status of the area of origin may vary in time), data to estimate the relative risk and the proportion of the total target population for the survey may not always be available or suitable for performing a risk-based survey to demonstrate pest freedom.

The risk factor could be formulated as follows:

- Premises handling seed potato lots originating from areas where the pest is present and fields where potatoes are produced from these lots.

Example 2: Vicinity to infested fields

Within the areas where the pest has been reported, a risk factor could be:

- The distance of infested fields to premises handling potatoes and fields producing potatoes. The distance could be set considering, for example, the possibility of spread via vehicles or equipment, or natural spread.

2. Detection and identification

Moths are not easily visible, except when gathering in large numbers. In the field they can be found on the borders of crops, where they take refuge in foliage and among the leaves of weeds and bushes. At dusk, adults fly excitedly, copulate and lay eggs individually or in small clusters on the soil surface near tubers or close to the base of potato plants (Torres, 1989). Eggs are rarely laid on the stems or foliage of potato plants (Povolný, 1973; Barreto, 2005). Eggs in potato storage facilities are usually laid directly onto exposed potato tubers (EPPO, 2006b). Egg and pupal stages are not reliable for identification (EPPO, 2006a). Low infestation densities are difficult to detect.

2.1. Visual examination

According to EPPO (2006a), for larvae and adults, morphological identification is recommended. For larvae, a binocular microscope should be used to identify the chaetotaxy. However, the only unequivocal means of identification is the preparation and observation of the male or female genitalia under the light microscope. For preparation of genitalia see Cribb (1972) or Robinson (1976). A key to the families is given in Arnett (2000).

2.1.1 Pest identification

Eggs are ovoid in form, 0.46–0.63 mm long and 0.39–0.43 mm wide (Povolný, 1973; EPPO, 2006a); directly after oviposition, they are pearly white, then turn matt white to yellow when maturing (Carrillo and Torrado-Leon, 2014) and dark brown when close to hatching (CABI, 2018).

After hatching, first instar larvae are approximately 1.2–1.4 mm long and translucent with the head and prothoracic shield dark brown. Typical dark spots are found along the larvae. Second-instar larvae are cream, with darker, coffee-coloured spots. Third-instar larvae are yellow-green; the spots along the body are more visible and the head and prothoracic shield are dark brown. Larvae become bluish-green as they mature; final stage larvae measure 12–15 mm × 2.5 mm and are purple on the dorsal side and green ventrally. Larvae are eruciform, with three pairs of true legs (thoracic) and five pairs of pseudolegs: four abdominal and one anal pair (Torres, 1998; CABI, 2018).

To detect larvae, it is necessary to cut open suspected tubers, or check them carefully to find signs of damage or exit holes made by larvae before pupating.

Pupae are fusiform, on average 8.5 mm × 3.0 mm (female) or 7.8 mm × 2.4 mm (male), 7.3–9.0 mm long, coffee-coloured light brown becoming dark brown as they develop (EPPO, 2006b). Female pupae tend to be larger and heavier than male pupae (Carrillo and Torrado-Leon, 2014). Pupation may occur on the ground, on the walls of storerooms, in sacking or within the tuber itself.

Adult females are 13.0 mm × 3.4 mm, bright brown, the first pair of wings having three marks and bright brown longitudinal lines. Males are smaller, 9.7 mm × 2.9 mm, dark brown, with two marks on the first pair of wings and scarcely visible longitudinal lines. Adults are rather stout moths with lanceolate front wings and larger rear wings with many fringes (Barroso, 1974; Torres, 1989; Sotelo, 1996; EPPO, 2006a; CABI, 2018).

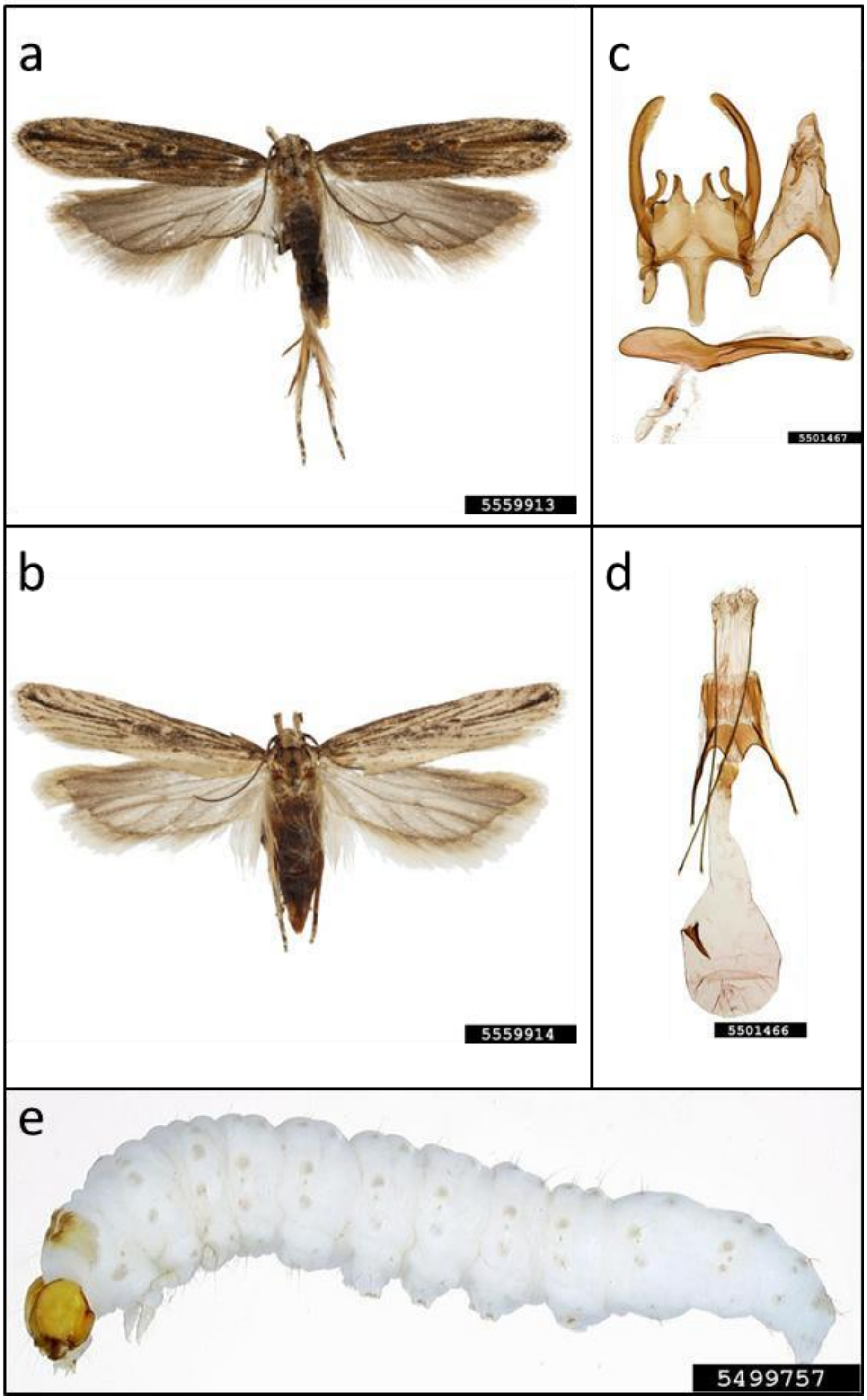

Figure 5: Morphological characteristics of *Tecia solanivora* in different life stages(a) Male adult (Source: Hanna Royals, Screening Aids, USDA APHIS PPQ, Bugwood.org), (b) female adult (Source: Hanna Royals, Screening Aids, USDA APHIS PPQ, Bugwood.org), (c) male genitalia above and phallus below (Source: Sangmi Lee, Microlepidoptera on Solanaceae, USDA APHIS PPQ, Bugwood.org), (d) female genitalia (Source: Sangmi Lee, Microlepidoptera on Solanaceae, USDA APHIS PPQ, Bugwood.org) and (e) larva (Source: James Hayden, Microlepidoptera on Solanaceae, USDA APHIS PPQ, Bugwood.org)

For a detailed description of adults see EPPO (2006a).

2.1.2 Symptoms

Larvae of *T. solanivora* create galleries containing residues of food, frass and larval exuviae. The damage caused by the larvae is similar to that caused by other moths developing in potato tubers, but (exit) holes and galleries of *T. solanivora* are larger than other species. The entry holes are inconspicuous, but the circular exit holes are 2–3 mm. They are free of excrements and become visible when larvae leave the tubers (EPPO 2006a). Another (although not species-specific) symptom is that secondary rotting may occur. Larvae normally feed on potato tubers, but when populations are high, they may also attack the green parts of the plant (Povolný, 1973). An illustration of damage caused by larvae in a potato tuber is provided in EPPO (2006a).

2.2. Traps

Light traps can be used to capture adults, which then need to be identified as described above as such traps are not species-specific. White delta plastic traps baited with a synthetic sex pheromone can also be used to detect adult males (Nesbitt et al., 1985; Bosa et al., 2005; Roblero et al., 2011).

The pheromone of *T. solanivora* is a blend of (E)-3-dodecenyl acetate, (Z)-3-dodecenyl acetate, and dodecyl acetate. When mixed in a ratio of 100:1:20 and formulated at 1,000 µg on rubber septa, the pheromone seems to be quite effective in capturing males, while it is also species-specific. It does not capture the potato tubermoth, *Phthorimaea operculella* (Bosa et al., 2005). Specificity for detecting *T. solanivora* is therefore high.

Roblero et al. (2011) placed four white delta plastic traps (Pherotech, Delta, BC, Canada) in a 25 ha potato field (10-day-old potato plants) in Tibaitatá, Colombia. Each trap was baited with a white rubber septum containing the pheromone (Nesbitt et al. 1985; Bosa et. al. 2005, 2006) formulated by Chemtica (Heredia, Costa Rica). Traps were hung on a wooden stake 60 cm above ground in the potato field for 1 month.

High-density pheromone trapping (16 traps/ha) in areas with a high risk factor could be useful (CABI, 2018).

In summary the detection survey of *T. solanivora* could be based on two survey components:

- visual examination of symptoms of the pest on potato tubers at pack-house level
- trapping the adult insects in premises handling the potatoes and in the potato fields.

The suspicious adult findings should be identified following the pest identification key as described in the diagnostic protocol EPPO (2006a).

3. Key elements for survey design

Based on the analyses of the information on the pest–host plant system, the different units that are needed to design the survey have to be defined, and tailored to the situation of each Member State. The size of the defined target population and its structure in terms of number of epidemiological units need to be known. When several pests have to be surveyed in the same crop, it is recommended to use the same epidemiological and inspection units for each pest to optimise the survey programme as much as possible. Table 1 shows an example of these definitions.

Table 1: Example of definitions of the target population, epidemiological unit and inspection unit for a survey for *Tecia solanivora* in seed potatoes

	Definition	Unit
Target Population	Harvested potato lots (a lot consists of a homogeneous group of tubers in terms of field, harvest, cultivars, cultural practices) in a Member State	Total number of lots of harvested potato tubers
Epidemiological Units	A lot of potatoes coming from the same field	One lot
Inspection Units	Individual tubers from a lot	One tuber

Table 2: Example of definitions of the target population, epidemiological unit and inspection unit for a survey for *Tecia solanivora* in fields that produce ware or starch potatoes

	Definition	Unit
Target Population	Potato fields in a Member State	Number of fields of potatoes
Epidemiological Units	Potato fields	One potato field
Inspection Units	Traps in the potato growing fields and potato handling premises	One trap

The general guidelines for the risk-based statistically sound surveillance are presented in a separate document and describe step- by-step the process of the survey design and include:

1/ the choice of the type of survey to develop depending on the objectives of the survey

2/ manual for guiding the user through the statistical tools for sample size calculations

3/ essential considerations when:

- choosing the sampling sites and taking the samples
- collecting the data
- reporting the data and the survey results

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Glossary

TERM	DEFINITION*
Component (of a survey)	In the general framework of surveillance, with the goal of demonstrating pest freedom, a component is an activity characterised by a given sensitivity of the method of detection and identification. The overall confidence of the survey for pest freedom will result from the combination of the different components. Two components of the same survey could have different target populations. E.g. Survey on an insect performed by trapping of the pest (component 1) and sampling the host plants for visual examination of signs or symptoms (component 2).
Confidence	Sensitivity of the survey. Is a measure of reliability of the survey procedure (Montgomery and Runger, 2010).
Design prevalence	It is based on a pre-survey estimate of the likely actual prevalence of the pest in the field (McMaugh, 2005). The survey will be designed in order to obtain at least a positive test result when the prevalence of the disease will be above the defined value of the design prevalence. In 'freedom from pest' approaches, it is not statistically possible to say that a pest is truly absent from a population (except in the rare case that a census of a population can be completed with 100% detection efficiency). Instead, the maximum prevalence that a pest could have reached can be estimated, this is called the 'design prevalence'. That is, if no pest is found in a survey, the true prevalence is estimated to be somewhere between zero and the design prevalence. (EFSA, 2018)
Diagnostic protocols	Procedures and methods for the detection and identification of regulated pests that are relevant to international trade (ISPM 27: FAO, 2016).
Epidemiological unit	A homogeneous area where the interactions between the pest, the host plants and the abiotic and biotic factors and conditions would result in the same epidemiology, should the pest be present. The epidemiological units are subdivisions of the target population and reflect the structure of the target population in a geographical area. They are the units of interest, on which statistics are applied (e.g. a tree, orchard, field, glasshouse, or nursery) (EFSA, 2018).
Expected prevalence	In prevalence estimation approaches, it is the proportion of epidemiological units expected to be infected or infested.
Identification	Information and guidance on methods that either used alone or in combination lead to the identification of the pest (ISPM 27: FAO, 2016).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine whether pests are present or to determine compliance with phytosanitary regulations (ISPM 5: FAO, 2018).
Inspection unit	The inspection units are the plants, plant parts, commodities or pest vectors that will be scrutinised to identify and detect the pests. They are the units within the epidemiological units that could potentially host the pests and on which the pest diagnosis takes place. (EFSA, 2018).
Inspector	Person authorised by a national plant protection organisation to discharge its functions (ISPM 5: FAO, 2018).
Method sensitivity	The conditional probability of testing positive given that the individual is diseased (Dohoo et al., 2010). The method diagnostic sensitivity (DSe) is the probability that a truly positive epidemiological unit will give a positive result and is related to the analytical sensitivity. It corresponds to the probability that a truly positive epidemiological unit that is inspected will be detected and

	confirmed as positive.
Pest diagnosis	The process of detection and identification of a pest (ISPM 5: FAO, 2018).
Pest freedom	An area in which a specific pest is absent as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (ISPM 5: FAO, 2018).
Population size	The estimation of the number of plants in the region to be surveyed (EFSA, 2018).
Potato lot	A potato crop identifiable by its homogeneity of composition (same cultivar), origin (same field), etc., or A number of potato tubers identifiable by their homogeneity of composition (same cultivar), origin (same field, same crop) and with traceability to the field in which they were produced.
Relative risk	The ratio of the risk of disease in the exposed group to the risk of disease in the non-exposed group (Dohoo et al., 2010).
Representative sample	A sample that describes very well the characteristics of the target population (Cameron et al., 2014).
RiBESS+	An online application that implements statistical methods for estimating the sample size, global (and group) sensitivity and probability of freedom from disease. Free access to the software with prior user registration is available at: https://shiny-efsa.openanalytics.eu/
Risk assessment	Evaluation of the probability of the introduction and spread of a pest and the magnitude of the associated potential economic consequences (ISPM 5: FAO, 2018).
Risk factor	The factor that may be involved in causing the disease (Cameron et al., 2014). It is defined as a biotic or abiotic factor that increases the probability of infestation of the epidemiological unit by the pest. The risk factors relevant for the surveillance should have more than one level of risk for the target population. For each level, the relative risk needs to be estimated as the relative probability of infestation compared to a baseline with a level 1. Consideration of risk factors in the survey design allows the survey efforts to be enforced in those areas where the highest probabilities exist to find the pest should the pest be present.
Risk-based survey	A survey design that considers the risk factors and enforces the survey efforts in the corresponding proportion of the target population.
Sample size	The number of sites that need to be surveyed in order to detect a specified proportion of pest infestation with a specific level of confidence, at the design prevalence (McMaugh, 2005).
Survey	An official procedure conducted over a defined period of time to determine the characteristics of a pest population or to determine which species are present in an area (ISPM 5: FAO, 2018).
Target population	The set of individual plants or commodities or vectors in which the pest under scrutiny can be detected directly (e.g. looking for the pest) or indirectly (e.g. looking for symptoms suggesting the presence of the pest) in a given habitat or area of interest. The different components pertaining to the target population that need to be specified are: • Definition of the target population – the target population has to be clearly identified • Target population size and geographic boundary. (EFSA, 2018)
Test	Official examinations, other than visual, to determine whether pests are present or to identify pests (ISPM 5: FAO, 2018).

Test specificity	The conditional probability of testing negative given that the individual does not have the disease of interest (Dohoo et al., 2010). The test diagnostic specificity (DSp) is the probability that a truly negative epidemiological unit will give a negative result and is related to the analytical specificity. In freedom from disease it is assumed to be 100%.
Visual examination	The physical examination of plants, plant products or other regulated articles using the unaided eye, lens, stereoscope or microscope to detect pests or contaminants without testing or processing (ISPM 5: FAO, 2018).

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