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Pest categorisation of *Leucinodes pseudorbonalis*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of the snout moth *Leucinodes pseudorbonalis* Mally, Korycinska, Agassiz, Hall, Hodgetts & Nuss (Lepidoptera: Crambidae), for the territory of the EU. This species is not included in the EU Commission Implementing Regulation 2019/2072. This oligophagous species, which feeds on fruit and leaves of *Solanum aethiopicum* (Ethiopian eggplant) and *S. melongena* (eggplant), is known to occur in sub-Saharan Africa (Angola, Liberia, Senegal, Uganda). Adults oviposit on leaves and newly hatched caterpillars can bore into shoots, causing wilting and dieback, before moving into the fruit, which they tunnel. Damage may be visible only if the fruit is cut open. A single aubergine can be infested by up to 20 larvae. Mature larvae abandon the fruit to pupate in a cocoon in the soil. Adult moths fly for short distances only in darkness. Potential entry pathways for *L. pseudorbonalis*, such as *Solanum* spp. plants for planting and soil/growing media are regulated and can be considered as closed. The fruit and leaves pathways remain open from countries where *L. pseudorbonalis* is known to occur. Indeed, this species was intercepted in the EU with S. *aethiopicum* eight times from January to June 2021. Should *L. pseudorbonalis* enter the EU, host availability (*S. melongena*) and climatic conditions in some limited areas of southern EU Member States could allow this species to successfully establish and spread within these areas. Economic impact in aubergine production is anticipated if establishment occurs. *L. pseudorbonalis* satisfies the criteria that are within the remit of EFSA to assess for this species to be regarded as a potential Union quarantine pest. Because this is a recently described species, there are knowledge gaps related to the biology of this moth and its distribution. However, these gaps do not affect the conclusions of this categorisation.

Keywords: pest risk, plant health, plant pest, quarantine, *Solanum melongena*, *Solanum aethiopicum*, Lepidoptera, Crambidae

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

The new Plant Health Regulation (EU) 2016/2031, on the protective measures against pests of plants, is applying from 14 December 2019. A focus on prevention and risk targeting is amongst the primary objectives of this legislation. Furthermore, conditions are laid down in this legislation for plant pests to qualify for listing as Union quarantine pests, protected zone quarantine pests or Union regulated non-quarantine pests. The lists of the EU regulated plant pests together with the associated import or internal movement requirements of commodities are included in Commission Implementing Regulation (EU) 2019/2072.

In line with the principles of the new plant health law, for a proactive approach, the European Commission with the Member States are discussing monthly the reports of the interceptions, together with data from horizon scanning for plant pests of concern of various sources. As outcome of those discussions, a number of plant pests of concern, not regulated in the EU, are identified, for which a risk assessment is needed to decide on potential EU regulation. *Leucinodes orbonalis* - which was recently spilt into two species *Leucinodes orbonalis* and *Leucinodes pseudorbonalis*, *and Xanthomonas citri* pv. *viticola* are amongst the species identified during these discussions.

In the EU, a number of actions are already in place to mitigate the various multilevel effects of climate change. The aim is to avoid adverse changes to the environment and to ensure food security. As the success of plant pests to establish in an area, depends on various abiotic and biotic parameters, it is anticipated that climate change might affect the risk that certain plant pests pose. Parameters as temperature, humidity, CO2 concentration and salinity of soil affect the survival and pathogenicity of a number of plant pests, as reported in the scientific literature. Changes in temperature, drought and salinity can affect also the geographic distribution of the hosts of plant pests, and as a consequence the plant pests' establishment.

There is therefore a need to develop further the quantitative risk assessment methodology followed for plant pests and consider including the effect of climate change in the assessment of the risk that plant pests pose to the EU.

1.1.2. Terms of Reference

In accordance with Article 29(1) of Regulation (EC) No 178/2002, the Commission asks EFSA to develop further the quantitative risk assessment (phase 1 and phase 2) methodology followed for plant pests, to include in the assessments the effect of climate change for plant pests. Such inclusion of climate change scenarios can benefit of the quantitative methodology with comparison of risk assessment scenarios which has been already developed by the EFSA PLH Panel and included in its Guidance on quantitative pest risk assessment. Examples of abiotic parameters affecting the biology of the pests and their hosts' distribution are given in the background. The aim of this methodological development is to enable risk projections in the future, with models taking into account the relevant critical parameters for spread, establishment and potential impact that are affected in a scenario of 'climate change'.

The risk assessments of *Leucinodes orbonalis*, *Leucinodes pseudorbonalis* and *Xanthomonas citri* pv. *viticola* can be used for the development of the methodology.

1.2. Interpretation of the Terms of Reference

The EFSA PLH Panel has been requested to conduct a risk assessment for *Leucinodes pseudorbonalis*. This document is the phase 1 component (pest categorisation) fulfilling the request. The purpose of the pest categorisation is to determine whether *L. pseudorbonalis* fulfils the criteria of a regulated pest for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform European Commission decision making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/2072.

If *L. pseudorbonalis* fulfils the criteria to be potentially listed as a regulated pest, risk reduction options aimed to prevent entry will be identified; consideration of climate change is beyond the scope

of pest categorisation, but will follow in a separated phase 2 assessment, if *L. pseudorbonalis* satisfies the criteria for quarantine pest (QP) status.

1.3. Additional information

Based on results of taxonomic studies on African species of the genus *Leucinodes* (Mally et al., 2015), the EPPO Council approved in September 2015, the addition of the recently described species *Leucinodes pseudorbonalis*, to the EPPO A1 List of pests recommended for regulation as QPs (EPPO, online). Revision of past interceptions of the closely related species *L. orbonalis* based on the studies by Mally et al. (2015) combined with recent interceptions of *L. pseudorbonalis* from several African countries indicated that these past interceptions were *L. pseudorbonalis* and thus a categorisation of this species was initiated.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *L. pseudorbonalis* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as search term. Papers relevant for the pest categorisation were reviewed, and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online), the CABI databases and scientific literature databases as referred above in Section 2.1.1.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

The Europhyt and TRACES databases were consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network run by the Directorate General for Health and Food Safety (DG SANTÉ) of the European Commission as a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. TRACES is the European Commission's multilingual online platform for sanitary and phytosanitary certification required for the importation of animals, animal products, food and feed of non-animal origin and plants into the EU, and the intra-EU trade and EU exports of animals and certain animal products. Up until May 2020, the Europhyt database managed notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the Member States and the phytosanitary measures taken to eradicate or avoid their spread. The recording of interceptions switched from Europhyt Interceptions to TRACES in May 2020.

2.2. Methodologies

The Panel performed the pest categorisation for *L. pseudorbonalis*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018), the EFSA guidance on the use of the weight of evidence approach in scientific assessments (EFSA Scientific Committee, 2017) and the International Standards for Phytosanitary Measures No. 11 (FAO, 2013) and No. 21 (FAO, 2004).

The criteria to be considered when categorising a pest as a Union QP is given in -Regulation (EU) 2016/2031 Article 3 and Annex 1 to this Regulation. Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. In judging whether a criterion is met the Panel uses its best professional judgement (EFSA Scientific Committee, 2017) by integrating a range of evidence from a variety of sources (as presented above in Section 2.1) to reach an informed conclusion as to whether or not a criterion is satisfied.

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable

impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. While the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for QP status. Assessing social impact is outside the remit of the Panel.

Table 1: Pest categorisation criteria under evaluation, as defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest (article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future.
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Specific import requirements) (Section 3.6)	Are there measures available to prevent the entry into the EU such that the likelihood of introduction becomes mitigated?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and/or to be transmissible?

Yes, *Leucinodes pseudorbonalis* is a pyraloid moth described by Mally et al. (2015).

Until recently, all pyraloid larvae damaging Solanaceae fruits in Asia and Africa and intercepted from imports to Europe had been regarded as two species, *Leucinodes orbonalis* Guenée, 1854, and *L.* (= *sceliodes*) *laisalis* (Walker, 1859) (Lepidoptera: Crambidae) (Mally et al., 2015). However, Hayden et al. (2013) and Gilligan and Passoa (2014) pointed out that *L. orbonalis* is restricted to Asia. More recently, Mally et al. (2015) described a complex of eight endemic *Leucinodes* species occurring in sub-Saharan Africa. One of them is *L. pseudorbonalis* Mally, Korycinska, Agassiz, Hall, Hodgetts & Nuss, 2015. The species name of this snout moth, from Greek *pseud*(*o*) 'false' and *orbonalis*, refers to the similarities in external and male genital characters with *L. orbonalis*, the closely related species restricted to Asia (Mally et al., 2015).

The EPPO code[1] for this species is: LEUIPS (EPPO, online).

[1] An EPPO code, formerly known as a Bayer code, is a unique identifier linked to the name of a plant or plant pest important in agriculture and plant protection. Codes are based on genus and species names. However, if a scientific name is changed the EPPO code remains the same. This provides a harmonised system to facilitate the management of plant and pest names in computerised databases, as well as data exchange between IT systems (Griessinger and Roy, 2015; EPPO, 2019).

3.1.2. Biology of the pest

Because of lack of specific information on *L. pseudorbonalis* (including absence of records in grey and scientific literature in the Horizon Scanning for Plant Health report 2017–2020; EFSA, 2021), this section is based on publications about eggplant borers of the genus *Leucinodes* occurring in sub-Saharan Africa at a time before *L. pseudorbonalis* was recognised as a distinct species (Mally et al., 2015). Because eight species of this genus occur in Africa (see Figure 2), from which at least three [*L. africensis* Mally, Korycinska, Agassiz, Hall, Hodgetts & Nuss, *L. rimavallis* Mally, Korycinska, Agassiz, Hall, Hodgetts & Nuss, and *L. laisalis* (Walker)] can feed on the same hosts as *L. pseudorbonalis* (*Solanum melongena* and *S. aethiopicum*), there is uncertainty as to whether all the details provided actually correspond to *L. pseudorbonalis*.

According to Korycinska and Cannon (2010), the eggs are laid singly or in groups on the underside of leaves. The newly hatched caterpillars sometimes bore into shoots, causing wilting and dieback, before moving into the fruit as they grow larger; or they may tunnel straight into the fruits. The later instars all bore into the fruit of the host plant, feeding from the inside, so that they are only visible if the fruit is cut open. A single aubergine can be infested by up to 20 caterpillars. Feeding damage to the fruit is often not immediately visible as the entry hole is usually small, near the calyx of the fruit, and the caterpillars block the entrance hole with excrement. The plant sometimes will regenerate tissue over the entry hole, making detection via visual inspection almost impossible. The entrance wound allows secondary damage to occur to the fruit, such as fungal attack or rotting, and this more noticeable symptom will give an indication of possible infestation. The larva only emerges from inside the fruit when it is ready to pupate in the soil, leaving a much larger and obvious exit hole at this stage. The larvae pupates outside the fruit, spinning a thick, fibrous, dark brown cocoon that is firmly attached to surrounding materials. The pupa cannot be seen through the cocoon. The moths only fly for short distances, in darkness, and typically rest on the underside of foliage with their abdomens curled upwards.

Onekutu et al. (2013) studied the life history of a *Leucinodes* species mistakenly identified at that time as *L. orbonalis* on *Solanum gilo* Raddi at laboratory conditions (27°C; 85% RH) in Nigeria. They found 5 larval instars (LI–LV). Developmental periods were 5.93 days for eggs, 1.00 days for LI, 1.16 for LII, 1.48 days for LIII, 2.63 days for LIV, 4.46 for LV and 11.2 days for pupae. Adult moths lived for 4 days. The male to female ratio was 1:2 and fecundity was 123 eggs per female (range of 72–207). Therefore, under these conditions, this species could complete its life cycle in 28.17 days.

Because the regions where *L. pseudorbonalis* is known to occur (see Section 3.2.1) are typically less variable than temperate areas in terms of photoperiod and temperature, *L. pseudorbonalis* could be multivoltine with no diapause. However, as dry and wet seasons follow one another in these areas, some kind of quiescence during unfavourable periods could be present in its life cycle.

3.1.3. Host range

Leucinoides pseudorbonalis can complete development in *Solanum aethiopicum* L. (Ethiopian eggplant, African scarlet eggplant, jilo) and *S. melongena* L. (aubergine, eggplant, brinjal) (Mally et al., 2015). This restricted host range, may reflect a bias of investigation, which so far has concentrated on fruits of economic importance. In nature, the *Leucinodes* species may have different host plants to which they were originally adapted (Mally et al., 2015).

3.1.4. Intraspecific diversity

There are no reports of intraspecific variation for *L. pseudorbonalis.*

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?
Yes, there are detection and identification methods for *L. pseudorbonalis*.

Symptoms

As mentioned before (see Section 3.1.2) feeding damage to the fruit is not always visible. Fungal colonisation or rotting, which sometimes appears at the entrance holes, is the most noticeable

symptom of a current infestation. A much larger and obvious exit hole can be seen when larvae have abandoned the fruit to pupate in the soil.

Identification

According to Mally et al. (2015), the wing pattern distinguishes *L. pseudorbonalis* from *L. malawiensis* by the absence of the forewing basal transversal streak and the presence of the apical half-moon-shaped patch, and from *L. laisalis*, *L. ethiopica* and *L. ugandensis* by the predominantly white forewing ground colour. However, the wing pattern of *L. pseudorbonalis* is indistinguishable from those of *L. orbonalis*, *L. africensis*, *L. rimavallis*, *L. kenyensis* and '*Leucinodes* spp.'. As a consequence, species–specific identification is based on male and female genitalia. Mally et al. (2015) provide an Identification key for African *Leucinodes* species based on male genitalia.

Analysis of the COI gene of the *Leucinodes* species demonstrated that interspecific differences allow the use of the marker as a DNA barcode, by which also the immature stages can be efficiently distinguished, for species identification (Mally et al., 2015).

Description

Based on Mally et al. (2015) for the genus *Leucinodes:*

- Adult: forewing length male 7.0–8.5 mm, female 9.0–11.0 mm; wing pattern as in *L. orbonalis* (Figure 1).
- Egg: no description found.
- Larva: early instar larvae white or cream with brown pinacula and black head, prothoracic and anal shields. Last instar larvae with pink dorsal integument, intersegmental areas cream or light pink, the ventral integument cream; strength of the colouration very variable, pink colour on majority of abdominal segments often interrupted laterally by a transverse cream line; head, prothoracic and anal shields mid brown with variable black markings. In older larvae the dorsal integument turns beige, then increasingly deeper pink as the moults progress.
- Pupa: yellow to pale brown, lightly sclerotised, developing adult clearly visible as development proceeds; two distinct, raised hood-like structures dorsal to spiracles on abdominal segments 2 and 3; four pairs of long hooked setae ventral to cremaster; cocoon stout leathery, made of silk, firmly attached to the substrate.

Figure 1: Male of *L. pseudorbonalis* (collected in Uganda) (source: Mally et al., 2015)

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

The distribution of *L. pseudorbonalis* (Figure 2), which relies on specimens collected in Angola, Liberia, Senegal and Uganda, leaving a considerable distribution gap in Central Africa (Mally et al., 2015; Poltavsky et al., 2019), could be wider in sub-Saharan Africa, as suggested by interceptions in the EU from African countries different from Angola, Liberia, Senegal and Uganda (i.e. Burundi, Kenya;

see Section 3.4.1). However, as other species within the genus *Leucinodes* occur in Africa (Figure 3), further research is needed to clarify the exact distribution of this moth.

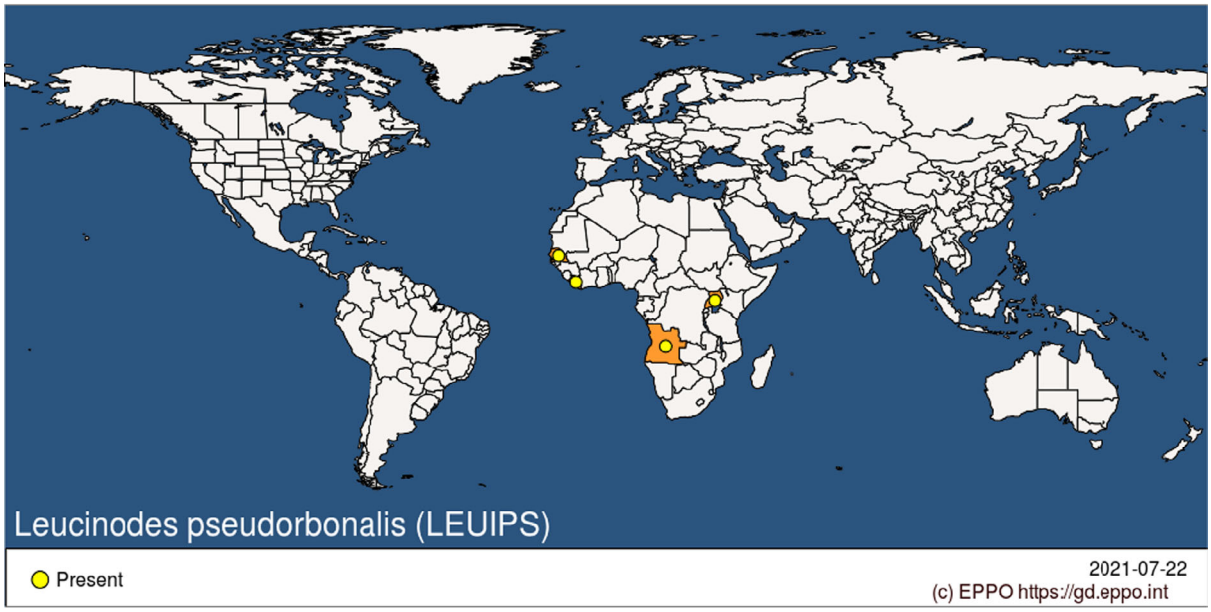

Figure 2: Global distribution of *L. pseudorbonalis* (Source: EPPO Global Database accessed on July 16th, 2021)

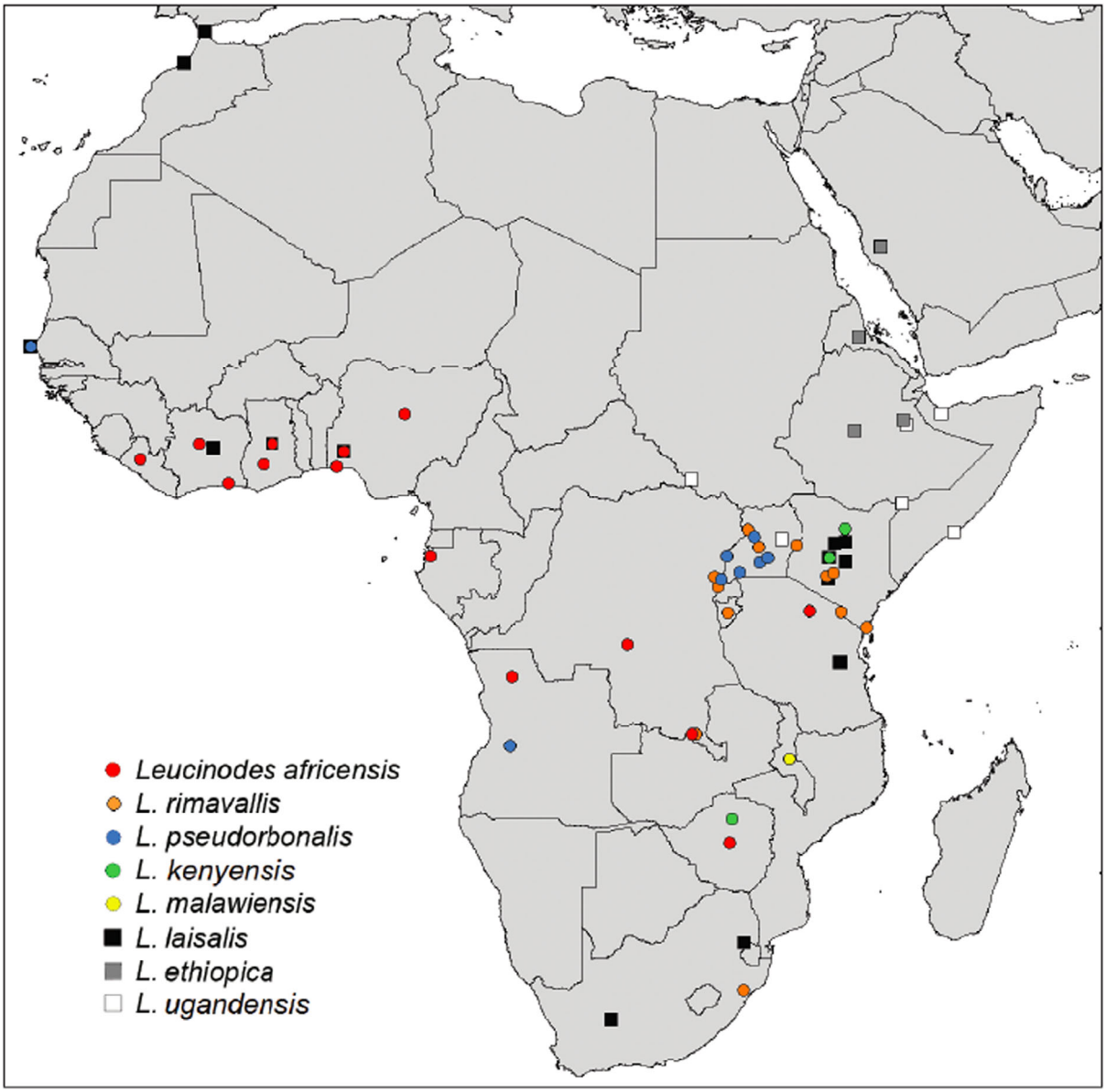

Figure 3: Distribution of *Leucinodes* spp. in Africa. Mally et al. (2015) reported *L. pseudorbonalis* from Angola, Senegal, and Uganda. In 2019 it was also found in Liberia (Poltavsky et al., 2019) (figure source: Mally et al., 2015)

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?

No. *L. pseudorbonalis* is not known to occur in the EU.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

L. pseudorbonalis is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, an implementing act of Regulation (EU) 2016/2031.

3.3.2. Hosts of *L. pseudorbonalis* that are prohibited from entering the Union from third countries

Table 2: List of plants, plant products and other objects that are *L. pseudorbonalis* hosts whose introduction into the Union from certain third countries is prohibited (Source: Commission Implementing Regulation (EU) 2019/2072, Annex VI)

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	**CN code**	**Third country, group of third countries or specific area of third country**
18.	Plants for planting of Solanaceae other than seeds and the plants covered by entries 15, 16 or 17	ex 0602 90 30 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries other than: Albania, Algeria, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Turkey and Ukraine
19.	Soil as such consisting in part of solid organic substances	ex 2530 90 00 ex 3824 99 93	Third countries other than Switzerland
20.	Growing medium as such, other than soil, consisting in whole or in part of solid organic substances, other than that composed entirely of peat or fibre of *Cocos nucifera* L., previously not used for growing of plants or for any agricultural purposes	ex 2530 10 00 ex 2530 90 00 ex 2703 00 00 ex 3101 00 00 ex 3824 99 93	Third countries other than Switzerland

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

Is the pest able to enter into the EU territory? If yes, identify and list the pathways.

Yes, larvae of *L. pseudorbonalis* have been intercepted in the EU with *S. aethiopicum* from sub-Saharan Africa (details below).

Comment on plants for planting as a pathway.

In principle plants for planting could provide a pathway for entry into the EU. However, as Solanaceae plants for planting other than seed are prohibited from many countries, including those where *L. pseudorbonalis* occur, plants for planting are not considered an entry pathway.

Adults of *L. pseudorbonalis* are unlikely to be carried by either plants for planting or fruit because they would fly off when disturbed during harvest and processing for shipment. Therefore, *L. pseudorbonalis* is more likely to move in international trade as immature stages on the plant (eggs and larvae), in the fruit (larvae), and in soil attached to roots (pupae) of host plants. However, the import into the EU of Solanaceae plants for planting other that seeds from sub-Saharan countries is prohibited (Annex VI, 18.). Moreover, the import of soil from countries where *L. pseudorbonalis* occurs is also prohibited (Annex VI 19. & 20.) and import requirements exist for soil attached to machinery (Annex VII 2.). Nevertheless, the import of fruits of *S. aethiopicum* and *S. melongena* from third countries is permitted and regulated (Annex VII 68-70). In the period 2016–2020, almost 24 thousand tons of aubergines from the countries where *L. pseudorbonalis* is known to occur were imported into the EU

(27) (Table 3). This amount represented around 44% of total imports into the EU of aubergines from sub-Saharan countries where Solanaceae boring moths of the genus *Leucinodes* occur (Figure 3) (Appendix A).

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. According to Mally et al. (2015), *L. pseudorbonalis* had already been intercepted by the Netherlands and the United Kingdom by 2015. However, as of July 2, 2021 there were eight records of interception of *L. pseudorbonalis* from Belgium in the TRACES database. These interceptions referred to *S. aethiopicum* ('edible vegetables' commodity group) imported from Burundi (one interception), Kenya (one interception) and Uganda (five interceptions) from January to June 2021. Therefore, leaves and fruit of *S. aethiopicum*, which are both edible, (and most probably fruit of *S. melongena*) provide an entry pathway for *L. pseudorbonalis* into the EU (Table 4).

Table 3: Imports (×1,000 Kg) of fresh or chilled aubergines (CN code 070930) from countries where *L. pseudorbonalis* is known to occur (Source: Eurostat; updated 7 July 2021; extracted 8 July 2021)

Partner/Period	Jan–Dec 2016	Jan–Dec 2017	Jan–Dec 2018	Jan–Dec 2019	Jan–Dec 2020	Total
Angola	0	0	0	0	0	0
Liberia	0	0	0	0	0	0
Senegal	717.75	714.68	665.41	697.04	1,369.92	4,164.8
Uganda	4,208.96	2,094.76	3,355.55	4,873.36	5,174.39	19,707.02
TOTAL	4,926.71	2,809.44	4,020.96	5,570.40	6,344.31	23,871.82
% total sub-Saharan Africa*	44.3	28.0	46.2	56.0	46.6	44.3

*: See Appendix B for imports into the EU of aubergines from sub-Saharan countries.

Table 4: Potential pathways for *L. pseudorbonalis* into the EU 27

Pathways Description (e.g. host/ intended use/source)	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI) or special requirements (Annex VII) within Implementing Regulation 2019/2072]
Plants for planting of *Solanum aethiopicum* and *S. melongena*	Egg, larva, pupa (in soil attached to roots), adult	Annex VI (18.) bans the introduction of plants for planting of Solanaceae other than seeds
Leaves of *S. aethiopicum*	Egg, larva	None
Fruits of *Solanum aethiopicum* and *S. melongena*	Larva	Annex VII (68.) Official statement that fruits of *S. aethiopicum* and *S. melongena* from third countries are free of *Neoleucinodes elegantalis* Annex VII (69.) Official statement that fruits of *S. melongena* from third countries are free of *Keiferia lycopersicella* Annex VII (70.) Official statement that fruits of *S. melongena* from third countries are free of *Thrips palmi*
Soil/growing media	Pupa	Annex VI (19. & 20.) bans the introduction of soil and growing media as such into the Union from third countries other than Switzerland
Soil on machinery	Pupa	Annex VII (2.) Official statement that machinery or vehicles are cleaned and free from soil and plant debris

3.4.2. Establishment

Is the pest able to become established in the EU territory?

Yes, *L. pseudorbonalis* would be able to establish in the EU. However, transfer to a suitable host would require a number of not too frequent events to occur (e.g. entry and full development of both sexes into a warm area of Southern Europe where aubergines are cultivated). Should this happen, this moth could most probably establish in some limited areas of southern EU where aubergines are cultivated.

Climatic mapping is the principal method for identifying areas that could provide suitable conditions for the establishment of a pest taking key abiotic factors into account (Baker et al., 2000). Availability of hosts is considered in Section 3.4.2.1. Climatic factors are considered in Section 3.4.2.2.

3.4.2.1. EU distribution of main host plants

As noted above (Section 3.4.1), *L. pseudorbonalis* is an oligophagous species feeding on *S. aethiopicum* and *S. melongena*. In the EU, aubergine (*S. melongena*) production concentrates in the Mediterranean countries and Romania (Table 5), where this crop is produced both outdoors and indoors. *S. aethiopicum* is a minor crop in the EU. Some commercial production can be found in south Italy (Rotonda, Basilicata).

Table 5: Area (cultivation/harvested/production of *S. melongena*) (1,000 ha) (Source: Eurostat; accessed 8 July 2021). MS with less than 10 ha not included

MS/Year	2016	2017	2018	2019	2020	Total
EU	21.58	20.73	21.44	20.63	21.36	105.74
Italy	10.13	9.45	9.76	9.55	9.51	48.40
Romania	4.56	4.42	4.80	4.81	4.76	23.35
Spain	3.75	3.58	3.62	3.47	3.70	18.12
Greece	1.75	1.70	1.67	1.35	1.70	8.17
France	0.73	0.73	0.80	0.71	0.79	3.76
Bulgaria	0.31	0.48	0.44	0.39	0.37	1.99
Netherlands	0.11	0.10	0.11	0.12	0.13	0.57
Portugal	0.10	0.14	0.11	0.11	0.10	0.56
Hungary	0.05	0.05	0.05	0.04	0.04	0.23
Poland	0	0	0	0	0.20	0.20
Cyprus	0.04	0.03	0.03	0.02	0.02	0.14
Slovenia	0.02	0.02	0.02	0.03	0.03	0.12
Belgium	0.02	0.02	0.02	0.02	0.00	0.08
Austria	0.01	0.01	0.01	0.01	0.01	0.05
Slovakia	0	0.01	0.01	0	0.01	0.03

3.4.2.2. Climatic conditions affecting establishment

L. pseudorbonalis is native to sub-Saharan Africa. If all climate types present in the countries where this moth has been found are considered, the number of climates also occurring into the EU is four (BSh-hot semi-arid, BSk-cold semiarid, Cfb-temperate oceanic, and Cfc-subpolar oceanic) (Figure 4). However, a more refined match between the exact locations where this moth has been recorded (Mally et al., 2015; Poltavsky et al., 2019) reduced this number to one: BSh. In the EU, this hot semi-arid climate type can be found in SE Spain and NE Cyprus only (Figure 5). Therefore, locations within these areas where aubergines are grown (140 ha in Cyprus and 18,000 ha in Spain) may be suitable for establishment of *L. pseudorbonalis*. Because this is a tropical species not known to diapause (see Section 3.1.2), any individual successfully entering the EU (most probably larvae within fruit) could complete development provided that temperature is warm enough to enable development and cool temperatures do not kill it. For successful establishment, completion of development, the adult should be able to find a mate (parthenogenesis is not known to occur in this species) and suitable hosts (*S. melongena* in the case of the EU) to oviposit. As this species is believed to disperse short distances (Korycinska and Cannon, 2010; see Section 3.4.3), only individuals entering areas of southern EU where aubergines are cultivated could successfully transfer to a suitable host. These characteristics

decrease the likelihood that *L. pseudorbonalis* would disperse naturally from imported fruit to come in contact with host material in the suitable areas in southern EU (i.e. Cyprus and Spain) and establish. Additionally, *L. pseudorbonalis* could be also transferred to indoor aubergines cultivated in cooler areas of the EU. However, these specimens would most probably not be able to endure outdoor winter conditions in these areas and therefore establishment would be extremely difficult.

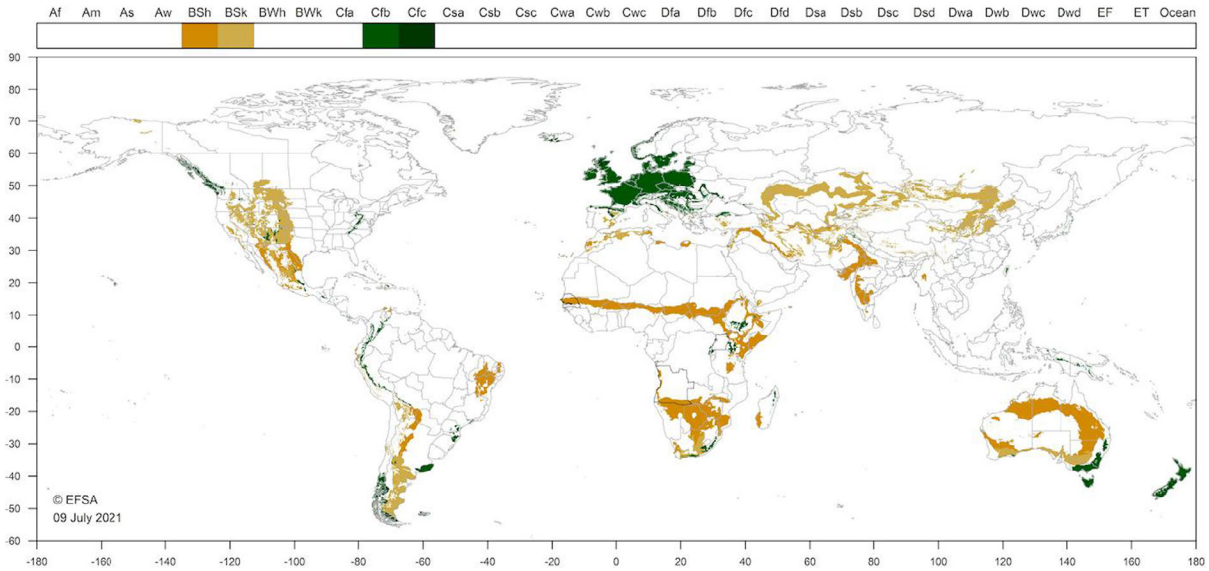

Figure 4: Occurrence of Köppen–Geiger BSh, BSk, Cfb and Cfc climate types in the World. These are the four climate types found in the countries where *L. pseudorbonalis* is known to occur that can be found in the EU as well

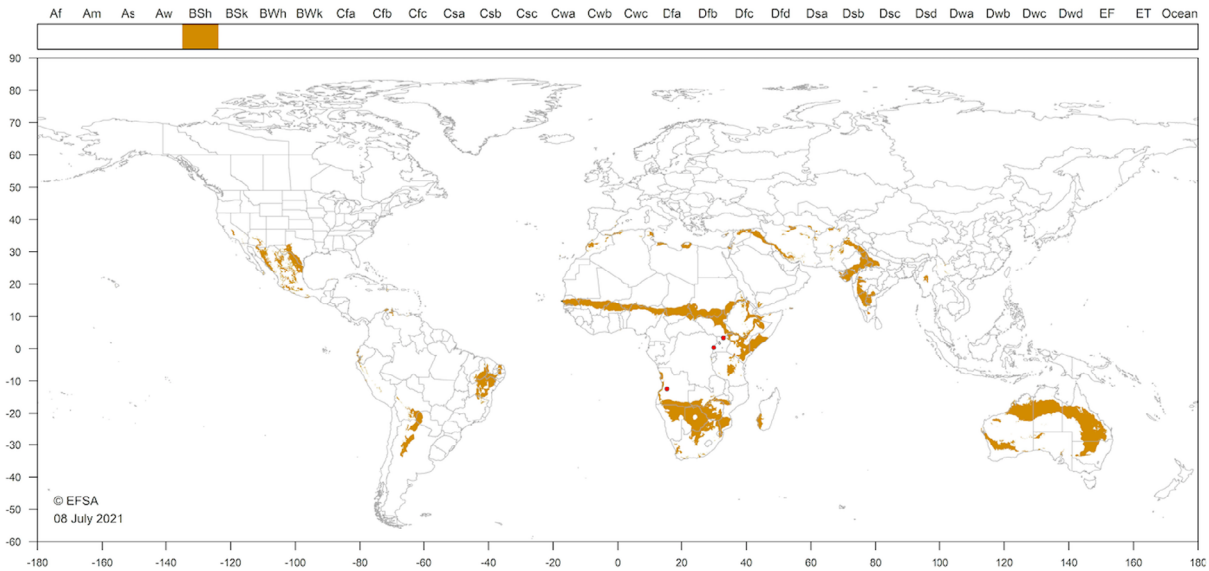

Figure 5: Occurrence of Köppen–Geiger BSh climate type in the World. This is the only climate type found in the locations where *L. pseudorbonalis* is known to occur that can be found in the EU as well

3.4.3. Spread

Describe how the pest would be able to spread within the EU territory following establishment?

L. pseudorpbonalis is reported not to be a good flier. Therefore, spread would be mostly human-assisted as immature larvae in infested produce (aubergines).

Comment on plants for planting as a mechanism of spread.

Plants for planting with soil could be a mechanism of spread. However, as young nursery plants do not have fruit, which is needed for larvae to complete development, only eggs and young larvae could use these nursery plants for planting as a mechanism of spread. The success of these larvae to further complete development (no fruit available), though, could be extremely low unless the new plants were planted close to older ones (something uncommon for commercial production of aubergines).

Adult *L. pseudorbonalis* is believed to disperse short distances within the same field (Korycinska and Cannon, 2010). Therefore, human assisted dispersal, mostly infested fruit but also infested plants for planting, would play a major role in the spread of this moth.

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?

Yes, the introduction of *L. pseudoronalis* would most probably have an economic impact on the EU territory.

As pointed out earlier (see Section 3.1.1), until recently, all pyraloid larvae damaging Solanaceae fruits in Asia and Africa and intercepted from imports to Europe had been regarded as *Leucinodes orbonalis* and *L. laisalis*. The species *L. pseudorbonalis* was not described until 2015 (Mally et al., 2015) and there is no information specifically focussed on impacts. Therefore, the information that follows refers to larvae of eggplant boring species like *L. pseudorbonalis*. These species are pests of Solanaceae, especially *S. melongena* fruits where they feed internally. Their infestation can substantially reduce yields from aubergine cultivation, and yield losses of more than 65% have been recorded from Asia (EPPO, 2012).

3.6. Available measures and/or potential specific import requirements and limits of mitigation measures

Are there measures available to prevent the entry into the EU such that the risk becomes mitigated?

Yes, *S. aethiopicum* and *S. melongena* plants from third countries are banned from entering the EU (see Sections 3.3.2 and 3.4.2). Their fruit require a phytosanitary certificate (see Section 3.4.2) which could explicitly mention *L. pseudorbonalis*-freedom. Fruit and leaves could be further sourced from areas free of *L. pseudorbonalis* (see Section 3.6.1).

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to *S. aethiopicum* and *S. melongena* plants for planting and to soil (see Section 3.3.2 for prohibitions and Section 3.4.2 for specific requirements on pathways). Therefore, these entry pathways can be considered as closed. However, current regulations applied to aubergines (see Section 3.4.2), do not specifically consider *L. pseudorbonalis*. As fruits of *S. aethiopicum* and *S. melongena* are currently not prohibited for import, potential additional measures are listed in Table 6.

Table 6: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry in relation to currently unregulated hosts and pathways

Special requirements summary (with hyperlink in blue to information sheet if available)	Potential control measures
Pest freedom	Used to mitigate likelihood of infestation by specified pest at origin, hence to mitigate entry. Aubergines could be sourced from *L. pseudorbonalis*-free *countries.*
Managed growing conditions	Cultural practices, including crop rotation, solarisation, or sanitation could be used to reduce field densities of *L. pseudorbonalis*.
Growing plants in isolation	Used to mitigate likelihood of infestation by specified pest in vicinity of growing site. Aubergines cultivated under insect-proof protection could be free of *L. pseudorbonalis.*
Certification of reproductive material (voluntary/official)	Used to mitigate pests that are included in a certification scheme.
Chemical treatments on crops including reproductive material	Pesticides can be used to reduce the densities of *L. pseudorbonalis*.
Inspections	Used to mitigate likelihood of infestation by specified pest at origin
Physical treatments on consignments or during processing	Used to mitigate likelihood of infestation of pests susceptible to physical treatments. Radiation could be used to reduce the density of infesting larvae of *L. pseudorbonalis* in fruit.
Heat and cold treatments	Used to mitigate likelihood of infestation of pests susceptible to physical treatments. Temperatures beyond thresholds of lethality for larvae of *L. pseudorbonalis* could be used to reduce the density of infesting immature stages in fruit. Potential hot water treatment is not proven for pest infestation, but fungal (Pekmezci and Karasahin, 2008)
Controlled atmosphere	Host fruits could be transported under controlled atmosphere conditions (Cargo Handbook online, accessed on 8/9/2021)
Conditions of transport	Used to mitigate likelihood of entry of pests that could otherwise infest material post-production
Phytosanitary certificate and plant passport	Used to attest which of the above requirements have been applied

3.6.1.1. Biological or technical factors limiting the effectiveness of measures to prevent the entry of the pest

- Infested fruit is difficult to detect unless cut open.

3.7. Uncertainty

The relatively recent description of this pest (Mally et al., 2015) means that there are relevant knowledge gaps related to the biology of *L. pseudorbonalis* and its exact distribution in sub-Saharan Africa. Although these deficiencies do not affect the conclusions of this categorisation, they may have an impact on the likelihood of entry, spread, and establishment (i.e. new hosts identified, thermal requirements wider than thought, occurrence of diapause, wider distribution in sub-Saharan Africa).

4. Conclusions

L. pseudorbonalis satisfies the criteria that are within the remit of EFSA to assess for this species to be regarded as a potential Union QP. Because this is a recently described species, there are knowledge gaps related to the biology of this moth and its distribution. However, these gaps do not affect the conclusions of this categorisation. Table 7 shows the summary of the PLH Panel conclusions.

Table 7: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	*Leucinodes pseudorbonalis* is a pyraloid moth described by Mally et al. (2015)	None
Absence/presence of the pest in the EU (Section 3.2)	*L. pseudorbonalis* is not known to occur in the EU.	None
Regulatory status (Section 3.3)	*L. pseudorbonalis* is not regulated in the EU.	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*L. pseudorbonalis* could enter the EU territory and most probably establish in some limited areas of southern EU MS. According to TRACES, this pest was intercepted 8 times from January to June 2021 with *S. aethiopicum*. Fruit of *S. melongena* and fruits and leaves of *S. aethiopicum* provide pathways for entry. Plants for planting and soil and growing media could provide pathways for spread within the EU.	The relatively recent description of this species by Mally et al. (2015) means there are knowledge gaps that do not affect the conclusions of this categorisation. However, they may have an impact on the likelihood of entry, spread, and establishment (i.e. new hosts identified, thermal requirements wider than thought, occurrence of diapause, wider distribution in sub-Saharan Africa).
Potential for consequences in the EU (Section 3.5)	The introduction of *L. pseudorbonalis* would most probably have an economic impact on the EU territory.	None
Available measures (Section 3.6)	*S. aethiopicum* and *S. melongena* plants for planting from third countries are banned from entering into the EU. Their fruit require a phytosanitary certificate which could explicitly mention *L. pseudorbonalis*-freedom. Fruit and leaves could be further sourced from areas free of *L. pseudorbonalis.*	None
Conclusion (Section 4)	*L. pseudorbonalis* satisfies the criteria that are within the remit of EFSA to assess for this species to be regarded as a potential Union quarantine pest.	None
Aspects of assessment to focus on/scenarios to address in future if appropriate:	A better knowledge of the biology and distribution of this species as well as for the eight congeneric species occurring in Africa would help refining this categorisation.	

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
QP	quarantine pest
PLH	EFSA Panel on Plant Health
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2018).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018).
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2018).
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018).
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units.
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2018).
Pathway	Any means that allows the entry or spread of a pest (FAO, 2018).
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2018).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2018).
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO, 2018).

Appendix A – Distribution of *L. pseudorbonalis*

Distribution records based on EPPO Global Database (EPPO, online).

Region	Country	Sub-national (e.g. State)	Status
North America			No records, presumed absent
Central America			No records, presumed absent
Caribbean			No records, presumed absent
South America			No records, presumed absent
EU (27)			Intercepted only, presumed absent
Other Europe			Intercepted only, presumed absent
Africa	Angola Liberia		Present, no details Present, no details
	Senegal Uganda		Present, no details Present, no details
Asia			No records, presumed absent
Oceania			No records, presumed absent

Appendix B – Imports (× 1,000 kg) into the EU of fresh or chilled aubergines (CN code 07930) from sub-Saharan countries (including those where *L. pseudorbonalis* is known to occur)

Source: EUROSTAT; updated 7 July, 2021; extracted 8 July, 2021.

Shadowed areas correspond to countries where *P. pseudorbonalis* is known to occur.

Partner/Period	Jan–Dec 2016	Jan–Dec 2017	Jan–Dec 2018	Jan–Dec 2019	Jan–Dec 2020	Total
Uganda	4208.96	2094.76	3355.55	4873.36	5174.39	19707.02
Burkina Faso	2202.53	3908.14	2339.70	1624.25	5115.89	15190.51
Kenya	1269.52	1081.58	799.63	885.61	1261.94	5298.28
Senegal	717.75	714.68	665.41	697.04	1369.92	4164.80
Cameroon	942.62	682.47	572.61	756.05	416.76	3370.51
South Africa	307.77	344.95	366.46	506.53	288.94	1814.65
Mali	897.30	800.80	96.00			1794.10
Togo	341.04	322.22	309.84	278.08	269.06	1520.24
Côte d'Ivoire (Ivory Coast)	92.94	37.29	82.48	170.41	22.06	405.18
Rwanda	3.54	16.08	53.41	84.53	75.88	233.44
Burundi	112.05					112.05
Tunisia	11.18	7.69	39.12	21.37	5.99	85.35
Ghana	12.25	9.23	17.13	29.88	12.55	81.04
Sudan				10.61	10.00	20.61
Madagascar	5.66			2.00	5.57	13.23
Sierra Leone			2.68	4.74	1.68	9.10
Congo, Democratic Republic of	0.27	6.77	0.15		1.12	8.31
Nigeria	2.42	2.86	0.10			5.38
Ethiopia		0.00	3.78			3.78
Tanzania, United Republic of				0.24		0.24
Congo	0.20					0.20
Total	11128.00	10029.52	8704.05	9944.70	14031.75	53838.02