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## Pest categorisation of *Spodoptera litura*

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### Abstract

The EFSA Panel on Plant Health (PLHP) performed a pest categorisation of *Spodoptera litura* (Lepidoptera: Noctuidae) for the EU. *S. litura* is widely distributed across South and East Asia and Oceania. It is established in tropical and subtropical regions where there are no, or few, frost days each year. It can extend its range into cooler temperate regions during summer months. *S. litura* is highly polyphagous feeding on hosts within at least 40 botanical families, including economically important crops within Brassicaceae, Cucurbitaceae, Fabaceae, Malvaceae, Poaceae and Solanaceae. Larvae are primarily leaf feeders and can cause complete defoliation. At high population densities almost all plant parts are eaten. *S. litura* is a serious pest in the Asia-Pacific region where it causes losses to many economically important cultivated field crops and crops such as eggplants, sweet peppers and tomatoes in protected cultivation. As a species that appears limited by winter temperatures, only a small area of the EU provides climatic conditions where establishment outdoors may be possible although cultivated and wild hosts are distributed across the EU. *S. litura* has been intercepted in the EU many times on ornamentals and leafy vegetables. Outbreaks have occurred in EU glasshouses and have been eradicated. Phytosanitary measures are available to inhibit entry. *S. litura* satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest. *S. litura* does not meet the criteria of occurring in the EU, and plants for planting being the principal means of spread for it to be regarded as a potential Union regulated non-quarantine pest.

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## 1. Introduction

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

#### 1.1.1. Background

Council Directive 2000/29/EC<sup>1</sup> on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community establishes the present European Union plant health regime. The Directive lays down the phytosanitary provisions and the control checks to be carried out at the place of origin on plants and plant products destined for the Union or to be moved within the Union. In the Directive's 2000/29/EC annexes, the list of harmful organisms (pests) whose introduction into or spread within the Union is prohibited, is detailed together with specific requirements for import or internal movement.

Following the evaluation of the plant health regime, the new basic plant health law, Regulation (EU) 2016/2031<sup>2</sup> on protective measures against pests of plants, was adopted on 26 October 2016 and will apply from 14 December 2019 onwards, repealing Directive 2000/29/EC. In line with the principles of the above mentioned legislation and the follow-up work of the secondary legislation for the listing of EU regulated pests, EFSA is requested to provide pest categorisations of the harmful organisms included in the annexes of Directive 2000/29/EC, in the cases where recent pest risk assessment/ pest categorisation is not available.

#### 1.1.2. Terms of reference

EFSA is requested, pursuant to Article 22(5.b) and Article 29(1) of Regulation (EC) No 178/2002<sup>3</sup>, to provide scientific opinion in the field of plant health.

EFSA is requested to prepare and deliver a pest categorisation (step 1 analysis) for each of the regulated pests included in the appendices of the annex to this mandate. The methodology and template of pest categorisation have already been developed in past mandates for the organisms listed in Annex II Part A Section II of Directive 2000/29/EC. The same methodology and outcome is expected for this work as well.

The list of the harmful organisms included in the annex to this mandate comprises 133 harmful organisms or groups. A pest categorisation is expected for these 133 pests or groups and the delivery of the work would be stepwise at regular intervals through the year as detailed below. First priority covers the harmful organisms included in Appendix 1, comprising pests from Annex II Part A Section I and Annex II Part B of Directive 2000/29/EC. The delivery of all pest categorisations for the pests included in Appendix 1 is June 2018. The second priority is the pests included in Appendix 2, comprising the group of *Cicadellidae* (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), the group of *Tephritidae* (non-EU), the group of potato viruses and virus-like organisms, the group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L. and the group of *Margarodes* (non-EU species). The delivery of all pest categorisations for the pests included in Appendix 2 is end 2019. The pests included in Appendix 3 cover pests of Annex I part A section I and all pests categorisations should be delivered by end 2020.

For the above mentioned groups, each covering a large number of pests, the pest categorisation will be performed for the group and not the individual harmful organisms listed under "such as" notation in the Annexes of the Directive 2000/29/EC. The criteria to be taken particularly under consideration for these cases, is the analysis of host pest combination, investigation of pathways, the damages occurring and the relevant impact.

Finally, as indicated in the text above, all references to 'non-European' should be avoided and replaced by 'non-EU' and refer to all territories with exception of the Union territories as defined in Article 1 point 3 of Regulation (EU) 2016/2031.

<sup>1</sup> 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 169/1, 10.7.2000, p. 1–112.

<sup>2</sup> Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants. OJ L 317, 23.11.2016, p. 4–104.

<sup>3</sup> Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31/1, 1.2.2002, p. 1–24.

### 1.1.2.1. Terms of Reference: Appendix 1

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

#### **Annex IIAI**

##### **(a) Insects, mites and nematodes, at all stages of their development**

<i>Aleurocantus</i> spp.	<i>Numonia pyrivorella</i> (Matsumura)
<i>Anthonomus bisignifer</i> (Schenkling)	<i>Oligonychus perditus</i> Pritchard and Baker
<i>Anthonomus signatus</i> (Say)	<i>Pissodes</i> spp. (non-EU)
<i>Aschistonyx eppoi</i> Inouye	<i>Scirtothrips aurantii</i> Faure
<i>Carposina niponensis</i> Walsingham	<i>Scirtothrips citri</i> (Moultext)
<i>Enarmonia packardi</i> (Zeller)	<i>Scolytidae</i> spp. (non-EU)
<i>Enarmonia prunivora</i> Walsh	<i>Scrobipalopsis solanivora</i> Povolny
<i>Grapholita inopinata</i> Heinrich	<i>Tachypterellus quadrigibbus</i> Say
<i>Hishomonus phycitis</i>	<i>Toxoptera citricida</i> Kirk.
<i>Leucaspis japonica</i> Ckll.	<i>Unaspis citri</i> Comstock
<i>Listronotus bonariensis</i> (Kuschel)	

##### **(b) Bacteria**

Citrus variegated chlorosis	<i>Xanthomonas campestris</i> pv. <i>oryzae</i> (Ishiyama) Dye and
<i>Erwinia stewartii</i> (Smith) Dye	pv. <i>oryzicola</i> (Fang. et al.) Dye

##### **(c) Fungi**

<i>Alternaria alternata</i> (Fr.) Keissler (non-EU pathogenic isolates)	<i>Elsinoe</i> spp. Bitanc. and Jenk. Mendes
<i>Anisogramma anomala</i> (Peck) E. Müller	<i>Fusarium oxysporum</i> f. sp. <i>albedinis</i> (Kilian and Maire) Gordon
<i>Apiosporina morbosa</i> (Schwein.) v. Arx	<i>Guignardia piricola</i> (Nosa) Yamamoto
<i>Ceratocystis virescens</i> (Davidson) Moreau	<i>Puccinia pittieriana</i> Hennings
<i>Cercoseptoria pini-densiflorae</i> (Hori and Nambu) Deighton	<i>Stegophora ulmea</i> (Schweinitz: Fries) Sydow & Sydow
<i>Cercospora angolensis</i> Carv. and Mendes	<i>Venturia nashicola</i> Tanaka and Yamamoto

##### **(d) Virus and virus-like organisms**

Beet curly top virus (non-EU isolates)	Little cherry pathogen (non- EU isolates)
Black raspberry latent virus	Naturally spreading psorosis
Blight and blight-like	Palm lethal yellowing mycoplasma
Cadang-Cadang viroid	Satsuma dwarf virus
Citrus tristeza virus (non-EU isolates)	Tatter leaf virus
Leprosis	Witches' broom (MLO)

#### **Annex IIB**

##### **(a) Insect mites and nematodes, at all stages of their development**

<i>Anthonomus grandis</i> (Boh.)	<i>Ips cembrae</i> Heer
<i>Cephalcia lariciphila</i> (Klug)	<i>Ips duplicatus</i> Sahlberg
<i>Dendroctonus micans</i> Kugelan	<i>Ips sexdentatus</i> Börner
<i>Gilpinia hercyniae</i> (Hartig)	<i>Ips typographus</i> Heer
<i>Gonipterus scutellatus</i> Gyll.	<i>Sternochetus mangiferae</i> Fabricius
<i>Ips amitinus</i> Eichhof	

##### **(b) Bacteria**

*Curtobacterium flaccumfaciens* pv. *flaccumfaciens*  
(Hedges) Collins and Jones

**(c) Fungi**

*Glomerella gossypii* Edgerton  
*Gremmeniella abietina* (Lag.) Morelet

*Hypoxylon mammatum* (Wahl.) J. Miller

**1.1.2.2. Terms of Reference: Appendix 2**

List of harmful organisms for which pest categorisation is requested per group. The list below follows the categorisation included in the annexes of Directive 2000/29/EC.

**Annex IAI****(a) Insects, mites and nematodes, at all stages of their development**

Group of Cicadellidae (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), such as:

- |   |   |
|---|---|
| 1) <i>Carneiocephala fulgida</i> Nottingham | 3) <i>Graphocephala atropunctata</i> (Signoret) |
| 2) <i>Draeculacephala minerva</i> Ball      |   |

Group of Tephritidae (non-EU) such as:

- |  |   |
|--|---|
| 1) <i>Anastrepha fraterculus</i> (Wiedemann) | 12) <i>Pardalaspis cyanescens</i> Bezzi     |
| 2) <i>Anastrepha ludens</i> (Loew)           | 13) <i>Pardalaspis quinaria</i> Bezzi       |
| 3) <i>Anastrepha obliqua</i> Macquart        | 14) <i>Pterandrus rosa</i> (Karsch)         |
| 4) <i>Anastrepha suspensa</i> (Loew)         | 15) <i>Rhacochlaena japonica</i> Ito        |
| 5) <i>Dacus ciliatus</i> Loew                | 16) <i>Rhagoletis completa</i> Cresson      |
| 6) <i>Dacus curcurbitae</i> Coquillett       | 17) <i>Rhagoletis fausta</i> (Osten-Sacken) |
| 7) <i>Dacus dorsalis</i> Hendel              | 18) <i>Rhagoletis indifferens</i> Curran    |
| 8) <i>Dacus tryoni</i> (Froggatt)            | 19) <i>Rhagoletis mendax</i> Curran         |
| 9) <i>Dacus tsuneonis</i> Miyake             | 20) <i>Rhagoletis pomonella</i> Walsh       |
| 10) <i>Dacus zonatus</i> Saund.              | 21) <i>Rhagoletis suavis</i> (Loew)         |
| 11) <i>Epochra canadensis</i> (Loew)         |   |

**(c) Viruses and virus-like organisms**

Group of potato viruses and virus-like organisms such as:

- |                                  |  |
|----------------------------------|--|
| 1) Andean potato latent virus    | 4) Potato black ringspot virus   |
| 2) Andean potato mottle virus    | 5) Potato virus T  |
| 3) Arracacha virus B, oca strain | 6) non-EU isolates of potato viruses A, M, S, V, X and Y (including Yo, Yn and Yc) and Potato leafroll virus |

Group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L., such as:

- |                                      |  |
|--------------------------------------|--|
| 1) Blueberry leaf mottle virus       | 8) Peach yellows mycoplasma  |
| 2) Cherry rasp leaf virus (American) | 9) Plum line pattern virus (American)  |
| 3) Peach mosaic virus (American)     | 10) Raspberry leaf curl virus (American)   |
| 4) Peach phony rickettsia            | 11) Strawberry witches' broom mycoplasma   |
| 5) Peach rosette mosaic virus        | 12) Non-EU viruses and virus-like organisms of <i>Cydonia</i> Mill., <i>Fragaria</i> L., <i>Malus</i> Mill., <i>Prunus</i> L., <i>Pyrus</i> L., <i>Ribes</i> L., <i>Rubus</i> L. and <i>Vitis</i> L. |
| 6) Peach rosette mycoplasma          |  |
| 7) Peach X-disease mycoplasma        |  |

**Annex IIAI****(a) Insects, mites and nematodes, at all stages of their development**

Group of *Margarodes* (non-EU species) such as:

- |  |  |
|--|--|
| 1) <i>Margarodes vitis</i> (Phillipi)        | 3) <i>Margarodes prieskaensis</i> Jakubski |
| 2) <i>Margarodes vredendalensis</i> de Klerk |  |

### 1.1.2.3. Terms of Reference: Appendix 3

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

#### **Annex IAI**

##### **(a) Insects, mites and nematodes, at all stages of their development**

<i>Acleris</i> spp. (non-EU)	<i>Longidorus diadecturus</i> Eveleigh and Allen
<i>Amauromyza maculosa</i> (Malloch)	<i>Monochamus</i> spp. (non-EU)
<i>Anomala orientalis</i> Waterhouse	<i>Myndus crudus</i> Van Duzee
<i>Arrhenodes minutus</i> Drury	<i>Nacobbus aberrans</i> (Thorne) Thorne and Allen
<i>Choristoneura</i> spp. (non-EU)	<i>Naupactus leucoloma</i> Boheman
<i>Conotrachelus nenuphar</i> (Herbst)	<i>Premnotrypes</i> spp. (non-EU)
<i>Dendrolimus sibiricus</i> Tschetverikov	<i>Pseudopityophthorus minutissimus</i> (Zimmermann)
<i>Diabrotica barberi</i> Smith and Lawrence	<i>Pseudopityophthorus pruinosus</i> (Eichhoff)
<i>Diabrotica undecimpunctata howardi</i> Barber	<i>Scaphoideus luteolus</i> (Van Duzee)
<i>Diabrotica undecimpunctata undecimpunctata</i> Mannerheim	<i>Spodoptera eridania</i> (Cramer)
<i>Diabrotica virgifera zea</i> Krysan & Smith	<i>Spodoptera frugiperda</i> (Smith)
<i>Diaphorina citri</i> Kuway	<i>Spodoptera litura</i> (Fabricus)
<i>Heliothis zea</i> (Boddie)	<i>Thrips palmi</i> Karny
<i>Hirschmanniella</i> spp., other than <i>Hirschmanniella</i> <i>gracilis</i> (de Man) Luc and Goodey	<i>Xiphinema americanum</i> Cobb sensu lato (non-EU populations)
<i>Liriomyza sativae</i> Blanchard	<i>Xiphinema californicum</i> Lamberti and Bleve-Zacheo

##### **(b) Fungi**

<i>Ceratocystis fagacearum</i> (Bretz) Hunt	<i>Mycosphaerella larici-leptolepis</i> Ito et al.
<i>Chrysomyxa arctostaphyli</i> Dietel	<i>Mycosphaerella populorum</i> G. E. Thompson
<i>Cronartium</i> spp. (non-EU)	<i>Phoma andina</i> Turkensteen
<i>Endocronartium</i> spp. (non-EU)	<i>Phyllosticta solitaria</i> Ell. and Ev.
<i>Guignardia loricata</i> (Saw.) Yamamoto and Ito	<i>Septoria lycopersici</i> Speg. var. <i>malagutii</i> Ciccarone and Boerema
<i>Gymnosporangium</i> spp. (non-EU)	<i>Thecaphora solani</i> Barrus
<i>Inonotus weirii</i> (Murril) Kotlaba and Pouzar	<i>Trechispora brinkmannii</i> (Bresad.) Rogers
<i>Melampsora farlowii</i> (Arthur) Davis	

##### **(c) Viruses and virus-like organisms**

Tobacco ringspot virus	Pepper mild tigré virus
Tomato ringspot virus	Squash leaf curl virus
Bean golden mosaic virus	Euphorbia mosaic virus
Cowpea mild mottle virus	Florida tomato virus
Lettuce infectious yellows virus	

##### **(d) Parasitic plants**

*Arceuthobium* spp. (non-EU)

#### **Annex I AII**

##### **(a) Insects, mites and nematodes, at all stages of their development**

<i>Meloidogyne fallax</i> Karssen	<i>Rhizoecus hibisci</i> Kawai and Takagi
<i>Popillia japonica</i> Newman	

**(b) Bacteria**

*Clavibacter michiganensis* (Smith) Davis et al. ssp. *Ralstonia solanacearum* (Smith) Yabuuchi et al.  
*sepedonicus* (Spieckermann and Kotthoff) Davis et al.

**(c) Fungi**

*Melampsora medusae* Thümen *Synchytrium endobioticum* (Schilbersky) Percival

**Annex I B****(a) Insects, mites and nematodes, at all stages of their development**

*Leptinotarsa decemlineata* Say *Liriomyza bryoniae* (Kaltenbach)

**(b) Viruses and virus-like organisms**

Beet necrotic yellow vein virus

**1.2. Interpretation of the Terms of Reference**

*Spodoptera litura* is one of a number of pests listed in the Appendices to the Terms of Reference (ToR) to be subjected to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States (MS) referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

**2. Data and methodologies****2.1. Data****2.1.1. Literature search**

A literature search on *S. litura* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as a search term. Relevant papers 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, 2019) and relevant publications.

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 database was 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 SANTE) of the European Commission, and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The Europhyt database manages 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 MS and the phytosanitary measures taken to eradicate or avoid their spread.

**2.2. Methodologies**

The Panel performed the pest categorisation for *S. litura* following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018) and in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

This work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union regulated non-quarantine pest in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required in accordance with the specific terms of



reference received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as a regulated non-quarantine pest. If one of the criteria is not met, the pest will not qualify. A pest that does not qualify as a quarantine pest may still qualify as a regulated non-quarantine pest that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

It should be noted that 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, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, whereas addressing social impacts 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	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
<b>Identity of the pest (Section 3.1)</b>	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
<b>Absence/presence of the pest in the EU territory (Section 3.2)</b>	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism.	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pest must be present in the risk assessment area).
<b>Regulatory status (Section 3.3)</b>	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.	The protected zone system aligns with the pest free area system under the International Plant Protection Convention (IPPC). The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone).	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?
<b>Pest potential for entry, establishment and spread in the EU territory (Section 3.4)</b>	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in, and spread within, the protected zone areas?  Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
<b>Potential for consequences in the EU territory (Section 3.5)</b>	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
<b>Available measures (Section 3.6)</b>	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated?  Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
<b>Conclusion of pest categorisation (Section 4)</b>	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.	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met.	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met.

The Panel will not indicate in its conclusions of the pest categorisation whether to continue the risk assessment process, but following the agreed two-step approach, will continue only if requested by the risk managers. However, during the categorisation process, experts may identify key elements and knowledge gaps that could contribute significant uncertainty to a future assessment of risk. It would be useful to identify and highlight such gaps so that potential future requests can specifically target the major elements of uncertainty, perhaps suggesting specific scenarios to examine.

### 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 to be transmissible?*

**Yes.** *Spodoptera litura* (Fabricius, 1775) is an established and well recognised species.

*Spodoptera litura* (Fabricius, 1775) is a lepidopteran insect in the family Noctuidae. Synonyms include *Mamestra albisparsa* Walker, *Noctua elata* Fabricius, *Noctua histrionica* Fabricius, *Noctua litura* Fabricius, *Prodenia ciligera* Guenée, *Prodenia declinata* Walker, *Prodenia evanescens* Butler, *Prodenia glaucistriga* Walker, *Prodenia litura* Fabricius, *Prodenia subterminalis* Walker and *Prodenia tasmanica* Guenée (Holloway, 1989).

##### 3.1.2. Biology of the pest

Eggs are generally laid on the underside of the outer lower leaves of hosts, in batches of 200–300 and can consist of 3 or 4 layers of eggs (Hely et al., 1982; Hill, 1983). The egg batches are covered with brown abdominal velvety hair-like scales from the abdomen of the adult female moth to protect them from predators (Ranga Rao et al., 1993). A single female moth can lay more than 2,000 eggs during her 6–8 day life, with most eggs laid on day 3 or 4 (Ahmad et al., 2013; Shekhawat et al., 2018). At 15°C, eggs hatch after 14 days while at 35°C eggs hatch after 2 days (Fand et al., 2015).

Literature reports five to seven larval instars (Ranga Rao et al., 1989), then prepupal and pupal stages. At 20°C, larval development takes around 27 days (Fand et al., 2015). Larvae usually feed on host leaves. Early instar larvae feed on soft leaf tissue; as larvae develop stronger biting mouthparts they can feed on veins and leaf ribs (Gupta et al., 2015). Older larvae feed at night and shelter in the soil at the base of the host plant during the day. Like other species of armyworm, fourth and later instar larvae group together and can move in columns from one field to another where they continue to feed. Pupation takes place in the soil and adults emerge after 12 days at 25°C (Gupta et al., 2015). No developmental stages enter diapause (Miyashita, 1971).

No mating takes place on the first night following emergence (Etman and Hooper, 1979). Females can mate three or four times during a lifetime of 6–8 days. Females attract males using 9Z, 11E, tetradecadienyl acetate as the major pheromone compound. This is also the major sex pheromone used in the sibling species *Spodoptera littoralis* Boisduval, which occurs across Africa, southern Europe and the Middle East (Brown and Dewhurst, 1975). As a consequence, interspecific matings can occur in zones of geographical overlap (e.g. southern Iran and Pakistan). However, fewer eggs are laid, and in laboratory studies no eggs hatched following matings between *S. litura* females and *S. littoralis* males (Saveer et al., 2014).

Miyashita (1971) calculated the lower development threshold temperature and the thermal constant (*K*) from the egg to the adult to be 10.3°C and 526 day-degrees (DD), respectively. Ranga Rao et al. (1989) give a lower development threshold of 10.5°C and *K* from egg to adult ovipositing female, i.e. egg to next generation egg laying, of 551 DD. Using data from Fand et al. (2015), the threshold is 10.0°C and *K* for egg to egg laying of 625 DD.

In China, *S. litura* is established south of approximately 30°N. Multiple generations occur each year between 28 and 30°N, where *S. litura* overwinters as pupae: In the north there are three generations per year while in the south there is continual, year-round breeding (approximately nine generations). North of 30°N *S. litura* cannot survive winters and is not established but it migrates there to breed in the summer (Fu et al., 2015).

In the wet tropics, there can be around eight generations per year (Hill, 1983). In Andhra Pradesh, India, *S. litura* completes 12 generations a year (CABI, 2018). In western Japan (the south of Honshu), larvae can be found in the early summer, but most are usually found in late summer (Murata and Tojo, 2002), suggesting only a few generations occur each year.

In conducting a literature review of the natural enemies of *S. litura*, Ranga Rao et al. (1993) reported 71 species of parasitoids, 36 predatory insects and 12 species of spiders which preyed upon *S. litura*. The mass release of egg and larval parasitoids to control *S. litura* has been a partial success in India (Ranga Rao et al., 1993).

### 3.1.3. Intraspecific diversity

No intraspecific diversity has been reported for this species.

### 3.1.4. Detection and identification of the pest

*Are detection and identification methods available for the pest?*

**Yes.** Light traps can capture adults (male and female), pheromone traps can capture adult males. Juvenile stages can be detected by visual inspections. Both morphological and molecular-based methods are available to determine specimens at species level.

#### Detection

*Spodoptera litura* is highly polyphagous and their larvae can be found feeding on a wide range of plants. It is the larval feeding damage that is most likely to be detected in the field first, as the damage is often highly conspicuous. The early instar-larvae scrape the softer and more digestible tissue from the lower surface of the foliage leaving the upper epidermis intact causing a condition called 'windowing'. The later instar larvae can digest the leaf lamina but tend to avoid the leaf mid rib and larger leaf veins, eating the tissue from between the veins causing a condition called 'skeletonising'. Mature larvae eat the whole leaf except for the toughest parts and large populations can completely strip the host plants of almost all foliage. The larvae also eat into buds and fruit, and frequently eat flowers. The larvae are mainly external feeders but will occasionally bore into plant parts

(Smith et al., 1997). As a consequence, large amounts of frass may be visible. These symptoms are not specific to *S. litura* but generic for many foliage feeding Lepidoptera species (EPPO, 2015).

All developmental stages of *S. litura* can be detected visually in the field. Eggs can be found on all above ground plant parts, mostly commonly on the lower leaf surface, and are most covered in a mat of hair scales. A hand lens will aid in detecting early instar larvae on the lower surface of the foliage and mature larvae may be found in the soil at the base of the plant during the day. The pupae occur in the soil and are consequently difficult to detect. Adults can be collected using a sweep net. Adults can also be collected at night using light traps and with pheromone baited traps for adult males.

### Identification

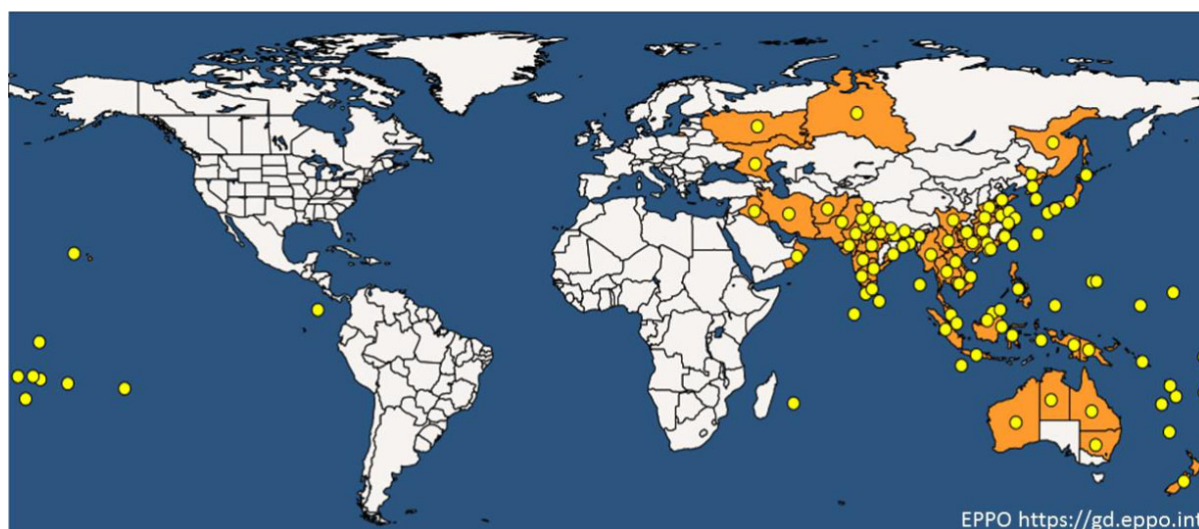
*S. litura* eggs are spherical, somewhat flattened, 0.6 mm in diameter, laid in batches and covered at least partially with hair scales from the female's abdomen moth. They are usually pale orange-brown or pink in colour. The larvae attain a length of up to 45 mm in length. They are highly variable regarding overall colouration and colour patterns, both between populations but also within populations. Furthermore, the colouration strongly fades after each moult until full chitinisation in the prepupal stage. The larvae are typically blackish-grey to dark-green, becoming reddish-brown or whitish-yellow; sides of body with dark and light longitudinal bands; dorsal side with two dark semilunar spots laterally on each segment, except for the prothorax; spots on the first and eighth abdominal segments larger than others, interrupting the lateral lines on the first segment. A bright-yellow stripe along the length of the dorsal surface is characteristic of *S. litura* larvae. The pupa is 15–20 mm long, red-brown; tip of abdomen with two small spines. The adult has a grey-brown body, 15–20 mm long; wingspan 30–38 mm. The forewings are grey to reddish-brown with a strongly variegated pattern and paler lines along the veins (in males, bluish areas occur on the wing base and tip); the hindwings are greyish-white with grey margins, often with dark veins (Smith et al., 1997).

A comprehensive review of the genus *Spodoptera* is provided by Pogue (2002, 2011). A detailed diagnostic protocol for the morphological and molecular identification of four species of economically important *Spodoptera* species (*S. littoralis*, *S. litura*, *S. frugiperda* (Smith) and *S. eridania* (Cramer)) has been published by EPPO (2015). Accurate morphological identification is best carried out on the adult by examination of the genitalia. Experts with experience on this genus may make identification to species level based on the morphology of mature larvae, given consideration of context (e.g. country of origin). However, there can be overlap in some character states of the larvae of *S. litura* and *S. littoralis* and molecular identification is recommended for accurate identification of immature stages.

## **3.2. Pest distribution**

### **3.2.1. Pest distribution outside the EU**

*S. litura* is widely distributed throughout, South and East Asia and Oceania within climate types ranging from tropical to temperate regions (Shu et al., 2017). Appendix A reports distribution as given in EPPO Global Database (2019) (Figure 1).



**Figure 1:** Global distribution of *Spodoptera litura* (extracted from the EPPO Global Database accessed on 27 April 2019)

The distribution of *S. litura* in Central Russia (present, few occurrences), Southern Russia (present, restricted distribution), Western Siberia (present, few occurrences) and Far East Russia (present, few occurrences) relate to notifications by the Russian NPPO to EPPO and could be transient populations resulting from *S. litura* entering the regions via trade or summer populations flying from the south; they are considered unlikely to be established populations given that *S. litura* doesn't diapause and doesn't survive frosts. For example, the most recent occurrence of *S. litura* in Far East Russia is based on it being found once in a pheromone trap in 2001 (EPPO, Global database, 2019).

### 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.** *S. litura* is not known to be present in the EU.

*S. litura* is not known to be present in the EU. Outbreaks have been reported in EU glasshouses in Denmark, Germany, Netherlands and the United Kingdom and all have been eradicated (EPPO global database, 2019).

In the UK, outbreaks of *S. litura* occurred under glass in 1973 (Aitkenhead et al., 1974) and 2010 (EPPO 2010). Both were eradicated (EPPO Global Database, 2019).

In 2002, *S. litura* was detected in a glasshouse propagating and producing aquarium plants in Germany; *Ludwigia* and *Eichhornia* plants were infested. The nursery regularly imported aquatic plants from Indonesia and Singapore, where *S. litura* occurs (EPPO, 2003). The NPPO of Germany informed EPPO that *S. litura* had been eradicated from Germany in 2004 (EPPO, 2004).

In 2017, *S. litura* was found in Norway having entered on *Polyscias* potted plants from a glasshouse nursery in Denmark (EPPO, 2017). Dead specimens of adult *S. litura* were found in light traps at the Danish glasshouse site. Surveys in Denmark detected five *S. litura* larvae in five plants for planting of *Polyscias scutellaria* grown in one greenhouse. Phytosanitary measures were taken and *S. litura* was eradicated from Denmark. *S. litura* probably arrived in the Danish glasshouse via imports of plants for planting from south-east Asia (EPPO Global Database, 2019). *S. litura* is not known to have established in Norway.

Information to EPPO dated April 2018 from the NPPO of the Netherlands noted that long term annual surveys had not detected *S. litura* and that *S. litura* had been eradicated from the Netherlands (EPPO Global Database, 2019).

Slovenia informed EPPO that *S. litura* is not present there due to no pest records (EPPO Global Database, 2019).

### 3.3. Regulatory status

#### 3.3.1. Council Directive 2000/29/EC

*Spodoptera litura* is listed in Annex I/AI of Council Directive 2000/29/EC. Details are presented in Tables 2 and 3.

**Table 2:** *Spodoptera litura* in Council Directive 2000/29/ EC

<b>Annex I, Part A</b>	<b>Harmful organisms whose introduction into, and spread within, all member states shall be banned</b>
<b>Section I</b>	<b>Harmful organisms not known to occur in any part of the community and relevant for the entire community</b>
(a)	Insects, mites and nematodes, at all stages of their development
	Species
23.	<i>Spodoptera litura</i> (Fabricius)

#### 3.3.2. Legislation addressing the hosts of *Spodoptera litura*

As a harmful organism listed in Annex I/AI of 2000/29 EC, the introduction and spread of *S. litura* in the EU is prohibited, regardless of what it may be found on. Nevertheless, Table 3 details hosts specifically regulated in relation to *S. litura* in Annex IV of 2000/29 EC (import prohibitions).

**Table 3:** Regulated hosts and commodities specifically named in relation to *S. litura* in Annex IV of Council Directive 2000/29/ EC

<b>Annex IV, Part A</b>	<b>Special requirements which must be laid down by all member states for the introduction and movement of plants, plant products and other objects into and within all member states</b>	
<b>Section 1</b>	<b>Plants, plant products and other objects originating outside the community</b>	
	<b>Plants, plant products and other objects</b>	<b>Special requirements</b>
27.2.	Plants of <i>Dendranthema</i> (DC.) Des Moul., <i>Dianthus</i> L. and <i>Pelargonium</i> l'Hérit. ex Ait., other than seeds	Without prejudice to the requirements applicable to the plants listed in Annex IV(A) (I)(27.1), official statement that:  (aa) the plants originate in an area free from [...] and <i>Spodoptera litura</i> (Fabricius), established by the national plant protection organisation in accordance with relevant International Standards for Phytosanitary Measures, or  (a) no signs of [...] or <i>Spodoptera litura</i> (Fabricius) have been observed at the place of production since the beginning of the last complete cycle of vegetation, or  (b) the plants have undergone appropriate treatment to protect them from the said organisms.

### 3.4. Entry, establishment and spread in the EU

#### 3.4.1. Host range

*S. litura* is a highly polyphagous pest (EPPO, 1979). A CABI (2018) factsheet reports that larvae feed on at least 120 plant species. Shekhawat et al. (2018) cites literature reporting *S. litura* as feeding on 180 host species, while Shu et al. (2017) cite literature reporting 389 hosts. Hosts occur in at least 40 plant families. Hosts grown in the EU include crops such as beans (*Phaseolus*), *Brassica* spp., eggplant (*Solanum melongena*), maize (*Zea mays*), onion (*Allium cepa*), potatoes (*Solanum tuberosum*), rice (*Oryza sativa*), strawberry (*Fragaria*), sugarbeet (*Beta vulgaris* var. *saccharifer*), sunflower (*Helianthus annuus*) and tomatoes (*Solanum lycopersicum*). Citrus, grapevines (*Vitis*) and ornamentals such as roses (*Rosa*) are also hosts. However, in Asia its most common hosts include beet (*Beta vulgaris*), chickpea (*Cicer arietinum*), cotton (*Gossypium*), groundnut (*Arachis hypogaea*), lucerne (*Medicago sativa*), maize, okra (*Abelmoschus esculentus*), rice, soybean (*Glycine max*), tea (*Camellia sinensis*), tobacco (*Nicotiana*), taro (*Colocasia esculenta*) and many vegetables (Hill, 1983; Smith et al.,

1997; Gupta et al., 2015). Appendix B lists the hosts compiled in CABI (2018) and the EPPO Global Database (2019).

### 3.4.2. Entry

*Is the pest able to enter into the EU territory?*

**Yes,** *S. litura* has been intercepted in the EU on many occasions since records began being centrally collected via Europhyt in 1995.

Given the highly polyphagous behaviour of *S. litura* there are many species of cut flowers, fruits, vegetables and plants for planting which could provide pathways for entry. Analysis of EUROPHYT interception data (Appendix E) indicates that most interceptions occur on:

- Fruits and vegetables While some host fruit and vegetables need special requirements, e.g. *Momordica* (2000/29 EC, Annex IV, 36.2), no Annex IV requirements are specifically in place with regard to *S. litura*
- Cut flowers or branches Annex IV requirements in 2000/29 EC are in place for *S. litura* with respect to *Dendranthema*, *Dianthus* and *Pelargonium* cut flowers. Other host cut flowers, such as *Rosa* require a phytosanitary certificate although the special requirements relate to pests other than *S. litura*
- Plants for planting While some host plants for planting are prohibited, e.g. *Citrus* and *Vitis* (2000/29 EC, Annex III), other host plants for planting are allowed into the EU with a phytosanitary certificate

While it is interesting to analyse interception data, there are limits as to the interpretation of such analysis. This is because the number of consignments imported into the EU potentially carrying *S. litura* and the total number of consignments examined is not centrally compiled or linked with interception data, preventing a more meaningful analysis. Recording sampling effort and the number of consignments entering the EU could provide information that could significantly help the interpretation of interception data in future. Moreover, it would better inform risk reduction decision making and would allow the efficacy of the risk reduction options affecting entry to be measured (MacLeod et al., 2005; MacLeod, 2015).

Tables 4–6 summarise EU imports of rose and orchid cut flowers (HS 0603 11 and HS 0603 13 respectively) and fresh or chilled asparagus (HS 0709 20), commodities on which many EU interceptions of *S. litura* have occurred. Countries listed in Tables 4–6, where *S. litura* is known to occur, are highlighted (\*). Many interceptions have also been found on *Ocimum* (basil). However, basil does not have its own HS code and the amount imported from third countries cannot be determined from EUROSTAT data. *S. litura* has been intercepted on roses from India on 38 occasions; a total of 30 *S. litura* interceptions have occurred on basil from Cambodia, Thailand, India and Malaysia. Appendices C–E provide a simple analysis of interceptions data.

**Table 4:** EU Imports of rose cut flowers (HS 0603 11) (Source Eurostat) (hundreds of kg) (\* = countries where *S. litura* is known to occur)

Sources/year	2014	2015	2016	2017	2018	5-year mean	% of 5-year total
India*	6,028	7,332	9,791	8,748	8,146	8,009	0.3
Vietnam*	–	–	208	–	–	42	0.0
Sri Lanka*	40	–	7	1	–	10	0.0
Japan*	–	1	24	7	6	8	0.0
Thailand*	–	–	9	6	18	7	0.0
South Korea*	20	–	–	–	–	4	0.0
Iran*	–	–	–	5	10	3	0.0
Australia*	2	2	2	1	1	2	0.0
China*	–	–	–	1	4	1	0.0

Sources/year	2014	2015	2016	2017	2018	5-year mean	% of 5-year total
<b>Subtotal <i>S. litura</i> sources</b>	6,090	7,335	10,041	8,769	8,185	8,084	0.3
Kenya	1,250,186	1,307,225	1,327,870	1,291,943	1,228,968	1,281,238	51.9
Ethiopia	487,542	850,131	834,932	833,749	551,707	711,612	28.8
Ecuador	173,158	176,075	184,207	175,171	198,073	181,337	7.3
Uganda	130,561	120,336	134,311	124,938	117,329	125,495	5.1
Zambia	73,578	66,800	59,938	51,739	53,135	61,038	2.5
Colombia	42,808	41,426	42,616	42,250	47,299	43,280	1.8
38 other countries where <i>S. litura</i> is not present	70,761	52,200	57,529	57,800	53,702	58,398	2.4
<b>Sum</b>	<b>2,234,684</b>	<b>2,621,528</b>	<b>2,651,444</b>	<b>2,586,359</b>	<b>2,258,398</b>	<b>2,470,483</b>	<b>100.0</b>

Table 4 indicates that over 99.5% of roses come from countries where *S. litura* is not present; the majority is sourced from Africa and South American countries where *S. litura* is not known to occur. Between 2014 and 2018, approximately 0.3% of cut roses imported into the EU were from countries where *S. litura* is present, predominantly India.

**Table 5:** EU Imports of orchid cut flowers (HS 0603 13) (Source Eurostat) (hundreds of kg) (\* = countries where *S. litura* is known to occur)

Source/year	2014	2015	2016	2017	2018	5-year mean	% of 5-year total
Thailand*	44,825	30,435	28,487	24,810	22,394	30,190	94.0
Malaysia*	1,265	720	966	733	658	868	2.7
Taiwan*	531	17	205	303	823	376	1.2
Singapore*	12	313	96	88	88	119	0.4
India*	–	–	110	–	304	83	0.3
New Zealand*	75	58	66	60	103	72	0.2
Vietnam*	31	28	22	17	73	34	0.1
China*	–	–	–	1	42	9	0.0
Japan *	–	–	1	7	13	4	0.0
Cambodia *	–	–	1	–	–	0	0.0
13 other countries where <i>S. litura</i> is not present	232	533	268	335	365	347	1.1
<b>Sum</b>	<b>46,971</b>	<b>32,104</b>	<b>30,222</b>	<b>26,354</b>	<b>24,863</b>	<b>32,103</b>	<b>100.0</b>

The great majority of orchid cut flowers come from Thailand, a country where *S. litura* is present (Table 5). Between 2014 and 2018, approximately 98.9% of orchid cut flowers imported into the EU were from countries where *S. litura* is present. Most interceptions of *S. litura* in the USA are on orchids from Thailand (Ellis, 2005; Gilligan and Passoa, 2014).

**Table 6:** EU Imports of fresh or chilled asparagus (HS 0709 20) (Source Eurostat) (hundreds of kg) (\* = countries where *S. litura* is known to occur)

Source/year	2014	2015	2016	2017	2018	5-year mean	% of 5-year total
Thailand*	2,506	2,190	1,866	1,622	1,436	1,924	0.5
China*	738	–	–	–	–	148	0.0
India*	4	7	–	38	–	10	0.0
Australia*	–	–	10	–	–	2	0.0
Cambodia*	1	–	–	–	–	–	0.0
<b>Subtotal <i>S. litura</i> sources</b>	<b>3,249</b>	<b>2,197</b>	<b>1,876</b>	<b>1,660</b>	<b>1,436</b>	<b>2,084</b>	<b>0.5</b>
Peru	314,144	306,362	301,797	278,775	326,766	305,569	82.0



Source/year	2014	2015	2016	2017	2018	5-year mean	% of 5-year total
Mexico	47,995	29,436	57,708	63,932	63,381	52,490	14.1
37 other countries where <i>S. litura</i> is not present	11,552	10,819	3,793	6,664	30,782	12,722	3.4
<b>Sum</b>	<b>376,940</b>	<b>348,814</b>	<b>365,174</b>	<b>351,031</b>	<b>422,365</b>	<b>372,865</b>	<b>100.0</b>

The great majority of asparagus imported into the EU comes from Peru, a country where *S. litura* is not known to be present. Considering the sources of asparagus from third countries where *S. litura* is present, most asparagus comes from Thailand. Between 2014 and 2018, small amounts also came from China, India, Australia and Cambodia.

Outbreaks of *S. litura* have occurred in EU glasshouses further indicating that not only can *S. litura* enter the EU, but it can also transfer to hosts.

### 3.4.3. Establishment

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

**Yes.** *S. litura* could perhaps establish in humid frost free regions of the southern EU and in protected cultivation more widely, such as in ornamental and vegetable glass or vinyl houses.

The distribution and abundance of an organism that cannot control or regulate its body temperature is largely determined by host distribution and climate. Comparing climates from the known distribution of an organism with climates in the risk assessment area can inform judgements regarding the potential distribution and abundance of an organism in the risk assessment area (Sutherst and Maywald, 1985; Ehrlén and Morris, 2015). The global Köppen–Geiger climate zone categories, and subsequent modifications made by Trewartha, describe terrestrial climate in terms of factors such as average minimum winter temperatures and summer maxima, amount of precipitation and seasonality (rainfall pattern) (Trewartha and Horn, 1980; Kottek et al., 2006) and can inform judgements of aspects of establishment during pest categorisation (MacLeod and Korycinska, 2019).

#### 3.4.3.1. EU distribution of main host plants

*S. litura* is a highly polyphagous plant pest that can feed on hundreds of plant species in at least 40 families. Many potential hosts occur widely over the EU, growing both in open field and in protected conditions e.g. glass and vinyl houses. Table 7 shows the harvested area of some key *S. litura* hosts grown in the EU.

**Table 7:** Harvested area of some key *S. litura* hosts in EU (28) Member States 2013–2017 (ha). Source EUROSTAT

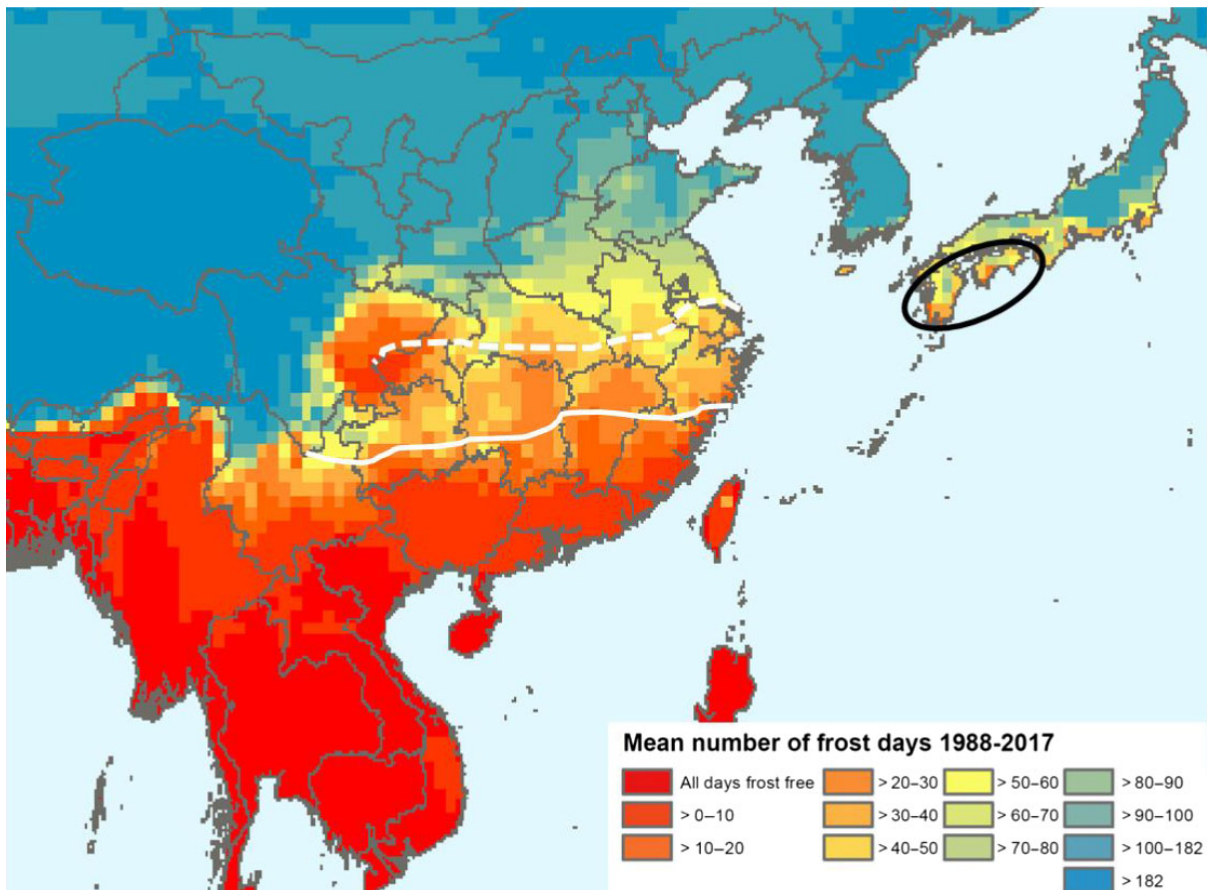
Host	Eurostat code	2013	2014	2015	2016	2017
Potatoes (including seed potatoes)	R1000	1,741.18	1,662.80	1,656.13	1,689.38	1,746.40
Leguminous plants harvested green	G2000	:	3,812.82	3,526.85	3,853.89	3,863.36
Fresh vegetables (including melons)	V0000	:	2,069.41	2,071.15	2,166.95	:
Tomatoes	V3100	230.58	248.09	254.43	246.85	252.58
Cucumbers	V3200	35.02	37.31	33.51	31.70	:
Eggplants	V3410	:	22.26	22.27	21.53	:
Peppers (Capsicum)	V3600	57.74	56.82	58.61	57.14	
Onions	V4210	:	172.70	172.94	179.72	:

': data not available.

Many hosts are also cultivated across the EU in domestic gardens.

### 3.4.3.2. Climatic conditions affecting establishment

Low winter temperatures are an important limiting factor affecting the distribution of species with no known diapause (Bale, 1991), such as *S. litura*. This species occurs in Asia and Pacific regions in climate types ranging from tropical to temperate regions (Fand et al., 2015). However, as a strong flier which might migrate or be carried long distances on air currents, reports of *S. litura* in cooler temperate regions, i.e. regions where frost occur, could be due to finding transient populations. For example, although *S. litura* is found north of approximately 30°N in China, it cannot survive winters there and it is not established, nevertheless it migrates there to breed in the summer (Fu et al., 2015; see Section 3.1.2). Figure 2 shows the mean number of frost days each year in eastern Asia and overlays information about where *S. litura* is established year round in China and Japan (map data for the 30-year period 1988–2017 was sourced from the Climatic Research Unit high resolution gridded dataset CRU TS v. 4.03 at 0.5° resolution (<https://crudata.uea.ac.uk/cru/data/hrg/>)).

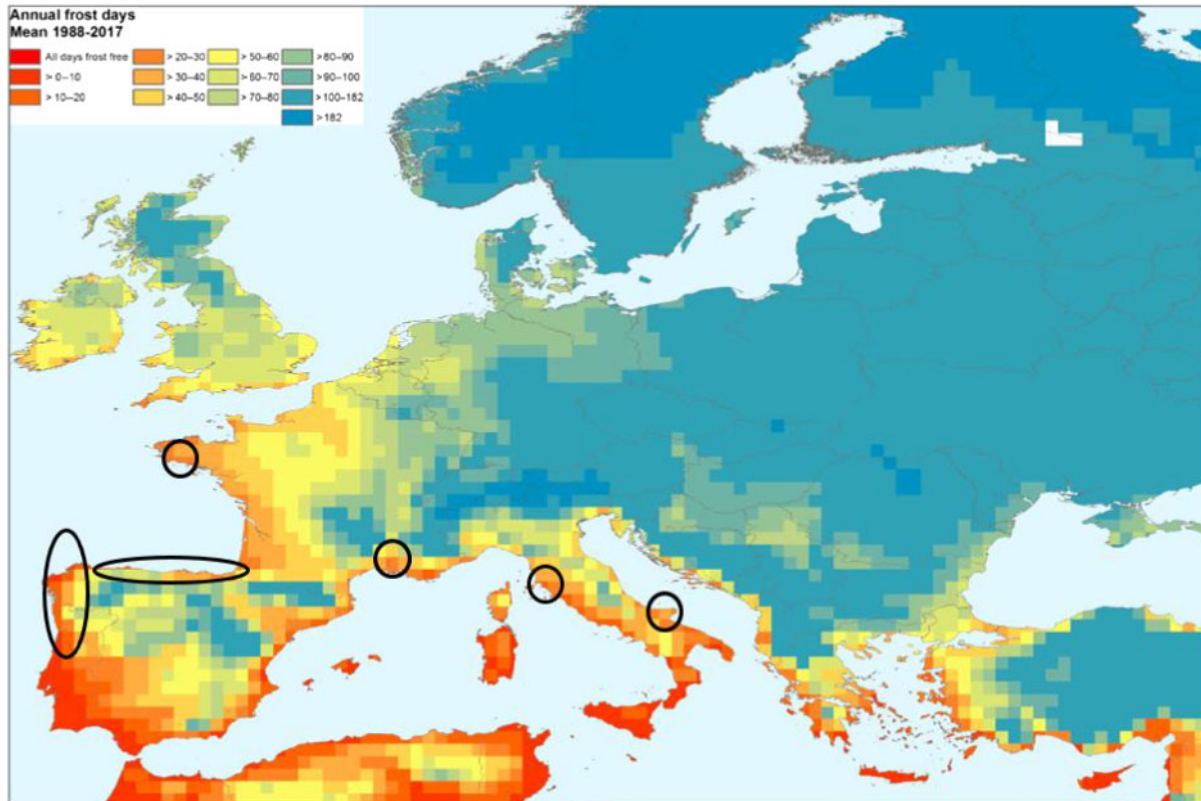


**Figure 2:** Mean number of annual frost days in East Asia, 1988–2017 in relation to establishment of *Spodoptera litura*. South of the solid white line *S. litura* is established and breeds year round; *S. litura* is established between the solid white line and the broken white line where it overwinters in the soil as pupae; *S. litura* is not established north of the broken white line but can breed and develop there during the summer. *S. litura* is established in southwestern Japan (black ellipse) where it is humid year-round with few frost days

*S. litura* established in the North Island of New Zealand (Northland and around Auckland) in the mid-1970s (Scott, 1984). The climate of Northland is categorised as oceanic (Cfb) in the Köppen–Geiger climate classification but as subtropical in the Köppen–Trewartha climate classification (Trewartha and Horn, 1980). Northland has warm humid summers (average maximum temperatures between 22°C and 26°C) and mild wet winters (minimum temperatures around 4°C) ground frosts are rare (Chappell, 2013).

In Australia, *S. litura* is reported as harmful mainly in coastal regions, for example in New South Wales (there are few frost days along coastal NSW) and can be especially problematic when late summer rainfall is above average (Hely et al., 1982), i.e. when it has been warm and humid.

Gallardo et al. (2013) provides a map of Köppen–Trewartha classifications for the EU and identifies regions that are subtropical and fully humid. Figure 3 combines annual mean frost days in Europe with approximate locations for areas that are fully humid according to the Köppen–Trewartha climate classification. Such areas are enclosed by ellipses and identify areas where climatic conditions may be suitable for *S. litura* to establish. Irrigation in the southern EU will affect local relative humidity and soil moisture and could offer additional foci for permanent populations in the south.



**Figure 3:** Mean number of annual frost days in Europe, 1988–2017. Black ellipses indicate regions where average temperatures are above 10°C for at least 8 months per year and there is no dry season. Such areas may be climatically suitable for establishment of *S. litura* (see text for detail)

The sibling species *S. littoralis* feeds on many of the same hosts as *S. litura* and occurs in temperate and tropical Africa and can overwinter in southern EU MS where winter frosts are infrequent, e.g. southern Spain, southern Greece and Crete (Smith et al., 1997) and southern Italy. Smith et al. (1997) considers that *S. litura* presents the same risk to Europe as *S. littoralis* and sees the establishment of either species under glass (or other protected environments such as vinyl houses) as of greatest significance.

*S. litura* is known to be a pest in glass and vinyl houses in India and Japan (Nakasuji and Matsuzaki, 1977; Vashisth et al., 2012). However, whether populations are established in protected environments or whether outdoor populations re-invade to sustain populations in protection is unknown.

Establishment of *S. litura* in the EU under glass may be possible if there are sources of *S. litura* outdoors which can invade into glasshouses to survive adverse conditions.

### 3.4.4. Spread

*Is the pest able to spread within the EU territory following establishment?*

**Yes**, *S. litura* could spread within the EU following establishment. Adults are strong fliers.

*RNQPs: Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?*

If *S. litura* established in the EU it could spread naturally; spread between glasshouses would be facilitated by movement of plants for planting.

Adults and larvae are free living and could disperse naturally locally. Given that adults are strong fliers (Hely et al., 1982; Tu et al., 2010), they would be able to spread further and faster than larvae. Adults are suspected of being migratory and with the aid of suitable winds are thought to migrate from southern China to Kyushu, southern Japan (Tu et al., 2010; Fu et al., 2015 and references therein) a distance of approximately 700 km.

In flight mill experiments, males and mated females have been shown to be able to fly for over 18 and 12 h, respectively (Murata and Tojo, 2002). During a 72-h period in a flight mill, Tu et al. (2010) measured males flying 105 km and females flying 83 km.

If *S. litura* established in areas of southern Europe, it could spread in the summer northwards to attack field and protected crops.

### 3.5. Impacts

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

**Yes**, larval feeding damage to host plants could reduce yield and quality of many economically important crops.

*RNQPs: Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?<sup>4</sup>*

**Yes**. The occurrence of *S. litura* on plants for planting could have an economic impact on the intended use of those plants. Infested plants, planted in glasshouses would be introducing a potentially serious pest that could affect future yield and quality of other hosts.

*S. litura* is a serious pest in the Asia-Pacific region where it causes losses to many economically important cultivated field crops such as cotton, corn, groundnut, soybean, tobacco and vegetables. (Patel et al., 1971; Hill, 1983; Smith et al., 1997). It is also a significant pest of crops such as eggplants, sweet peppers and tomatoes in protected cultivation (glasshouses and vinyl-houses) (Nakasuji and Matsuzaki, 1977; Vashisth et al., 2012).

Larvae are generally leaf feeders but when leaf material is in short supply larvae can feed on almost all parts of hosts (Ahmad et al., 2013) and at high population densities can cause complete defoliation.

Larvae damage maize by feeding on whorl leaves, corn bracts and fresh kernels (Shu et al., 2017). The larvae cause heavy damage to flowers, flower buds and bolls of cotton by eating their contents (Chattopadhyay et al., 2019).

In reporting losses caused by insect pests in major crops in Asia, Oerke et al. (1994) note that *S. litura* has been estimated to cause 5–100% yields losses in potato in India. However, they also report that during a 3-year trial in India losses in potato by *S. litura* were not economically relevant. Larvae in the soil can feed on groundnuts causing serious losses. *S. litura* reduces soybean crop value both quantitatively and qualitatively with most damage occurring during or just after warm and humid conditions. For example, temperatures between 21 and 27°C, with morning relative humidity above 90% are conditions which favour outbreaks 1 or 2 weeks later (Chattopadhyay et al., 2019).

*S. litura* is one of the most destructive insect pests of cabbages and cauliflowers in the world (Imran et al., 2017). *S. litura* is a regular pest of cabbages and cauliflowers in late summer in coastal districts of New South Wales where it also attacks tomatoes, apples and cotton (Hely et al., 1982). In

<sup>4</sup> See Section 2.1 on what falls outside EFSA's remit.

the north of North Island New Zealand, *S. litura* can completely defoliate clover and broad-leaved weeds in pastures. It also feeds on vegetables such as beans, celery and cabbage (Scott, 1984).

*S. litura* has developed resistance to many chemical insecticides particularly pyrethroids and carbamates (Kranthi et al., 2001; Ahmad et al., 2007; Imran et al., 2017) and has low susceptibility to transgenic Bt cotton (Wan et al., 2008), increasing its pest significance due to the difficulty in controlling it.

In the EU, many protected vegetable and ornamental crops could be impacted with potential for damage to field crops in the summer.

### 3.6. Availability and limits of mitigation measures

*Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?*

**Yes**, see Sections 3.3 (existing measures) and 3.6.1 (potential additional measures).

*RNQPs: Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?*

**Yes**, see Section 3.6.1 (potential additional measures).

#### 3.6.1. Identification of additional measures

Phytosanitary measures specifically against *S. litura* are currently applied to *Dendranthema*, *Dianthus* and *Pelargonium* cut flowers. However, as a pest listed in Annex I/AI of 2000/29 EC, *S. litura* is a pest whose introduction and spread in the EU is banned irrespective of what it is found on. *S. litura* is a highly polyphagous species with a history of international spread, e.g. into New Zealand in the 1970s (Scott, 1984). There have been outbreaks of *S. litura* in the EU (see Section 3.2.2); hence, in addition to the cut flowers listed in 2000/29 EC (Annex IV, A 1, 27.2) numerous other plants or plant products provide pathways (see Section 3.4.2 and Appendices C–E). Existing specific measures against *S. litura* could be extended to other ornamentals such as *Rosa* and Orchidaceae, and hosts such as *Asparagus* and *Ocimum*, commodities on which there have been the most interceptions.

As a pest that spends one part of its life cycle in the soil, the prohibition of soil from third countries not belonging to continental Europe (see 2000/29 EC, Annex III, point 14) will assist in inhibiting the entry of *S. litura* into the EU with plants for planting not specifically listed in the Plant Health Directive.

Additional and supporting measures are shown in Sections 3.6.1.1. and 3.6.1.2.

##### 3.6.1.1. Additional control measures

Potential additional control measures are listed in Table 8.

**Table 8:** Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry/ establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/ establishment/ spread / impact)
<a href="#">Growing plants in isolation</a>	Smith et al. (1997) suggests plants be sourced from areas deemed free from <i>S. litura</i> for at least three months prior to shipping	Entry
<a href="#">Chemical treatments on consignments or during processing</a>	Use of chemical compounds that may be applied to plants or to plant products after harvest, during process or packaging operations and storage. The treatments addressed in this information sheet are: a) fumigation; b) spraying/dipping pesticides; c) surface disinfectants; d) process additives; e) protective compounds	Entry

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/ establishment/ spread / impact)
<b>Heat and cold treatments</b>	Controlled temperature treatments aimed to kill or inactivate pests without causing any unacceptable prejudice to the treated material itself. The measures addressed in this information sheet are: autoclaving; steam; hot water; hot air; cold treatment.  Smith et al. (1997) recommend storage of some cut flower species for at least 10 days at temperatures not exceeding 1.7°C (cold storage (EPPO, 1984))	Entry

### 3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 9.

**Table 9:** Selected supporting measures (a full list is available in EFSA PLH Panel, 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance.

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/ spread / impact)
<b>Phytosanitary certificate</b>	The need for a phytosanitary certificate as required in 2000/29 EC, could be extended to other plant product hosts (fruits, vegetables and ornamentals) <sup>(a)</sup>	Entry

(a): The PLH Panel recognises that EC Regulation 2016/2031 will extend the scope of phytosanitary certification in future, but as of June 2019 the Regulation has not come into force.

### 3.6.1.3. Biological or technical factors limiting the effectiveness of measures to prevent the entry, establishment and spread of the pest

- The pest feeds on many host plant species.
- Eggs are laid on the underside of leaves and may be missed during inspections.
- Rapid and long distance dispersal, sometimes assisted by air currents.
- Hosts are widely available throughout the EU.
- Insecticide resistance. Frequent use of insecticides against *S. litura* over long periods, together with multiple generations developing in a year, has driven the development of insecticide resistance to many older conventional pesticides such as organophosphates and pyrethroids and to newer insecticides including spinosad, avermectins and imidacloprid (Armes et al., 1997; Ahmad et al., 2007; Abbas et al., 2012; Abbas et al., 2014; Imran et al., 2017). Variation in detoxification enzyme activity among *S. litura* from different origins can be matched to insecticide usage patterns (Karuppaiah et al., 2017).

### 3.6.1.4. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting

There are factors that limit the ability to prevent the presence of the pest on plants for planting such as:

- Highly mobile and fecund adult females can disperse widely, rapidly depositing eggs on many host plants for planting
- *S. litura* has developed insecticide resistance to many insecticides.

## 3.7. Uncertainty

- There is uncertainty around the precise nature of climatic conditions required for *S. litura* to establish outdoors in the EU. Temperature and humidity are likely to be critical although specific thresholds for humidity have not been found in the literature.

- Evidence from EU outbreaks indicates that temperature and humidity within some EU glasshouses and vinyl houses could support development of *S. litura*; however, there is uncertainty as to whether *S. litura* could establish in protected cultivation, or whether repeated introductions would be required to sustain populations in such protected conditions.

#### 4. Conclusions

*Spodoptera litura* meets the criteria assessed by EFSA for consideration as a potential Union quarantine pest (it is absent from the EU, potential pathways exist, and its establishment would cause an economic impact). The criterion of the pest being present in the EU, which is a prerequisite for RNQP and PZ QP status, is not met, nor is the criterion for plants for planting being the primary means of spread.

Table 10 provides a summary of the conclusions of each part of this pest categorisation.

**Table 10:** 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	Panel’s conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
<b>Identity of the pests (Section 3.1)</b>	<i>Spodoptera litura</i> (Fabricius, 1775) is an established and well recognised species of Lepidoptera, family Noctuidae	<i>Spodoptera litura</i> (Fabricius, 1775) is an established and well recognised species of Lepidoptera, family Noctuidae	None
<b>Absence/presence of the pest in the EU territory (Section 3.2)</b>	<i>S. litura</i> is not known to occur in the EU. Previous outbreaks have been eradicated. Therefore, the criterion of absence or presence with restricted distribution and under official control for Union quarantine pest status is satisfied	<i>S. litura</i> is not known to occur in the EU. Therefore, the criterion of widespread distribution within the EU for RNQP status is not satisfied	None
<b>Regulatory status (Section 3.3)</b>	<i>S. litura</i> is listed in Annex IAI of Council Directive 2000/29/EC as a harmful organism not known to occur in any part of the community and relevant for the entire community and whose introduction into, and spread within, all member states is banned	<i>S. litura</i> is currently regulated as a quarantine pest in the EU. The EFSA PLHP is not aware of any grounds to consider its status as such should be revoked	None
<b>Pest potential for entry, establishment and spread in the EU territory (section 3.4)</b>	<p><i>S. litura</i> has been intercepted in the EU on many occasions since records began being centrally collected via Europhyt in 1995, Common pathways are:</p> <ul style="list-style-type: none"> <li>• cut flowers,</li> <li>• fruits and vegetables,</li> <li>• plants for planting.</li> </ul> <p>Frost free humid regions could provide suitable climatic conditions for establishment outdoors, hosts are widely available. Establishment in glasshouses may be possible</p>	Plants for planting are not the main pathway for entry or spread. Adults are strong fliers. The criterion of plants for planting being the main means of spread for RNQP status is not satisfied	Whether or not <i>S. litura</i> could really establish outdoors, or in protected environments in the EU is uncertain. More detailed and sophisticated modelling and mapping would better inform this judgment. If establishment is not possible then <i>S. litura</i> would not meet a key criterion for it to be classified as a Union quarantine pest

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
<b>Potential for consequences in the EU territory (Section 3.5)</b>	Larval feeding damage to host plants could reduce yield and quality of many economically important crops	The occurrence of <i>S. litura</i> on plants for planting could have an economic impact on the intended use of those plants. Infested plants, planted in glasshouses would spread a potentially serious pest that could affect future yield and quality of other hosts	None
<b>Available measures (Section 3.6)</b>	There are measures available to prevent the likelihood of entry into the EU (e.g. source cut flowers of <i>Dendranthema</i> , <i>Dianthus</i> and <i>Pelargonium</i> from a pest free area, pest free place of production or apply treatments). However, other pathways also exist, and measures could be extended to them	Measures such as sourcing plants for planting from PFA could be applied	None
<b>Conclusion on pest categorisation (Section 4)</b>	<i>S. litura</i> satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest	<i>S. litura</i> does not meet the criteria of (a) occurring in the EU, and (b) plants for planting being the principal means of spread. Hence it does not satisfy all of the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union regulated non-quarantine pest	None
<b>Aspects of assessment to focus on/ scenarios to address in future if appropriate</b>	Conditions for establishment outdoors or in protected environments across the EU		

PFA: pest-free area.

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## Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 1995, 2017)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 1995, 2017)
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, 2017)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2017)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2017)
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, 2017)
Measures	Control (of a pest) is defined in ISPM 5 (FAO 2017) as 'Suppression, containment or eradication of a pest population' (FAO, 1995) Control measures are measures that have a direct effect on pest abundance Supporting measures are organisational measures or procedures supporting the choice of appropriate Risk Reduction Options that do not directly affect pest abundance
Pathway	Any means that allows the entry or spread of a pest (FAO, 2017)
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, 2017)
Protected zones (PZ)	A Protected zone is an area recognised at EU level to be free from a harmful organism, which is established in one or more other parts of the Union
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, 2017)
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO, 2017)
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 2017)

## Abbreviations

DD	day-degrees
DG	SANTÉ Directorate General for Health and Food Safety
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
PFA	Pest Free Areas
PLHP	EFSA Panel on Plant Health
PZ	Protected Zone
QP	Quarantine Pest
RNQP	Regulated non-quarantine pest
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

## Appendix A – Detailed *Spodoptera litura* global distribution

Continent	Country	Subnational distribution	Status	
Africa	Reunion		Present, no details	
North America	USA		Present, restricted dist.	
		Florida	Absent, no longer present	
		Hawaii	Present, no details	
Asia	Afghanistan		Present, no details	
	Bangladesh		Present, widespread	
	Brunei Darussalam		Present, no details	
	Cambodia		Present, no details	
	China			Present, restricted dist.
		Anhui, Fujian, Guangdong, Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Jilin, Macau, Shandong, Shanghai, Sichuan, Yunnan, Zhejiang		Present, no details
		Hong Kong		Present, widespread
	Christmas Island		Present, no details	
	Cocos Islands		Present, no details	
	India			Present, widespread
		Andaman and Nicobar Is., Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttaranchal, Uttar Pradesh, West Bengal		Present, no details
	Indonesia			Present, no details
		Irian Jaya, Java, Kalimantan, Maluku, Sulawesi, Sumatra		Present, no details
	Iran		Present, no details	
	Iraq		Present, no details	
	Japan			Present, widespread
		Hokkaido, Honshu, Kyushu, Shikoku		Present, widespread
		Ryukyu Archipelago		Present, no details
	Korea DPR		Present, no details	
	Korea, Republic		Present, no details	
	Lao		Present, widespread	
	Malaysia			Present, widespread
		Sabah, Sarawak		Present, no details
		West		Present, widespread
	Maldives		Present, no details	
	Myanmar		Present, no details	
	Nepal		Present, no details	
	Oman		Present, no details	
	Pakistan		Present, no details	
Philippines		Present, no details		
Singapore		Present, no details		
Sri Lanka		Present, no details		
Taiwan		Present, widespread		
Thailand		Present, no details		
Viet Nam		Present, no details		

Continent	Country	Subnational distribution	Status
Europe (non EU)	Russia		Present, restricted dist.
		Central Russia, Far East Russia, Western Siberia	Present, few occurrences
		Southern Russia	Present, restricted dist.
Oceania	American Samoa		Present, no details
	Australia		Present, restricted dist.
		New South Wales, Queensland, Western Australia	Present, restricted dist.
		Northern Territory	Present, no details
		Victoria	Absent, confirmed by survey
	Cook Islands		Present, no details
	Fiji		Present, no details
	French Polynesia		Present, restricted dist.
	Guam		Present, no details
	Kiribati		Present, no details
	Marshall Islands		Present, no details
	Micronesia		Present, no details
	New Caledonia		Present, no details
	New Zealand		Present, restricted dist.
	Niue		Present, no details
	Norfolk Island		Present, no details
	Northern Mariana Is.		Present, no details
	Palau		Present, no details
	Papua New Guinea		Present, no details
	Samoa		Present, no details
Solomon Islands		Present, no details	
Tonga		Present, no details	
Tuvalu		Present, no details	
Vanuatu		Present, no details	
Wallis & Futuna Is.		Present, restricted dist.	

Source: EPPO Global database online, accessed 27 April 2019.

## Appendix B – *Spodoptera litura* host plants compiled by CABI and EPPO

Sources: CABI 2018 and EPPO Global database online, accessed 30 March 2019.

Plant name	Common name	Family	Status as host	
			CABI	EPPO
<i>Abelmoschus esculentus</i>	Okra	Malvaceae	Main	–
<i>Acacia mangium</i>	Brown salwood	Fabaceae	Main	–
<i>Allium cepa</i>	Onion	Liliaceae	Main	–
<i>Amaranthus</i>	Amaranth	Amaranthaceae	Main	–
<i>Annona squamosa</i>	Sugar apple	Annonaceae	Other	–
<i>Arachis hypogaea</i>	Groundnut	Fabaceae	Main	Minor
<i>Begonia</i>	Begonia	Begoniaceae	Main	–
<i>Beta vulgaris</i> var. <i>saccharifera</i>	Sugarbeet	Chenopodiaceae	Main	–
<i>Boehmeria nivea</i>	Ramie	Urticaceae	Main	–
<i>Brassica oleracea</i> var. <i>botrytis</i>	Cauliflower	Brassicaceae	Main	Minor
<i>Brassica oleracea</i> var. <i>capitata</i>	Cabbage	Brassicaceae	Main	–
<i>Brassica</i> spp.	Brassica	Brassicaceae	Main	–
<i>Callistephus chinensis</i>	China aster	Asteraceae	Unknown	–
<i>Camellia sinensis</i>	Tea	Theaceae	Main	Minor
<i>Capsicum annuum</i>	Sweet pepper	Solanaceae	–	Minor
<i>Capsicum frutescens</i>	Chilli	Solanaceae	Main	–
<i>Chrysanthemum</i>	Daisy	Asteraceae	Other	–
<i>Cicer arietinum</i>	Chickpea	Fabaceae	Main	–
<i>Citrus</i>	Citrus	Rutaceae	Main	–
<i>Coffea</i>	Coffee	Rubiaceae	Main	–
<i>Colocasia esculenta</i>	Taro	Araceae	Main	Minor
<i>Corchorus</i>	Jutes	Tiliaceae	Main	–
<i>Corchorus olitorius</i>	Jute	Tiliaceae	Main	Minor
<i>Coriandrum sativum</i>	Coriander	Apiaceae	Main	–
<i>Crotalaria juncea</i>	Sunn hemp	Fabaceae	Main	–
<i>Cynara cardunculus</i> var. <i>scolymus</i>	Globe artichoke	Asteraceae	Main	–
<i>Fabaceae</i>	Leguminous plants	Fabaceae	Main	–
<i>Foeniculum vulgare</i>	Fennel	Apiaceae	Main	–
<i>Fragaria ananassa</i>	Strawberry	Rosaceae	Main	–
<i>Gaillardia pulchella</i>	Indian blanket	Asteraceae	Unknown	–
<i>Gerbera</i>	Barbeton daisy	Asteraceae	Other	–
<i>Gladiolus hybrids</i>	Sword lily	Iridaceae	Main	–
<i>Glycine max</i>	Soya bean	Fabaceae	Main	Major
<i>Gossypium hirsutum</i>	Bourbon cotton	Malvaceae	Main	Major
<i>Helianthus annuus</i>	Sunflower	Asteraceae	Main	–
<i>Hevea brasiliensis</i>	Rubber	Euphorbiaceae	Main	–
<i>Ipomoea aquatica</i>	Swamp morning-glory	Convolvulaceae	Main	–
<i>Ipomoea batatas</i>	Sweet potato	Convolvulaceae	Main	Minor
<i>Jatropha curcas</i>	Jatropha	Euphorbiaceae	Main	–
<i>Lathyrus odoratus</i>	Sweet pea	Fabaceae	Main	–
<i>Leucaena</i>	Leucaena	Fabaceae	–	Minor
<i>Lilium</i>	Lily	Liliaceae	Main	–
<i>Linum usitatissimum</i>	Flax	Linaceae	Main	Minor
<i>Malus domestica</i>	Apple	Rosaceae	Main	–
<i>Manihot esculenta</i>	Cassava	Euphorbiaceae	Main	–

Plant name	Common name	Family	Status as host	
			CABI	EPPO
<i>Medicago sativa</i>	Lucerne	Fabaceae	Main	Minor
<i>Mentha arvensis</i>	Corn mint	Lamiaceae	Unknown	–
<i>Morus alba</i>	White mulberry	Moraceae	Main	Minor
<i>Musa</i>	Banana	Musaceae	Main	–
<i>Nicotiana tabacum</i>	Tobacco	Solanaceae	Main	Major
<i>Oryza sativa</i>	Rice	Poaceae	Main	Minor
<i>Papaver</i>	Poppies	Papaveraceae	Main	–
<i>Paulownia tomentosa</i>	Paulownia	Scrophulariaceae	Main	–
<i>Phaseolus</i>	Beans	Fabaceae	Main	–
<i>Piper nigrum</i>	Black pepper	Piperaceae	Main	–
Poaceae	Grasses	Poaceae	Main	–
<i>Prunus mume</i>	Japanese apricot tree	Rosaceae	Other	–
<i>Psophocarpus tetragonolobus</i>	Winged bean	Fabaceae	Main	–
<i>Raphanus sativus</i>	Radish	Brassicaceae	Main	–
<i>Ricinus communis</i>	Castor bean	Euphorbiaceae	Main	–
<i>Rosa</i>	Roses	Rosaceae	Main	–
<i>Sesbania grandiflora</i>	Agati	Fabaceae	Main	–
<i>Solanum lycopersicum</i>	Tomato	Solanaceae	Main	Minor
<i>Solanum melongena</i>	Aubergine	Solanaceae	Main	Minor
<i>Solanum tuberosum</i>	Potato	Solanaceae	Main	Minor
<i>Sorghum bicolor</i>	Sorghum	Poaceae	Main	–
<i>Syzygium aromaticum</i>	Clove	Myrtaceae	Main	–
<i>Tagetes</i>	Marigold	Asteraceae	Other	–
<i>Tectona grandis</i>	Teak	Lamiaceae	Main	–
<i>Theobroma cacao</i>	Cocoa	Sterculiaceae	Main	–
<i>Trigonella foenum-graecum</i>	fenugreek	Fabaceae	Main	–
<i>Vigna mungo</i>	Black gram	Fabaceae	Main	Minor
<i>Vigna radiata</i>	Mung bean	Fabaceae	Main	–
<i>Vigna unguiculata</i>	Cowpea	Fabaceae	Main	–
<i>Vitis vinifera</i>	Grapevine	Vitaceae	Main	–
<i>Zea mays</i>	Maize	Poaceae	Main	Major
<i>Zinnia elegans</i>	Zinnia	Asteraceae	Main	–



### Appendix C – Sources of *Spodoptera litura* interceptions notified on Europhyt, 1995–2018

Source	1995	1996	1997	1999	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Sum	% of total	cumulative %	
India						1			3	3	7	12	4	2	6	7	1	3	5	3	1	58	30.4	30.4	
Thailand			1	1		1	2	5	3	8	3	4	4	1		2	2	3	3	4	3	50	26.2	56.5	
Cambodia															5	7	5					17	8.9	65.4	
China						2		1					3						1		3	10	5.2	70.7	
Malaysia														1		3	1	1			4	10	5.2	75.9	
Bangladesh																2	1	2	1	1		7	3.7	79.6	
Israel <sup>(a)</sup>	2				1	3	1															7	3.7	83.2	
Vietnam														3	1		1			1		6	3.1	86.4	
Laos																		1		3	1	5	2.6	89.0	
Singapore						1							2	1	1							5	2.6	91.6	
Nigeria	4																					4	2.1	93.7	
Sri Lanka			1								1			2								4	2.1	95.8	
Pakistan																1					1	2	1.0	96.9	
Cyprus <sup>(b)</sup>	1																					1	0.5	97.4	
Egypt		1																				1	0.5	97.9	
Netherlands <sup>(c)</sup>													1									1	0.5	98.4	
Taiwan										1												1	0.5	99.0	
Tunisia	1																					1	0.5	99.5	
United States						1																1	0.5	100	
Sum	8	1	2	1	1	9	3	6	6	11	12	16	14	10	13	22	11	10	10	10	12	13	191	100	

(a): *Spodoptera litura* is not known to occur in Israel.  
 (b): *Spodoptera litura* is not known to occur in Cyprus.  
 (c): *Spodoptera litura* is not known to occur in the Netherlands.

## Appendix D – Interceptions by plant genera from source countries providing most interceptions 1995–2018

Between 1995 and 2018, over 75% of 191 EU interceptions of *Spodoptera litura* were from five countries (India, Thailand, Cambodia, China and Malaysia). The genera of plants on which interceptions were made from these countries, together with the number of interceptions, are shown in the table below.

Plant (type)	India	Thailand	Cambodia	China	Malaysia	Sum
<i>Rosa</i> (cut flowers & buds)	38	2				40
<i>Ocimum</i> (leaves & branches)	7	8	14		1	30
<i>Dendrobium</i> (cut flowers)		9				9
<i>Asparagus</i> (vegetables)		6			1	7
<i>Brassica</i> (vegetables)		4			1	5
<i>Tagetes</i> (cut flowers)		5				5
<i>Ficus</i> (plants for planting)				4		4
unspecified	1	2			1	4
<i>Artemisia</i>			3			3
<i>Apium</i>		1			1	2
<i>Basella</i>	2					2
<i>Ipomoea aquatica</i>		2				2
<i>Mokara</i>					2	2
<i>Momordica</i>	2					2
<i>Abelmoschus esculentus</i>	1					1
<i>Allium</i>	1					1
<i>Amaranthus</i>	1					1
<i>Aranda</i>		1				1
<i>Capsicum</i>	1					1
<i>Colocasia</i>	1					1
<i>Corchorus</i>	1					1
<i>Coriandrum</i>		1				1
<i>Dracaena</i>				1		1
<i>Euphorbia</i>		1				1
<i>Forsythia</i>				1		1
<i>Hydrocotyle</i>					1	1
<i>Ixora</i>		1				1
<i>Juniperus</i>				1		1
<i>Lagenaria</i>	1					1
<i>Limonium</i>	1					1
<i>Mangifera indica</i>		1				1
<i>Microsorium</i>					1	1
<i>Monstera</i>		1				1
<i>Oncidium</i>					1	1
Orchidaceae		1				1
<i>Photinia</i>				1		1
<i>Psidium guajava</i>		1				1
<i>Serissa</i>				1		1
<i>Sesbania</i>		1				1
<i>Solanum melongena</i>		1				1
<i>Strelitzia</i>				1		1
<i>Vanda</i>		1				1
Sum	58	50	17	10	10	145
% of 191 interceptions	30.4	26.2	8.9	5.2	5.2	75.9

**Appendix E – Europhyt interceptions by plant type 1995–2018**

<b>Plant type</b>	<b># interceptions</b>	<b>% of total</b>
Fruit & vegetables	92	48.2
Cut flowers and branches with foliage	65	34.0
Plants for planting	29	15.2
Other living plants	5	2.6
Sum	191	100.0