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Pest categorisation of *Pantoea stewartii* subsp. *stewartii*

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Abstract

Following a request from the European Commission, the EFSA Plant Health Panel performed a pest categorisation of *Pantoea stewartii* subsp. *stewartii* (hereafter *P. s.* subsp. *stewartii*). *P. s.* subsp. *stewartii* is a Gram-negative bacterium that causes Stewart's vascular wilt and leaf blight of sweet corn and maize, a disease responsible for serious crop losses throughout the world. The bacterium is endemic to the USA and is now present in Africa, North, Central and South America, Asia and Ukraine. In the EU, it is reported from Italy with a restricted distribution and under eradication. The bacterium is regulated according to Council Directive 2000/29/EC (Annex IIAI) as a harmful organism whose introduction and spread in the EU is banned on seeds of *Zea mays*. Other reported potential host plants include various species of the family Poaceae, including weeds, rice (*Oryza sativa*), oat (*Avena sativa*) and common wheat (*Triticum aestivum*), as well as jackfruit (*Artocarpus heterophyllus*), the ornamental *Dracaena sanderiana* and the palm *Bactris gasipaes*, but there is uncertainty about whether these are hosts of *P. s.* subsp. *stewartii* or of the other subspecies. The pest could enter the EU via host plants for planting (including seed) and via insect vectors from neighbouring countries. Host plants are widely distributed and climatic conditions are conducive in the EU. *P. s.* subsp. *stewartii* could spread by movement of host plants for planting (including seeds) and insect vectors. Impacts could occur on maize and rice. Methods to certify pest freedom of maize seeds are available. The main knowledge gaps concern the availability of vectors in the EU, the level of susceptibility of the maize cultivars grown in the EU, the virulence of strains in recent outbreaks, and the host range of the bacterium. The criteria assessed by the Panel for consideration as a potential quarantine pest are met.

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Keywords: *Erwinia stewartii*, European Union, monocots, pest risk, plant health, plant pest, quarantine

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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/EC¹ 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) 2016/2031² 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 categorizations 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 178/2002³, 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.

¹ 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.

² 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.

³ 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> (Moultex)
<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)
<i>Erwinia stewartii</i> (Smith) Dye	Dye and 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> Kugelán	<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

Hypoxyton mammatum (Wahl.) J. Miller

Gremmeniella abietina (Lag.) Morelet

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>Carneocephala 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) *Margarodes vitis* (Phillipi)
- 2) *Margarodes vredendalensis* de Klerk
- 3) *Margarodes prieskaensis* Jakubski

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> (Fabricius)
<i>Heliothis zea</i> (Boddie)	<i>Thrips palmi</i> Karny
<i>Hirschmanniella</i> spp., other than <i>Hirschmanniella gracilis</i> (de Man) Luc and Goodey	<i>Xiphinema americanum</i> Cobb <i>sensu lato</i> (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 laricina</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 A II

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

Meloidogyne fallax Karssen

Rhizoecus hibisci Kawai and Takagi

Popillia japonica 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

Erwinia stewartii (Smith) Dye is one of a number of pests listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest (RNQP) 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.

The bacterial genus *Pantoea* was established in 1989 (Gavini et al., 1989) and all strains of the plant pathogenic species formerly known as *Erwinia stewartii* were assigned to that genus in 1993 (Mergaert et al., 1993; Hauben et al., 1998). All the strains causing Stewart's wilt and leaf blight of corn were assigned to the subspecies *P. s.* subsp. *stewartii*. The currently valid name for *Erwinia stewartii* is thus *Pantoea stewartii* subsp. *stewartii* (hereafter *P. s.* subsp. *stewartii*), which is used in this pest categorisation.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *P. s.* subsp. *stewartii* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database for the time period 1990–2018, using the following search string: *Pantoea* near/1 *stewartii* OR *Erwinia* near/1 *stewartii* OR *Pseudomonas* near/1 *stewartii* OR *Xanthomonas* near/1 *stewartii* OR *Stewart** near/0 wilt. The search yielded 325 results. 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, 2018) 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 *P. s.* subsp. *stewartii*, following guiding principles and steps presented in the EFSA guidance on the harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was started 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 RNQP 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 RNQP. 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 RNQP 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, in agreement with the EFSA guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

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
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?	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?
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!	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 RNQP. (A RNQP must be present in the risk assessment area)

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
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	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?
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!	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!
Potential for consequences in the EU territory (Section 3.5)	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?
Available measures (Section 3.6)	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?
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	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 RNQP 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, the identity of the pest is established.

P. s. subsp. stewartii is a non-motile and non-sporing, Gram-negative bacterium of the family Enterobacteriaceae (EPPO, 1997; Roper, 2011). A new family (Erwiniaceae) accommodating the genus *Pantoea* (among others) has been recently proposed (Adeolu et al., 2016).

A phylogeny of the plant pathogenic bacteria within the Enterobacteriaceae, including the species within the genus *Pantoea* and the closely related genus *Erwinia*, has been developed based on rDNA sequences (Hauben et al., 1998). Mergaert et al., (1993) divided *P. stewartii* into two subspecies according to criteria based on DNA hybridisation data and cellular fatty acid composition. *P. s. subsp. stewartii* group strains are pathogenic on maize and *P. stewartii* subsp. *indologenes* affects foxtail millet (Mergaert et al., 1993; Walterson and Stavrinides, 2015).

In addition to *E. stewartii*, various other names have been used in the past for what is now described as *P. s. subsp. stewartii*: *Pseudomonas stewartii* (1898), *Bacterium stewartii* (1914), *Aplanobacter stewartii* (1918), *Bacillus stewartii* (1920), *Phytomonas stewartii* (1923) and *Xanthomonas stewartii* (1939) (EPPO, 1997; Pataký and Ikin, 2013). Some scientific papers (e.g. Coplin et al., 2002) refer to *P. stewartii* subsp. *stewartii* simply with *P. stewartii* while others use *Pantoea stewartii* for the species in general or for unnamed potential subspecies, which maintains the confusion in the identity of strains causing the Stewart's vascular wilt and leaf blight of sweet corn and maize.

3.1.2. Biology of the pest

P. s. subsp. stewartii is a bacterium that causes Stewart's vascular wilt and leaf blight of sweet corn and maize, a disease responsible for serious crop losses throughout the world (Coplin et al., 2002).

Typical symptoms are longitudinal leaf streaks with irregular or wavy margins, which are parallel to the veins and may extend along the whole leaf (Albarracín Orío et al., 2012). Lesions often originate from insect bites (Menelas et al., 2006). The bacterium first colonises the interstitial spaces in maize leaf tissues, where it causes the development of water-soaked lesions (De Maayer et al., 2017). These pale to green yellow lesions turn to brown with disease progression resulting in leaf blight (Roper, 2011). *P. s. subsp. stewartii* is also able to colonise the vascular system of host plants (systemic infection), thereby causing necrosis and wilting by obstructing the free flow of water in the host xylem (Beck von Bodman and Farrand, 1995; Bae et al., 2015). Susceptible maize plantlets that are early infected are severely affected in their growth.



Figure 1: Left-hand panel: symptoms on maize leaves that show traces of insect bites. Right-hand panel: susceptible maize lines showing heavy dwarfing compared to neighbouring less susceptible lines (both pictures taken in Iowa, USA, and kindly provided by David Caffier, INRA)

The bacterium is seed-borne, seed playing an important role for long-distance dissemination (Block et al., 1998). However, no information was found on how *P. s. subsp. stewartii* colonises seedlings from infected seeds. Seed-to-seedling transmission has been observed even though the transmission rate is very low (e.g. less than 0.06% for seed with less than 10% infected kernels) (Block et al., 1998).

The bacterium is mechanically transmitted to maize under laboratory or field conditions by wounding (Freeman and Pataky, 2001; Correa et al., 2012). In nature, local spread of *P. s. subsp. stewartii* largely depends on insect vectors. In the US, the corn flea beetle *Chaetocnema pulicaria* (Coleoptera: Chrysomelidae) is considered as the main vector (Pepper, 1967; Bae et al., 2015). Insect vectors (see Section 3.4.4.1) make it possible for the pathogen to bypass contact with parenchyma cells and enter directly into xylem vessels (Bae et al., 2015). The bacterium is associated with the alimentary tract (foregut, midgut and hindgut) of *C. pulicaria* (Orlovskis et al., 2015). Corn flea beetles overwinter as adults, their survival is reduced by temperatures below freezing (Cook et al., 2005). South to north migration of vectors is also known to occur (EPPO, 1997).

Two major cycles of *P. s. subsp. stewartii* infection are described in relation with insect vectors (Roper, 2011):

- a first cycle (the most damaging, as it leads to early infections) occurs when the overwintering infected adults transmit *P. s. subsp. stewartii* to young maize seedlings while feeding;
- a second type of cycle (usually only leading to leaf blight symptoms, without killing the plants) takes place when the first (and later) previously healthy summer generations of the beetles first acquire *P. s. subsp. stewartii* from infected plants and then further infect other maize plants.

Two or more generations of the corn flea beetle *C. pulicaria* develop during one growing season in Illinois, USA, for instance (Cook et al., 2005). The last beetle generation of the season acquires *P. s. subsp. stewartii* from infected plants and becomes the overwintering population (Roper, 2011). For other insect vectors, no detailed information is available. According to EPPO (1997), the bacterium can also overwinter in soil, manure and maize stalks.

According to Block et al. (1999), the bacterium has been observed in the remnants of the vascular tissue at the base of the kernel, in the endosperm, and externally on the seed coat, but not in the embryo. However, other researchers have stated that when seed is produced on susceptible parents, *P.*

s. subsp. stewartii may reach the kernels, but is unlikely to move to the embryo, which would leave that possibility open (Khan et al., 1996).

3.1.3. Intraspecific diversity

Within the *P. stewartii* species, two subspecies are currently distinguished: *P. s. subsp. stewartii* and *P. s. subsp. indologenes* (Gehring et al., 2014). Only the first one leads to typical symptoms on maize.

In comparison to other bacteria, *P. s. subsp. stewartii* has long been considered to be a phenotypically homogeneous organism (Pataky, 2003). This intraspecific homogeneity was attributed to the specificity of the bacterium to its main host (maize) and its main vector in the US (the corn flea beetle *C. pulicaria*) (Wilson et al., 1999; Pataky, 2003). Recent reports of new hosts of *P. s. subsp. stewartii* (see Section 3.4.1) now suggest that its intraspecific diversity compared to non-specialist plant pathogenic bacteria might need to be reconsidered.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, detection and identification methods are available.

A variety of detection methods have been described in the past, relying on isolation, serology or molecular biology. Conventional techniques are considered relatively insensitive for detection from seeds but molecular ones may require complex and expensive equipment (Uematsu et al., 2015).

Various types of polymerase chain reaction (PCR) assays (PCR, multiplex PCR, loop-mediated isothermal amplification (LAMP)) for the identification of this bacterium from field samples and for use in seed health tests have been developed (for instance, Coplin et al., 2002; Tambong et al., 2008). Molecular differentiation of *P. s. subsp. stewartii* from *P. s. subsp. indologenes* is possible using PCR methods (Gehring et al., 2014; Nechwatal et al., 2018).

A diagnostic procedure for *P. s. subsp. stewartii* has been published by EPPO (2016).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

P. s. subsp. stewartii is endemic to the USA where it was first reported on Long Island, New York, in the late 1890s by F. C. Stewart (Roper, 2011). In Canada, it occurs intermittently (Uematsu et al., 2015). The pathogen is now present in Africa, North, Central and South America, Asia and Europe (Table 2, Figure 1).

In non-EU Europe, it is officially declared by the NPPO as 'transient, under eradication' in Ukraine in 2018. The EPPO Reporting Service (<http://archives.eppo.int/EPPOreporting/2018/Rse-1803.pdf>) reports that the disease in Ukraine was first detected in 2014 on maize in the Poltava region, on an area of approximately 100 ha. The total infected area (2018) is now estimated at about 3,500 ha, in various regions of the country: Zhytomyr (1,022 ha), Ivano-Frankivsk (1,084 ha), Lviv (128 ha), Poltava (50 ha), Rivne (546 ha), Ternopil (533 ha) and Chernihiv (120 ha). Even if the total amount of contaminated maize surfaces looks rather limited in Ukraine, the distribution of the disease appears to be wide. In addition, the disease has been present there since 2014. This implies that the bacterium can survive under European conditions from growing season to growing season even if winters are harsh and suggests that vectors are present and efficient.

Table 2: Current distribution of *Pantoea stewartii* subsp. *stewartii* outside the EU based on information from the EPPO Global Database (Table 2, Figure 1). In the EPPO GD, *P. s. subsp. stewartii* is still listed as *P. stewartii*

Continent	Country (including sub-national states)	EPPO Global Database Last updated: 16 February 2018 Date accessed: 23 February 2018
Africa	Benin	Present, restricted distribution
	Togo	Present, restricted distribution

Continent	Country (including sub-national states)	EPPO Global Database Last updated: 16 February 2018 Date accessed: 23 February 2018
America	Argentina	Present, no details
	Bolivia	Present, no details
	Brazil (Sao Paulo)	Absent, unreliable record
	Canada (Alberta, British Columbia, Quebec)	Absent, pest no longer present
	Canada (Ontario)	Present, no details
	Costa Rica	Present, no details
	Guyana	Present, no details
	Mexico	Present, restricted distribution
	Paraguay	Absent, invalid record
	Peru	Present, restricted distribution
	Puerto Rico	Present, no details
	Trinidad and Tobago	Absent, intercepted only
	United States of America (Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, West Virginia Wisconsin)	Present, no details
	United States of America (Idaho, Washington)	Absent, pest no longer present
Asia	China (Henan)	Absent, pest no longer present
	India	Present, no details
	Republic of Korea	Present, few occurrences
	Malaysia (West)	Present, few occurrences
	Philippines	Present, no details
	Thailand	Absent, pest no longer present
	Vietnam	Absent, pest no longer present
Europe (non-EU countries)	Ukraine	Transient, under eradication

Distributor

Last updated: 2018-03-29

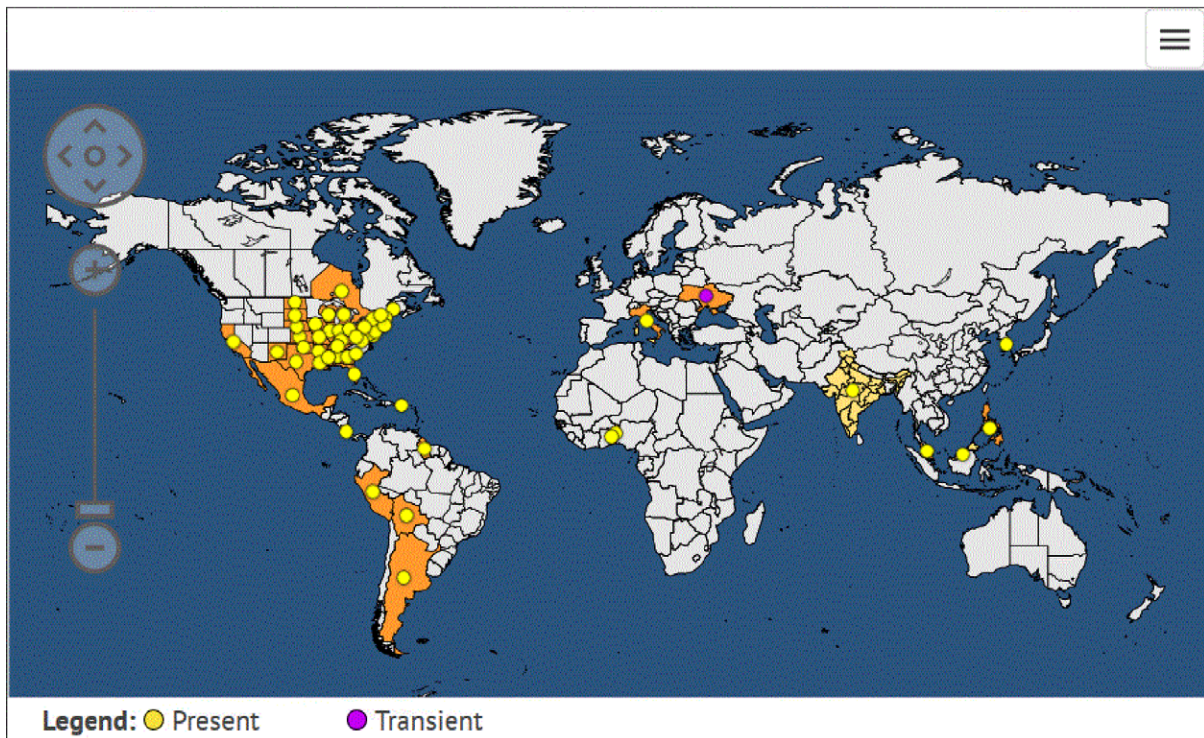


Figure 2: Global distribution map for *Pantoea stewartii* subsp. *stewartii* (extracted from the EPPO Global Database (EPPO, 2018) accessed March 2018)

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?

Yes, *P. s. subsp. stewartii* is officially reported as present in the EU, with a restricted distribution (North Italy).

In Italy, *P. s. subsp. stewartii* was detected during official surveys carried out in maize fields in the Friuli-Venezia Giulia region during the summer of 2017. The infected area was about 7 ha large (Anon, 2018a,b). In the infected area and surroundings, maize is cultivated for forage only (Anon, 2018a,b). The official pest status of *P. s. subsp. stewartii* in Italy is now 'present, restricted distribution' (EPPO, 2018).

Serious damage already occurred previously in Italy (Veneto region) prior to the 1950s in connection with the use of seed imported from the USA (EPPO, 1997).

There were also isolated outbreaks, then declared as eradicated, in Italy in the 1980s (Mazzucchi, 1984; EPPO, 1997).

The pest has been recently reported from the Emilia Romagna region. One case is reported from the Parma province in 2015 (three samples) and one from the Bologna province in 2016 (16 samples), with no positive findings in 2017 based on 30 samples (Alessandrini et al., 2017).

According to EPPO (2018), *P. s. subsp. stewartii* is absent (pest no longer present) in:

- Austria (surveys carried out (after an isolated finding in 1992) for 3 consecutive years in all maize-producing areas did not detect the bacterium),
- Greece (no further details, situation evaluated by EPPO on the basis of information dated 1992),
- Poland (following an interception in Italy of infected maize seeds from Poland in 2013, 201 maize seed samples were collected across the country in 2012–2014, with all tests negative),
- and Romania (no further details, situation evaluated by EPPO on the basis of information dated 1992).

The bacterium is reported as absent (confirmed by survey) in Croatia (information dated 1996) and the Netherlands (information dated 2017), and absent (no pest record) in Belgium and Slovenia (EPPO, 2018).

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

P. s. subsp. *stewartii* is listed in Council Directive 2000/29/EC as *Erwinia stewartii*. Details are presented in Tables 3 and 4.

Table 3: *Pantoea stewartii* subsp. *stewartii* in Council Directive 2000/29/EC

Annex II, Part A	Harmful organisms whose introduction into, and whose spread within, all Member States shall be banned if they are present on certain plants or plant products	
Section I	Harmful organisms not known to occur in the Community and relevant for the entire Community	
(a)	Insects, mites and nematodes, at all stages of their development	
	Species	Subject of contamination
3.	<i>Erwinia stewartii</i>	Seeds of <i>Zea mays</i> L.

3.3.2. Legislation addressing the hosts of *Pantoea stewartii* subsp. *stewartii*

Table 4: Regulated hosts and commodities that may involve *Pantoea stewartii* subsp. *stewartii* in Annexes III, IV and V of Council Directive 2000/29/EC

Annex IV, Part A	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	
Section I	Plants, plant products and other objects originating outside the community	
	Plants, plant products and other objects	Special requirements
52.	Seeds of <i>Zea mays</i> L.	Official statement that: (a) the seeds originate in areas known to be free from <i>Erwinia stewartii</i> (Smith) Dye; or (b) a representative sample of the seeds has been tested and found free from <i>Erwinia stewartii</i> (Smith) Dye in this test.
Annex V	Plants, plant products and other objects which must be subject to a plant health inspection (at the place of production if originating in the Community, before being moved within the Community—in the country of origin or the consignor country, if originating outside the Community) before being permitted to enter the Community	
Part B	Plants, plant products and other objects originating in territories, other than those territories referred to in Part A	
I.	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community	
1.	Plants, intended for planting, other than seeds but including seeds of [...] <i>Zea mays</i> [...]	

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The main proven host of *P. s.* subsp. *stewartii* is maize (*Zea mays*) (EPPO, 1997). Until recently, and based on data from the US, the most susceptible maize cultivars have been sweet corn ones (*Zea mays* var *rugosa*) and some elite inbred lines used as parents for hybrid maize seed production (Roper, 2011). In the USA, the use of resistant corn hybrids (grain maize) has made the disease unimportant for grain production (Roper, 2011). The occurrence of recent outbreaks in Italy and Ukraine on corn for grain or forage shows the disease can develop and cause problems on corn varieties in general, and not only on sweet corn.

P. s. subsp. *stewartii* had been reported to cause diseases on host plants other than sweet corn or maize. In all cases, robust scientific evidence is missing on the identification of those strains as *P. s.* subsp. *stewartii* as described by Mergaert et al. (1993) and the ability of the corresponding strains to cause the Stewart's vascular wilt and leaf blight of sweet corn and maize. For example, the following monocot

species have been reported as hosts of *P. s. subsp. stewartii*: *Agrostis gigantea*, *Dactylis glomerata*, *Digitaria* spp., *Panicum capillare*, *Panicum dichotomiflorum*, *Poa pratensis*, *Setaria lutescens*, *Sorghum sudanense* and *Triticum aestivum* (Roper, 2011; CABI, 2018), but without reliable characterisation at the subspecies level of the bacterial strains considered.

Moreover, Azad et al. (2000) reported the pathogenicity on oat (*Avena sativa*) and triticale (an hybrid of wheat and rye) of a strain of *P. stewartii* isolated from *S. sudanense* in California, but this strain did not cause on maize the wilting expected from strains of *P. s. subsp. stewartii* that cause Stewart's wilt.

The isolation of *P. s. subsp. stewartii* was reported from onion (*Allium cepa*) seeds and foliage in Puerto Rico (Alameda and Rivera-Vargas, 2010; Calle-Bellido et al., 2012). However, research using PCR assays able to differentiate between *P. s. subsp. stewartii* and *P. s. subsp. indologenes* showed that the subspecies *indologenes* was responsible for a centre rot of onion outbreak in 2003 in Georgia, USA (Stumpf et al., 2018).

Together with the fungus *Fusarium* spp., *P. s. subsp. stewartii* was reported as causing palm heart bacteriosis on the palm *Bactris gasipaes* in Costa Rica (Arroyo-Oquendo et al., 2007; Chaimsohn et al., 2008), but again, there is uncertainty about whether *P. s. subsp. stewartii* or another subspecies may be implicated.

EPPO (2018) also lists other plant species as hosts:

- *Artocarpus heterophyllus* (on which the bacterium causes an emerging disease called 'jackfruit bronzing', reported in the Philippines, Malaysia and Mexico; Gapasin et al., 2014; Hernández-Morales et al., 2017; Zulperi et al., 2017);
- *Dracaena sanderiana* (an ornamental plant native to Cameroon, on which the bacterium was reported from greenhouses in South Korea causing chlorosis, wilting and leaf blight; Choi and Kim, 2013), and
- *Oryza sativa* (*P. s. subsp. stewartii* is reported as an emerging rice pathogen in Benin and Togo; Anon, 2017; Kini et al., 2017a,b).

Also in these cases, there is uncertainty about whether *P. s. subsp. stewartii* or the other subspecies is the cause of these diseases.

Given these recent reports of potential new hosts, there is uncertainty about the host range of *P. s. subsp. stewartii*.

3.4.2. Entry

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

Yes, mainly by movement of infected seeds (and potentially plant for planting for other hosts). Transboundary natural introduction of infected insect vectors from countries neighbouring the EU is also possible.

The identified pathways of entry (EPPO, 2018) are:

- maize seed
- other host plants for planting
- infected insects from countries neighbouring the EU.

The bacterium is thought to have been introduced to various African, Asian and European countries with maize seeds. The risk of introducing *P. s. subsp. stewartii* by international shipment of maize seed is considered to be important and more than 50 countries ban its import unless it is certified to be free of the pathogen (Coplin et al., 2002).

EPPO (1997) mentions that the insect vectors only disseminate the disease at rather short distance and are very unlikely to be carried on traded plants. Insects may disseminate the bacterium from infected plots. Nevertheless, as the disease is now present in EU neighbouring countries, transboundary natural entry on insects is possible.

Table 5 reports the import into the EU of hybrid and non-hybrid maize seed for sowing from the countries with reported presence of *P. s. subsp. stewartii* (2011–2015). Notice that part of the maize imports consists of GM seeds, especially from the Americas to Spain and Portugal (ISAAA, 2016), that are the main producers of GM maize in the EU.

Table 5: EU-28 import of hybrid and non-hybrid maize seed for sowing (in 100 kg) from countries with reported presence of *Pantoea stewartii* subsp. *stewartii* (2011–2015; Source: EUROSTAT; codes: 10051013, 10051015, 10051018, 10051019 and 10051090)

Year Origin country	2011	2012	2013	2014	2015
Argentina	18,247	10,826	17,429	10,455	7,761
Benin	0	0	0	0	0
Bolivia	0	0	0	0	0
Canada	908	635	5,859	6,960	100,292
Costa Rica	0	0	0	0	0
Guyana	0	0	0	0	0
India	4	3	11	1	106
Mexico	1,086	1,002	1,027	1,071	1,127
Peru	41	102	73	185	313
Philippines	0	26	0	0	0
South Korea	7	3	0	0	0
Ukraine	391	2	988	3,656	1,758
USA	45,921	47,017	68,855	67,326	57,223
Total	66,214	59,614	93,254	85,998	166,822

Between 1999 and May 2018, there were 15 records of interception of *P. s.* subsp. *stewartii* in the Europhyt database (code: ERWIST), all on *Zea mays*. Nine interceptions were made in 1999 originating from Hungary (7) and Romania (2) before they joined the EU and reported by Austria (3), France (2), Germany (3) and the Netherlands (1). One interception was made in 2005 (origin: Turkey; destination: Germany), one in 2008 (origin: USA; destination: Germany), one in 2013 (the already mentioned (see Section 3.2.2) interception by Italy of infected seeds from Poland) and three in 2017 (all originating from Mexico, with France (2) and Germany (1) as destination).

As of May 2018, there are no records of interception of the corn flea beetle *C. pulicaria* (code: CHAEPU) in Europhyt, as expected as that insect is not considered in Directive 2000/29/CE.

3.4.3. Establishment

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

Yes, the pest can establish in the EU, as shown by past and recent outbreaks in the EU and neighbouring country Ukraine, and as the climate is suitable and the main host (maize) is widely grown.

3.4.3.1. EU distribution of main host plants

Maize, either for grain or fodder production, is grown throughout most of the EU. Cultivation of sweet corn is less developed. Tables 6 and 7 report the area of grain and green maize grown in the EU MS (2012–2016).

Table 6: Area of cultivation/production of grain maize (1,000 ha) in EU MS (Source: EUROSTAT)

Year Country	2012	2013	2014	2015	2016
EU-28	9,838	9,775	9,610	9,256	8,563
Austria	220	202	216	189	195
Belgium	67	74	63	58	52
Bulgaria	467	428	408	499	407
Croatia	299	288	253	264	252
Cyprus	0.0	0.0	0.0	0.0	0.0
Czech Republic	119	97	99	80	86
Denmark	13	13	10	9	6
Estonia	0.0	0.0	0.0	0.0	0.0

Year Country	2012	2013	2014	2015	2016
Finland	0.0	0.0	0.0	0.0	0.0
France	1,710	1,840	1,848	1,639	1,458
Germany	526	497	481	456	416
Greece	184	183	160	152	139
Hungary	1,191	1,243	1,191	1,146	1,012
Ireland	0.0	0.0	0.0	0.0	0.0
Italy	977	908	870	727	661
Latvia	0.0	0.0	0.0	0.0	0.0
Lithuania	13	17	19	12	12
Luxembourg	0.2	0.2	0.2	0.1	0.1
Malta	0.0	0.0	0.0	0.0	0.0
Netherlands	21	21	18	16	12
Poland	544	614	678	670	594
Portugal	102	112	108	98	89
Romania	2,731	2,519	2,514	2,608	2,584
Slovakia	212	222	216	191	185
Slovenia	39	42	38	38	36
Spain	390	442	419	398	359
Sweden	2.4	1.3	1.0	1.3	1.7
United Kingdom	9	11	0.0	4.0	5.0

Table 7: Area of cultivation/production of green maize (1,000 ha) in EU MS (Source: EUROSTAT)

Year Country	2012	2013	2014	2015	2016
EU-28	5,873	6,075	6,148	6,262	6,251
Austria	82	111	83	92	85
Belgium	171	177	178	173	169
Bulgaria	32	21	25	27	31
Croatia	29	29	29	33	31
Cyprus	0.4	0.2	0.3	0.3	0.2
Czech Republic	205	234	237	245	234
Denmark	185	181	178	182	182
Estonia	3.6	5.0	7.4	8.5	8.0
Finland	0.0	0.0	0.0	0.0	0.0
France	1,396	1,487	1,412	1,475	1,433
Germany	2,038	2,003	2,093	2,100	2,138
Greece	12	65	83	90	119
Hungary	104	102	85	90	76
Ireland	14	15	14	13	11
Italy	296	327	343	337	321
Latvia	18	20	21	25	26
Lithuania	22	23	29	29	27
Luxembourg	14	14	15	14	15
Malta	0.0	0.0	0.0	0.0	0.0
Netherlands	232	230	226	224	204
Poland	508	462	541	555	597
Portugal	80	84	85	81	79
Romania	50	56	48	46	51
Slovakia	85	93	86	90	78

Year	2012	2013	2014	2015	2016
Country					
Slovenia	27	30	29	29	29
Spain	107	107	113	108	106
Sweden	14	15	16	16	16
United Kingdom	148	183	171	179	186

3.4.3.2. Climatic conditions affecting establishment

P. s. subsp. *stewartii* is found in North America from Ontario to Mexico and from California to Maine (Figure 1). Its distribution thus covers a variety of climates that are also found in the maize-growing areas of the EU. Climate is thus not expected to be a limiting factor for establishment.

3.4.4. Spread

Is the pest able to spread within the EU territory following establishment? (Yes or No) How?

Yes, mainly by the movement of maize seed and insect vectors.

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

Yes, spread (in the absence of vectors) is mainly via plants for planting, including seed.

Spread of *P. s.* subsp. *stewartii* is known to occur through seed, even if at low rate (EPPO, 1997; Menelas et al., 2006; Anon, 2018b). Infected seed is considered the main route of long distance spread (Anon, 2018b).

In addition, *P. s.* subsp. *stewartii* is transmitted by insect vectors (EPPO, 1997; Menelas et al., 2006; Anon, 2018b) that are responsible for local spread and also for long-distance dissemination in the case of *C. pulicaria* (see Section 3.4.4.1).

3.4.4.1. Vectors and their distribution in the EU

The main known vector responsible for overwintering and spread of *P. s.* subsp. *stewartii* in the USA is the beetle *C. pulicaria* (EPPO, 1997) (see Section 3.1.2). This insect is known to migrate in North America and can be carried over considerable distances in air currents (EPPO, 1997).

Other known North American vectors include *Diabrotica undecempunctata* (both adult and larva), *Chaetocnema denticulata*, larvae of *Delia platura*, *Agriotes mancus*, *Phyllophaga* sp. and *Diabrotica longicornis* (EPPO, 1997).

With the exception of *D. platura* (which is reported as widespread in the EU), all these species are considered not present in the EU (Fauna Europaea). As of May 2018, there were no interception records in Europhyt of the EU-regulated *D. undecempunctata*.

EU insect species have been considered to be inefficient as vectors (EPPO, 1997), at least in the EU countries that have reported the presence of the bacterium. Nevertheless, that consideration is now doubtful when considering the recent outbreaks in Ukraine. There is thus uncertainty regarding the availability of effective insect vectors in the EU.

3.5. Impacts

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

Yes, the pest introduction would have economic impacts in the EU.

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?⁴

Yes, the pest presence on plants for planting (including seed) would have to some extent an economic impact on their intended use.

⁴ See Section 2.1 on what falls outside EFSA's remit.

P. s. subsp. stewartii is reported to cause the most serious bacterial disease of sweet corn in the north-central and eastern USA (Roper, 2011). Impact is limited in the US on grain or forage corn (green maize) as resistant hybrids are grown, but it may be serious if non-resistant varieties are used (Roper, 2011). Stewart's wilt is one of the first plant diseases for which a disease forecast system was developed (Pataky, 2003). Epidemics of the disease are reported to have increased in the 1990s due to favourable weather conditions (mild winters) and the susceptibility of some maize hybrids (Brown et al., 2001; Esker and Nutter, 2002). Although much of the commercial maize grown today in the USA has been bred for resistance to Stewart's wilt, there are still sweet corn hybrids and some elite inbred lines used for hybrid maize seed production that remain highly susceptible to the disease (Michener et al., 2003; Roper, 2011).

Impacts due to Stewart's wilt are reported as extreme when sweet corn is infected at the seedling stage and when the hybrids are susceptible or moderately susceptible (Pataky et al., 1995). Conversely, in resistant cultivars, symptoms are usually limited to within 2–3 cm around corn flea beetle feeding wounds and systemic infections rarely occur (Pataky, 2003). In Argentina, where the disease was recently first reported, incidence reached 54% in maize fields in the Cordoba province (Albarracín Orió et al., 2012). In the USA, yield of cultivars with greater than 30% incidence was shown to be reduced to unsatisfactory levels (Freeman and Pataky, 2001). In Iowa, where the disease is endemic, the prevalence of Stewart's disease was 25% of seed production fields in 1998 and 58% in both 1999 and 2000 (Esker and Nutter, 2003).

Impacts have also been reported on rice production in Benin, with disease incidence from 30% to 100% in 14 surveyed sites, and in Togo (Anon, 2017).

Given the large area of maize cultivation in the EU (see Section 3.4.3.1), and taking into account that the disease is present on grain and green maize field in Italy and Ukraine, impacts can be expected, should the bacterium be further introduced and should it extend its currently restricted distribution. There is uncertainty about the availability of suitable vectors in the EU and the level of susceptibility of maize hybrids and varieties grown in the EU. A comparison of the reaction to Stewart's wilt of maize accessions collected from various regions of the world concluded that high levels of resistance are prevalent only among accessions collected from areas where the disease has been endemic (Pataky et al., 2000). Nevertheless, that study relies on old data and experiments that are possibly no longer suitable.

An assessment of the potential effects of climate change on plant diseases in Ontario (Canada) concluded that climate change is likely to increase the primary inoculum, rate of disease progress and potential duration of epidemics of Stewart's wilt, mainly due to (i) increased survival of the main insect vector because of milder winters and (ii) increased plant stress because of drier and/or warmer growing conditions (Boland et al., 2004). The severity of the disease is directly related to the numbers of corn flea beetles surviving the winter (Roper, 2011). In addition, drought and hot weather, by causing stress to maize plants, tend to increase the severity of Stewart's wilt (Hoffmann et al., 1995). Similar effects of climate change on the potential impacts of Stewart's wilt in the EU can be expected.

Regarding seed transmission, its rate is considered as very low. Impact in field conditions is therefore dependent on the availability of vectors where infected seed lots are grown.

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 Section 3.6.2.

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

Yes, measures to prevent pest presence on plants for planting are available.

3.6.1. Phytosanitary measures

Phytosanitary measures are in place for the import of maize seeds into the EU (see Section 3.3.2).

The absence of the disease in the area of production may nevertheless be difficult to assess as symptoms can be weak on partially resistant varieties.

Detection methods on seeds have limitations in relation with their sensitivity (capability to detect low concentration in seeds) and the size of samples (low prevalence of the disease in seeds that implies that samples should be large).

For hosts other than maize, production of plants for planting in pest-free areas could be a measure to avoid the risk of introduction of the pathogen. However, this measure is not in place with the current regulation.

Insecticides may help controlling insect vector populations. Nevertheless, insects may have time to infect plantlets before being killed by insecticides.

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

- Field observation and detection methods are not sensitive enough to guarantee the absence of *P. s. subsp. stewartii* in seed lots (Feng et al., 2015).
- The rate of infection in maize seeds is low and thus difficult to assess.
- Visual inspection of fields does not differentiate between systemic infection and infection that is restricted by host resistance (Michener et al., 2002).
- No characteristic symptoms are visible on seeds infected by *P. s. subsp. stewartii* (Tambong et al., 2008).
- False negative ELISA seed tests (i.e. negative ELISA response with nonetheless recoverable *P. s. subsp. stewartii* from seeds) are possible (Lamka et al., 1991).
- Seed treatments may negatively interact with detection methods, even if the viability of the bacterium is not altered.

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

- There is a lack of chemical methods to control the disease in the field.
- Production of maize seed under protected conditions is possible only for early stage breeding.

3.6.2. Pest control methods

- Starting crop production with clean seed and transplants is a standard recommendation (Dutta et al., 2013);
- Producing seed in areas where Stewart's wilt does not occur ensures that *P. s. subsp. stewartii* will not be introduced on seed (Pataky, 2003), provided that initial seeds are healthy;
- Methods to certify pest freedom of maize seeds are available (Tambong et al., 2008; Roper, 2011) even if not fully satisfying;
- Impacts can be reduced by the use of resistant maize cultivars (Roper, 2011) when available;
- In the USA, insecticides applied as seed treatments or foliar sprays are used to reduce the abundance of corn flea beetles and to decrease the risk of spread of Stewart's wilt in susceptible maize varieties (Cook et al., 2005).

3.7. Uncertainty

The host range of *P. s. subsp. stewartii* remains uncertain:

- i) some of the papers recently published describe '*P. stewartii*' as pathogenic to new hosts, but do not provide sufficient evidence to determine whether the isolated bacteria belong to the subspecies *P. s. subsp. stewartii* and cause Stewart's vascular wilt and leaf blight of sweet corn and maize.
- ii) sweet corn is considered as the most impacted maize type, which seems to still be true in the US, but the recent outbreaks in Italy and Ukraine lead to consider that maize for grain production and green maize can also be affected by *P. s. subsp. stewartii*.

The virulence of the strains of *P. s. subsp. stewartii* found in the EU and Ukraine is unknown.

The level of resistance available in EU maize germplasm collections, in commercial maize and corn varieties grown in the EU and in the lines for hybrid creation is largely unknown.

The capacity of insects to carry and disseminate *P. s. subsp. stewartii*, in the EU and neighbouring countries, is largely unknown.

There is often uncertainty about whether papers related to *P. s. subsp. stewartii* refer to sweet corn varieties or maize (other than sweet corn) varieties.

4. Conclusions

P. s. subsp. *stewartii* meets the criteria assessed by EFSA for consideration as a potential quarantine pest (Table 8).

Table 8: 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
Identity of the pest (Section 3.1)	The identity of the pest as a subspecies is clearly established	The identity of the pest as a subspecies is clearly established	Some papers deal with " <i>P. stewartii</i> " and not with " <i>P. s.</i> subsp. <i>stewartii</i> ". It is not always clear whether the species or subspecies is considered, and whether the literature deals with strains that are known to cause Stewart's wilt or leaf blight of corn. This does not affect the possibility to identify strains, but makes some papers questionable
Absence/ presence of the pest in the EU territory (Section 3.2)	The pest is reported to be present again in the EU (there were outbreaks in the past), but with a restricted distribution (Italy). It is under official control	The pest is reported to be present again in the EU (there were outbreaks in the past), but with a restricted distribution (Italy). It is under official control	Official surveys are not organised in all EU MS. The disease may remain undetected as symptoms might not be seen until severe impacts occur
Regulatory status (Section 3.3)	The pest is regulated by Council Directive 2000/29/EC (Annex IIAI) as a harmful organism whose introduction into, and whose spread within, all Member States shall be banned if present on seeds of <i>Zea mays</i>	The pest is regulated by Council Directive 2000/29/EC (Annex IIAI) as a harmful organism whose introduction into, and whose spread within, all Member States shall be banned if present on seeds of <i>Zea mays</i>	For some plants described as potential hosts, the reported identity of the causal agent as <i>P. s.</i> subsp. <i>stewartii</i> is questionable
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	<p>Entry: the pest could enter the EU via seeds, as well as via infected insects from neighbouring countries</p> <p>Establishment: maize (the main host) is widely grown in the EU and climatic conditions are favourable to the disease.</p> <p>Spread: the pest would be able to spread following establishment by movement of infected seed and, possibly, insect vectors.</p>	<p>Plants for planting (including seed) are the major pathway of spread</p> <p>Taking into account recent outbreaks in the EU (Italy) and neighbouring countries (Ukraine), spread by seed and/or vectors is possible</p>	<p>The susceptibility to the bacterium of maize types (grain, green, sweet) and varieties grown in the EU is largely unknown.</p> <p>The virulence of the strains isolated in Italy and Ukraine is largely unknown. There is uncertainty about the availability of suitable vectors in the EU.</p> <p>The susceptibility of potential hosts other than maize is uncertain.</p> <p>There is uncertainty about the host range of the bacterium</p>

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
Potential for consequences in the EU territory (Section 3.5)	<p>The pest introduction would have direct and indirect economic consequences, given the importance of maize as a crop and as seeds for trade in the EU.</p> <p>At least some maize varieties already grown in the EU and neighbouring countries are susceptible to the bacterium as outbreaks are recorded</p>	<p>The pest introduction would have direct and indirect economic impacts on the intended use of plants for planting</p>	<p>A knowledge gap is the level of susceptibility of maize types (sweet, grain, green, etc.) and varieties currently grown in the EU and in neighbouring countries.</p> <p>Another knowledge gap is the virulence of the strains responsible for recent outbreaks</p> <p>How large the impact of the disease can be under European conditions and on varieties grown in the EU is largely unknown</p> <p>The potential impact on the export of maize seeds from the EU, should the bacterium spread within the EU, is unknown</p>
Available measures (Section 3.6)	<p>Methods to certify pest freedom of maize seeds are available but not fully satisfying.</p> <p>Impacts could be reduced by the use of resistant maize cultivars, providing they are available.</p> <p>Treatments against insects may reduce spread through insect vectors, but insecticide treatments are no longer well accepted by population</p> <p>No measures are in place regarding host consignments other than maize seed</p>	<p>Producing seed in areas where Stewart's wilt does not occur reduces the risk that <i>P. stewartii</i> will be introduced on seed</p>	<p>There is uncertainty about the level of resistance of maize types (sweet, dent, forage, etc.) and varieties currently grown in the EU MS and in Ukraine.</p> <p>There is uncertainty about the virulence of the strains responsible for the recent outbreaks</p>
Conclusion on pest categorisation (Section 4)	<p>The criteria assessed by the Panel for consideration as a potential quarantine pest are met. The pest is present in the EU, but with a restricted distribution and is under official control</p>	<p>The criterion on the pest presence in the EU (the pest is present, but with a restricted distribution and is under official control) is not met</p>	
Aspects of assessment to focus on/ scenarios to address in future if appropriate	<p>The main knowledge gaps concern (i) the occurrence of effective vectors in the EU, (ii) the susceptibility level of maize cultivars grown in the EU, (iii) the virulence of the strains isolated from the newly reported hosts and the recent outbreaks in Italy and Ukraine, and (iv) the host range of the pathogen</p>		

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Abbreviations

DG SANTE	Directorate General for Health and Food Safety
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
LAMP	loop-mediated isothermal amplification
MS	Member State
PCR	polymerase chain reaction
PLH	EFSA Panel on Plant Health
RNQP	Regulated non-quarantine pest
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference