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Pest categorisation of *Pantoea ananatis*

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Abstract

The EFSA Plant Health Panel performed a pest categorisation of *Pantoea ananatis*, a Gram-negative bacterium belonging to the Erwiniaceae family. *P. ananatis* is a well-defined taxonomic unit; nonetheless, its pathogenic nature is not well defined and non-pathogenic populations are known to occupy several, very different environmental niches as saprophytes, or as plant growth promoting bacteria or biocontrol agents. It is also described as a clinical pathogen causing bacteraemia and sepsis or as a member of the gut microbiota of several insects. *P. ananatis* is the causal agent of different diseases affecting numerous crops: in particular, centre rot of onion, bacterial leaf blight and grain discoloration of rice, leaf spot disease of maize and eucalyptus blight/dieback. A few insect species have been described as vectors of *P. ananatis*, among them, *Frankliniella fusca* and *Diabrotica virgifera virgifera*. This bacterium is present in several countries in Europe, Africa, Asia, North and South America, and Oceania from tropical and subtropical regions to temperate areas worldwide. *P. ananatis* has been reported from the EU territory, both as pathogen on rice and maize and as an environmental, non-pathogenic bacterium in rice marshes and poplar rhizosoil. It is not included in EU Commission Implementing Regulation 2019/2072. The pathogen can be detected on its host plants using direct isolation, or PCR-based methods. The main pathway for the entry of the pathogen into the EU territory is host plants for planting, including seeds. In the EU, there is a large availability of host plants, with onion, maize, rice and strawberry being the most important ones. Therefore, disease outbreaks are possible almost at any latitude, except in the most northern regions. *P. ananatis* is not expected to have frequent or consistent impact on crop production and is not expected to have any environmental impact. Phytosanitary measures are available to mitigate the further introduction and spread of the pathogen into the EU on some hosts. The pest does not satisfy the criteria, which are within the remit for EFSA to evaluate whether the pest meets the definition of a Union quarantine pest. *P. ananatis* is probably widely distributed in different ecosystems in the EU. It may impact some specific hosts such as onions while on other hosts such as rice it has been reported as a seed microbiota without causing any impact and can even be beneficial to plant growth. Hence, the pathogenic nature of *P. ananatis* is not fully established.

Keywords: *Erwinia ananatis*, plant pathogenic bacteria, 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

The new Plant Health Regulation (EU) 2016/2031, on the protective measures against pests of plants, is applying from 14 December 2019. Conditions are laid down in this legislation in order for pests to qualify for listing as Union quarantine pests, protected zone quarantine pests or Union regulated non-quarantine pests. The lists of the EU regulated pests together with the associated import or internal movement requirements of commodities are included in Commission Implementing Regulation (EU) 2019/2072. Additionally, as stipulated in the Commission Implementing Regulation 2018/2019, certain commodities are provisionally prohibited to enter in the EU (high risk plants, HRP). EFSA is performing the risk assessment of the dossiers submitted by exporting to the EU countries of the HRP commodities, as stipulated in Commission Implementing Regulation 2018/2018. Furthermore, EFSA has evaluated a number of requests from exporting to the EU countries for derogations from specific EU import requirements.

In line with the principles of the new plant health law, the European Commission with the Member States are discussing monthly the reports of the interceptions and the outbreaks of pests notified by the Member States. Notifications of an imminent danger from pests that may fulfil the conditions for inclusion in the list of the Union quarantine pest are included. Furthermore, EFSA has been performing horizon scanning of media and literature.

As a follow-up of the above-mentioned activities (reporting of interceptions and outbreaks, HRP, derogation requests and horizon scanning), a number of pests of concern have been identified. EFSA is requested to provide scientific opinions for these pests, in view of their potential inclusion by the risk manager in the lists of Commission Implementing Regulation (EU) 2019/2072 and the inclusion of specific import requirements for relevant host commodities, when deemed necessary by the risk manager.

1.1.2. Terms of Reference

EFSA is requested, pursuant to Article 29(1) of Regulation (EC) No 178/2002, to provide scientific opinions in the field of plant health.

EFSA is requested to deliver 53 pest categorisations for the pests listed in Annex 1A, 1B, 1D and 1E (for more details see mandate M-2021-00027 on the Open.EFSA portal). Additionally, EFSA is requested to perform pest categorisations for the pests so far not regulated in the EU, identified as pests potentially associated with a commodity in the commodity risk assessments of the HRP dossiers (Annex 1C; for more details see mandate M-2021-00027 on the Open.EFSA portal). Such pest categorisations are needed in the case where there are not available risk assessments for the EU.

When the pests of Annex 1A are qualifying as potential Union quarantine pests, EFSA should proceed to phase 2 risk assessment. The opinions should address entry pathways, spread, establishment, impact and include a risk reduction options analysis.

Additionally, EFSA is requested to develop further the quantitative methodology currently followed for risk assessment, in order to have the possibility to deliver an express risk assessment methodology. Such methodological development should take into account the EFSA Plant Health Panel Guidance on quantitative pest risk assessment and the experience obtained during its implementation for the Union candidate priority pests and for the likelihood of pest freedom at entry for the commodity risk assessment of High Risk Plants.

1.2. Interpretation of the Terms of Reference

Pantoea ananatis is one of a number of pests listed in Annex 1D to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest (QP) for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform EU decision making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/2072. If a pest fulfils the criteria to be potentially listed as a Union QP, risk reduction options will be identified.

1.3. Additional information

This pest categorisation was initiated as a result of media monitoring, PeMoScoring and subsequent discussion in PAFF, resulting in it being included in the current mandate within the list of pests identified by Horizon Scanning and selected for pest categorisation.

2. Data and methodologies

2.1. Data

2.1.1. Information on pest status from NPPOs

In the context of the current mandate, EFSA is preparing pest categorisations for new/emerging pests that are not yet regulated in the EU. When official pest status is not available in the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, 2020, online), EFSA consults the NPPOs of the relevant MSs. To obtain information on the official pest status for *Pantoea ananatis*, EFSA has consulted the NPPOs of Austria, Belgium, Italy, Poland and Spain. The results of this consultation are presented in Section 3.2.2.

2.1.2. Literature search

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

2.1.3. Database search

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

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

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

GenBank was searched to determine whether it contained any nucleotide sequences for *P. ananatis*, which could be used as reference material for molecular diagnosis. GenBank® (www.ncbi.nlm.nih.gov/genbank/) is a comprehensive publicly available database that as of August 2019 (release version 227) contained over 6.25 trillion base pairs from over 1.6 billion nucleotide sequences for 450,000 formally described species (Sayers et al., 2020).

2.2. Methodologies

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

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

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. Whilst the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel et al., 2018). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for QP status. Assessing social impact is outside the remit of the Panel.

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest (Article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest clearly defined, 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 in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
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 for entry and spread.
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent pest entry, establishment, spread or impacts?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the taxonomic identity of the pest is clearly defined; nonetheless, several isolates described in the literature are not able to produce any symptoms on the plants from which they were isolated.

The bacterium *P. ananatis* is described in several scientific papers as a common member of the environmental microbiota. Its pathogenic nature has been demonstrated for a limited number of strains. Some strains are saprotrophs, others are commensal endophytes of a large number of plants and, some of them, can even exert beneficial effects on plant physiology and are recognized as plant growth promoting bacteria (PGPB) and are recognised microbial biocontrol agents. *P. ananatis* is also a member of the gut microbiota of several insects. Clinical isolates have been also described.

P. ananatis is a Gram-negative, rod-shaped, peritrichous, non-spore forming bacterium, with facultative anaerobic metabolism, belonging to the family Erwiniaceae (Adeolu et al., 2016); it produces bright yellow colonies in culture media, and it is one of the few bacterial species isolated from plants that have the ice nucleation gene (ina) (Abe et al., 1989; McCorkle, 2009). Serrano (1928) first described *P. ananatis* as *Erwinia ananas*, later corrected into *E. ananatis* (International Code of Nomenclature of Prokaryotes (ICNP)). Mergaert et al. (1993) proposed the name *P. ananas*, which was corrected to 'ananatis' by Trüper and De' Clari (1997). A closely related species, *E. uredovora* (Pon et al., 1954) Dye 1963 (syn. *P. uredovora*), was synonymized to *P. ananatis* by Mergaert et al. (1993), based on a high level of genotypic relatedness (heterotypic synonym). This synonymy was supported by numerical analysis (Dye, 1981; Mergaert et al., 1984; Verdonck et al., 1987). Waleron et al. (2002) have shown that the two species are in the same recA polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) group, and Brady, Venter, et al. (2007) and Brady, Cleenwerck, et al. (2007) have shown that these strains also form part of the same fluorescent amplified fragment length polymorphism (F-AFLP) cluster. Despite this research, the synonymy of these two species was not widely accepted for several years, and the name *E. uredovora* has been found in literature until recent years.

The EPPO code[1] (Griessinger and Roy, 2015; EPPO, 2019) for this species is: ERWIAN (EPPO, 2020, online).

3.1.2. Biology of the pest

Table 2 describes the main aspects of *P. ananatis* life history, from the overwintering phase to the latency period after its seasonal life cycle.

Table 2: Important features of the life history strategy of *P. ananatis*

Disease cycle	Infection process and relation to host	Other relevant information
Overwintering phase	*P. ananatis* is a common epiphyte on its host and non-host plants (Gitaitis et al., 2002). *P. ananatis* has also been isolated as an endophyte from a large number of plant species (Lodewyckx et al., 2002), where it may exert beneficial effects on plant growth (Kang et al., 2007; Thomas et al., 2007). As a pathogen, it may have a latent phase *in planta* (Mano and Morisaki, 2008). *P. ananatis* may also overwinter/survive in crop debris (Sauer et al., 2015). Additionally, *P. ananatis* has been isolated from a diverse range of environments as a saprophyte (Lai and Hsu, 1974; Mohammed et al., 1991; Rauch et al., 2006). Finally, *P. ananatis* is a common inhabitant of the gut microflora of several insects (Takahashi et al., 1995; Watanabe et al., 1996; Wells et al., 2002; Gitaitis et al., 2003; Bell et al., 2007).	*P. ananatis* is described as a very common bacterium that belongs to the microbiota of the most diverse environments.
Primary inoculum	*P. ananatis* is a confirmed seed-borne and seed-transmitted bacterium for some important plant species, e.g. onion (Walcott et al., 2002; Goszczynska et al., 2006), rice (Azegami et al., 1983; Tabei et al., 1988), sudangrass (Azad et al., 2000) and maize (Rijavec et al., 2007). Thrips (e.g. *Frankliniella fusca*) and beetles (e.g. *Diabrotica virgifera virgifera*) have been shown to vector *P. ananatis* and, therefore, they may be sources of primary inoculum (Dutta et al., 2014; Krawczyk et al., 2021).	Dispersal of primary inoculum may occur through insects and seeds of some of its host plants. Primary inoculum may be present as an epiphyte in a large range of weeds.

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

Disease cycle	Infection process and relation to host	Other relevant information
Penetration into the host plants	Pathogen penetration into its host plants is passive through flowers (Serrano, 1928; Hasegawa et al., 2003), stomata, lenticels, wounds (e.g. thrips feeding, Watanabe et al., 1996; Wells et al., 2002; Gitaitis et al., 2003; Grode et al., 2017), mechanical injury (Serrano, 1928) and plant to plant contact during high winds (Azad et al., 2000; Cother et al., 2004) or through the stalk/neck in onions (possibly during irrigation from above when irrigation water is contaminated by the pathogen, Morohoshi et al., 2007) or via thrips faeces (Dutta et al., 2014). Penetration into its host plants is sometimes due to insect feeding.	
Secondary inocula	Secondary inocula may be produced in symptomatic plants when bacteria evade from the affected tissue and disperse in the environment.	Rain or irrigation may support the dissemination of secondary inocula.
Latency	Pathogen latency and its duration has been described and depends on the host plant (Coutinho and Venter, 2009). *P. ananatis* may show latency in some field crops (e.g. onions, melons, cantaloupes) causing post-harvest decay of fruits and bulbs (Bruton et al., 1986, 1991; Lim, 1986; Wells et al., 1987)	In case of post-harvest diseases caused by *P. ananatis*, the pathogen is presumably present epiphytically or endophytically on the hosts at the pre-harvest stage.

3.1.3. Host range/species affected

P. ananatis may be found in several environments and on/in several plants, taxonomically very distant (both mono- and dicotyledons) as an epiphyte/endophyte, without causing any specific disease. In the last 100 years, disease outbreaks were reported, in which *P. ananatis* was recognised as the causal agent, or as an associated bacterium that increased disease severity, in association with other pathogens (Paccola-Meirelles et al., 2001; Xue et al., 2021). A few cases are associated with a pre- or post-harvest decay of fruits or bulbs, but lacking any specific symptoms on other plant parts (Serrano, 1928; Ceponis et al., 1985; Bruton et al., 1991; Liao et al., 2016; Das et al., 2020). Currently, the main hosts of *P. ananatis* reported in the most recent literature are: onion (*Allium cepa*), rice (*Oryza sativa*), maize (*Zea mays*), sorghum (*Sorghum* spp.), and eucalypt (*Eucalyptus* spp.). The complete list of hosts is reported in Appendix A.

3.1.4. Intraspecific diversity

P. ananatis is currently a clear taxonomic unit, not divided into subspecies or pathovars or races. Nevertheless, it has been differentiated into three functional groups according to its ability to cause symptoms on Welsh onion and develop a hypersensitive reaction on tobacco mesophyll: Group I (pathogenic), Group II (weak pathogenic), Group III (nonpathogenic); additionally, these three identified groups have been substantiated by the presence/absence of specific genes, namely iaaM, iaaH, etz (Kido et al., 2010). Finally, isolates colonizing the same ecological niche (e.g. maize seeds from healthy plants) and having the highest genome similarity were found to develop different interaction strategies with the host plant (maize), from pathogenic to beneficial: such peculiar behaviour was ascribed to differences in genes encoding protein secretion systems and putative effectors, as well as transposase/integrases/phage related genes (Sheibani-Tezerji et al., 2015). Non-pathogenic isolates were also described by several other authors (e.g. Nunes and de Melo, 2006; Cho et al., 2007; Thomas et al., 2007).The genome plasticity of *Pantoea ananatis* (Weller-Stuart et al., 2017) may explain the observed versatility and behaviour in different environments.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?
Yes, methods are available to detect and identify *P. ananatis*.

P. ananatis can be detected in its host plants in multiple ways. Symptoms may greatly differ from host to host but, generally, they are associated with the development of leaf spots, blights, or rots of different organs (leaves, stems, fruits, bulbs). Most symptoms are consistent with a parenchymatic disease though, in some cases, *P. ananatis* seems to have a systemic nature, as infected seeds are produced by symptomatic host plants (Walcott et al., 2002). Molecular methods for the detection and identification of *P. ananatis* and its differentiation from other phytopathogenic bacteria are also available (Kini et al., 2021; Shin et al., 2022). The commonly used detection and identification methods (direct isolation on nutrient media, PCR protocols) are not able to differentiate pathogenic from non-pathogenic isolates, unless pathogenicity assays are performed on a large selection of putative host plants. Symptomless plant material (e.g. seeds or seedlings) may latently harbour *P. ananatis* and detection of the pathogen in such material might be quite cumbersome. No standard method has ever been published by EPPO for the detection and identification of *P. ananatis* (Table 3)

Table 3: *Pantoea ananatis* symptoms on its reported host plants (only crop plants and ornamentals have been considered)

Host plant	Symptoms	Authority
Aglaonema	Yellow and water-soaked spots, later necrotizing, and with surrounding chlorotic areas	Yazdani et al. (2018)
Cucumber	Spots on leaves, later coalescing, yellow veins and, eventually, chlorosis on the entire leaves.	Lao et al. (2022)
Eucalypt	Leaf spot and blight, premature leaf abscission, dieback.	Coutinho et al. (2002)
Fragrant pear	Shoot blight	Wang et al. (2019)
Ginger	Leaf blight, developing as V shaped lesions.	Dohroo et al. (2013)
Maize	Water-soaked leaf spots, later desiccating and coalescing into white spots; premature senescence of leaves and plant stunting. Brown stalk rot.	Paccola-Meirelles et al. (2001); Goszczynska et al. (2007)
Mandarin	Irregular water-soaked areas on skin, later turning dark brown or black, sunken. Fruits become dry, wrinkled and, eventually, drop.	Das et al. (2020)
Mango	Brown necrosis of apical twigs affecting the buds.	Gutiérrez-Barranquero et al. (2019b)
Melon and cantaloupe	Brown spot of honeydew melons; Water-soaked lesions on cantaloupe melons, enlarging along the epidermal surface. Symptoms appear during post-harvest storage.	Ceponi et al. (1985); Bruton et al. (1991)
Onion	Leaf blight, seed stalk rot, and bulb decay.	Gitaitis and Gay (1997)
Peach	Fruit rot in post-harvest	Liao et al. (2016)
Pineapple	Fruitlet discoloration and rot, mainly internal. Development of a dull colour during ripening.	Serrano (1928)
Rice	Palea browning, spikelet discoloration and stem necrosis.	Cother et al. (2004); Cortesi and Pizzatti (2007)
Sorghum	Irregular leaf spots, with reddish-brown borders and chlorotic centres.	Cota et al. (2010)
Strawberry	Water-soaked, angular spots on leaves, coalescing, later reddish-brown and necrotizing. Necrotizing crown, with the development of pockets inside.	Abdel-Gaied et al. (2022); Zhang et al. (2022)
Sudan grass	Leaf chlorosis and necrosis of leaf tips, development of necrotic streaks on leaves, leaf scorching associated with reddish-purple to dark-brown margins.	Azad et al. (2000)
Syngonium	Yellow and water-soaked spots, later necrotizing, and with surrounding chlorotic areas	Yazdani et al. (2018)
Wheat	Dark brown necrotic and irregular lesions with yellow haloes developing on leaves.	Krawczyk et al. (2020)

Symptoms may have a diagnostic value nonetheless, *P. ananatis* has been also found to be associated with other bacterial and fungal pathogen on plants, thus contributing to symptom development. Direct isolation from symptomatic material is, in most cases, a successful method to obtain pure cultures (Serrano, 1928 Wells et al., 1987; Bruton et al., 1991; Gitaitis and Gay, 1997; Coutinho et al., 2002; Gitaitis et al., 2002; Cota et al., 2010).

Pure cultures of *P. ananatis* grown on nutrient agar (NA) are yellow, 3–4 mm in diameter after 6–7 days of incubation at 25°C, shiny and drop-shaped, with small, darker, granular inclusions; cells are Gram-negative rods (1.5–2.0 μm length and 0.5–0.75 μm width), motile, oxidase negative and catalase positive (Goszczynska et al., 2006). Other nutrient media, such as yeast extract–dextrose–calcium carbonate agar (Azad et al., 2000), King's Medium B (Cother et al., 2004) and PA20 (Goszcynska et al., 2006) have also been successfully employed for isolation.

Molecular methods to detect *P. ananatis* in symptomatic and/or symptomless plant materials are also available, and they are based on PCR (Gitaitis et al., 2000, 2002; Carr et al., 2010; Figueiredo and Paccola-Meirelles, 2012). The complete genome sequence of *P. ananatis* strain LMG20103, a highly virulent strain from eucalypt, is currently available (De Maayer et al., 2010, 2014) and might be used to identify specific sequences for the development of detection protocols. Many other *P. ananatis* sequences, from other plant sources, are available in the GeneBank (Asselin et al., 2016).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU (Figure 1)

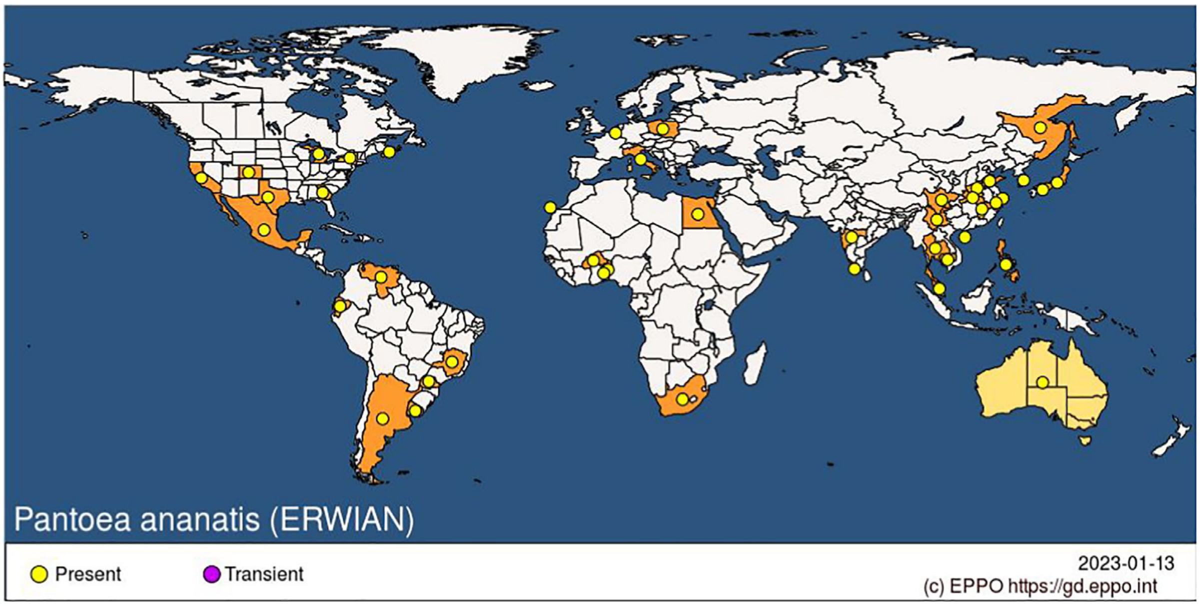

Figure 1: Global distribution of *Pantoea ananatis* (Source: EPPO Global Database accessed on 13 January 2022). It is noted that the distribution map is based on published disease notes. Several papers report the presence of non-pathogenic or beneficial *P. ananatis* strains in countries that are not highlighted in the map

P. ananatis, as a plant pathogen or as an endophyte/epiphyte, has been reported is several countries worldwide on different crop plants, ornamentals and weeds. As a pathogenic bacterium, it has been repeatedly reported in China, Malaysia, Japan, Thailand, South Africa, USA, Mexico, Argentina, Brazil. Due to its nature as an organism frequently described as a common member of the environmental microbiota, its distribution might be remarkably wider as described in the current literature. This is a key uncertainty.

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.

Yes, the pest has been reported in the EU territory, but its known distribution as a plant pathogen is very limited. Non-pathogenic *P. ananatis* isolates have been also reported in the EU territory to be associated with crop plants, or as clinical isolates.

P. ananatis has been reported from northern Italy (Lombardy) on rice (Cortesi and Pizzatti, 2007); 3 years later, it was reported once in Poland (Greater Poland Voivodeship) on maize (Krawczyk et al., 2010). More recently, it has been reported associated with a bacterial apical necrosis of mango trees (*Mangifera indica*) in the Canary Islands (Spain) (Gutiérrez-Barranquero et al., 2019a,b). Such latter report states that *P. ananatis* isolates, associated with *P. agglomerans* that has been recognized as the causal agent of the mango apical necrosis, were able to produce necrotic symptoms on mango; despite this assumption, the authors did not specify how the pathogenicity test was done and whether the Koch's postulates were verified for all the five putative *P. ananatis* isolates from mango. Finally, Krawczyk et al. (2020) described again its presence in Poland (same Greater Poland Voivodeship) but affecting wheat. Due to its nature as a common epiphyte on host and non-host plants, or as an endophyte inside other plants, saprotroph (water, soil, rhizosphere of uncountable plant species), member of the microbiota associate with some insects, a key uncertainty is identified on its distribution in the EU territory. Indeed, a paper published in 2015 reported the isolation of *P. ananatis* strains from seeds of healthy maize plants grown in Lower Austria (Sheibani-Tezerji et al., 2015): one of those strains proved to be pathogenic on maize. One year later, *P. ananatis* was isolated in the municipality of Genk (Belgium) from the rhizosphere of poplar (Gkorezis et al., 2016). In 2016 and 2017, *P. ananatis* was repeatedly isolated in rice paddies in southern Spain and characterised as a plant growth promoting bacterium (PGPB) (Megías et al., 2016, 2017). Finally, a clinical case of *P. ananatis* causing a bacteremic infection was reporting its presence in Belgium (De Baere et al., 2004). Therefore, because of its ubiquitous distribution (Coutinho and Venter, 2009) the presence of *P. ananatis* in the EU territory might be broader than reported. This represents a key uncertainty, especially considering the phytopathogenic nature of the bacterium which, in addition to its opportunistic behaviour, also includes saprotrophs, beneficial microorganisms and clinically relevant populations.

The presence of the pathogen in Andalucia was confirmed by the Spanish NPPO. No measures are applied. The Belgium NPPO informed that they do not have records of findings or interceptions of *P. ananatis* and that no measures or systematic surveys are planned. According to the Polish NPPO, the current status of *P. ananatis* in Poland is present with low prevalence. No measures currently planned to be applied in Poland. The Austrian NPPO informed that visual inspection of maize did not result in any findings of symptoms of *P. ananatis* and that *P. ananatis* was found in four samples of different plant species (*Cucurbita pepo*, *Prunus domestica*, *Rubus ideaus* and *Triticum aestivum*). There was no indication that *P. anantis* causes damage under current climatic conditions on the hosts from which the *P. ananatis* strains were isolated.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

Pantoea ananatis is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, an implementing act of Regulation (EU) 2016/2031, or in any emergency plant health legislation.

3.3.2. Hosts or species affected that are prohibited from entering the Union from third countries

A list of hosts included in Annex VI of Commission Implementing Regulation (EU) 2019/2072 is provided in Table 4. Hosts of the genera Malus and Prunus are included in the Commission Implementing Regulation (EU) 2018/2019 on high risk plants.

Table 4: List of plants, plant products and other objects that are *Pantoea ananatis* hosts, whose introduction into the Union from certain third countries is prohibited (Source: Commission Implementing Regulation (EU) 2019/2072, Annex VI)

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	**CN Code**	**Third country, group of third countries or specific area of third country**
8.	Plants for planting of [. . .] *Prunus* L., *Pyrus* L. [. . .]., other than dormant plants free from leaves, flowers and fruits	ex 0602 10 90 ex 0602 20 20 ex 0602 20 80 ex 0602 40 00 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries other than: Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Faeroe Islands, Georgia, Iceland, Liechtenstein, Moldova, Monaco, Montenegro, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Türkiye and Ukraine
9.	Plants for planting of [. . .]., *Prunus* L. and *Pyrus* L. and their hybrids, and *Fragaria* L., other than seeds	ex 0602 10 90 ex 0602 20 20 ex 0602 90 30 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries, other than: Albania, Algeria, Andorra, Armenia, Australia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canada, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, New Zealand, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Türkiye, Ukraine, and United States other than Hawaii

3.3.3. Legislation addressing the organisms that vector *P. ananatis* (Commission Implementing Regulation 2019/2072)

Pantoea ananatis is known to be associated with the gut microflora of several insects, e.g. *Diabrotica virgifera virgifera* (Krawczyk et al., 2020), tobacco and onion thrips (Gitaitis et al., 2003), cotton fleahoppers (*Pseudatomoscelis seriatus*) (Coutinho and Venter, 2009), mulberry pyralid (*Glyphodes pyloalis*) (Takahashi et al., 1995), ticks, lice, and fleas (Murrell et al., 2003). Bacterial transmission to crop plants has been confirmed for *Diabrotica virgifera virgifera* (Coleoptera, Crysomelidae) and thrips, namely *Frankliniella fusca* (Thysanoptera, Thripidae), the tobacco thrips. *P. ananatis* is not circulative in *D. virgifera virgifera*, which transmits the pest as adults feed on plant leaves (Krawczyk et al., 2020). Similarly, *F. fusca* transmits *P. ananatis* in its adult stage (Gitaitis et al., 2003). Other insects may play a role in the epidemiology of *P. ananatis*, but merely producing lesions on leaf tissues, through which the pathogenic bacterium may occasionally enter, as in the case of *Oulema melanopus* (Coleoptera, Crysomelidae) (Krawczyk et al., 2020). *Frankliniella fusca* is not addressed by the current legislation and *Diabrotica* is present in the current legislation as *D. virgifera zeae*, a QP not known to occur in the EU territory. Other *Diabrotica* species (namely *D. barberi*, *D. undecimpunctata howardi*, *D. u. undecimpunctata*) known to feed on maize and other host plants, and present in areas where *P. ananatis* has been reported on maize and onion, are regulated.

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

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

Comment on plants for planting as a pathway.

Yes, phytopathogenic populations of the pest are able to further enter into the EU territory on specific plants for planting, including seeds, and fruits.

Main pathways that have been identified are:

- Seeds for sowing of onion
- Seeds for sowing of rice
- Seeds for sowing of maize
- Seeds for sowing of sorghum
- Plants for planting, other than seeds, of strawberry
- Plants for planting, other than seeds, of eucalypt
- Fruits of pineapple
- Bulbs of onion
- *Diabrotica virgifera virgifera*
- *Frankliniella fusca*

Less likely pathways are: fruits of melons, plums, peaches, mangoes, citrus; plants of Pyrus, ginger, Syngonium, Aglaonema; seeds for sowing of wheat.

Pantoea ananatis is described as a common member of rice microbiota (Mano and Morisaki, 2008; Kaga et al., 2009). It has been found in maize seeds as an endophyte (Sheibani-Tezerji et al., 2015) and, as an endophyte, is present in several crop and non-crop plants (Lodewyckx et al., 2002; Nunes and de Melo, 2006; Cho et al., 2007; Kang et al., 2007; Rijavec et al., 2007). It is also a recognised PGPB (Kang et al., 2007; Thomas et al., 2007), as a rhizospheric bacterium or as an epiphyte (Gitaitis et al., 2002). It also belongs to the microbial communities harboured in several insects (Takahashi et al., 1995; Watanabe et al., 1996; Wells et al., 2002; Gitaitis et al., 2003; Bell et al., 2007). Therefore, there is a high probability that the pathogen may enter the EU territory via a wide range of plant and animal matrices. An overview of potential pathways and relevant mitigations is provided in Tables 5 and 6 lists the quantities of imported fresh produce of main hosts from countries where *P. ananatis* is present.

Table 5: Potential pathways for *P. ananatis* into the EU 27 ()

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Description (e.g. host/ intended use/source)		
Seeds for sowing of rice (*Oryza sativa*)	Primary inoculum in its latent phase is harboured in seeds.	**Annex XI, part A** Phytosanitary certificates are required for seeds of Rice, for sowing for their introduction into the Union Territory from third countries other than Switzerland.
Seeds for sowing of onion (*Allium cepa*)	Primary inoculum in its latent phase is harboured in seeds.	**Annex XI, part A** Phytosanitary certificates are required for seeds of onions (Allium cepa), for sowing for their introduction into the Union Territory from third countries other than Switzerland.
Seeds for sowing of maize (*Zea mays*)	Primary inoculum in its latent phase is harboured in seeds.	**Annex XI, part A** Phytosanitary certificates are required for seeds of maize and sweetcorn, for sowing for their introduction into the Union Territory from third countries other than Switzerland.

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Seeds for sowing of sorghum (*Sorghum* x *drummondii*; *Sorghum* spp.)	Primary inoculum in its latent phase is harboured in seeds.	**Annex XI, part A** Phytosanitary certificates are required for seeds of sorghum originating in Argentina, Australia, Bolivia, Brazil, Chile, New Zealand and Uruguay **Annex XI, part B** Phytosanitary certificates are required for seeds of grain sorghum seed, for sowing for their introduction into the Union Territory from third countries other than Switzerland.
Seeds for sowing of buckwheat (*Fagopyrum esculentum*)	Primary inoculum in its latent phase is harboured in seeds.	**Annex XI, part B** Phytosanitary certificates are required for seeds for sowing of Buckwheat for their introduction into the Union Territory from third countries other than Switzerland
Plants for planting other than seeds of strawberry (*Fragaria* L.)	*P. ananatis* may be latently present into the crown or petioles in strawberry plants.	**Annex VI** Introduction into the EU is prohibited from third countries other than Third countries other than Albania, Algeria, Andorra, Armenia, Australia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canada, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, New Zealand, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo- Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Turkey, Ukraine, the United Kingdom (1) and United States other than Hawaii
Plants for planting other than seeds of eucalypts (*Eucalyptus* spp.)	*P. ananatis* has been reported in Eucalyptus sp. seedlings and cuttings as an endophyte.	**Annex XII.** A phytosanitary certificate is required for plants, plant parts and seeds of Eucalyptus for their introduction into a protected zone from third countries other than Switzerland.
Orange (*Citrus sinensis*), Mandarin (*Citrus reticulata*)	*P. ananatis* may be present on/in fruits in their latent, exponential, or stationary phase: if bacteria are present in the last two phases, fruits are symptomatic.	**Annex VI.** Plants of Citrus L. . . . and their hybrids, other than fruits and seeds are prohibited from all third countries. Plants, plant products and other objects of *C sinensis* are prohibited from Argentina **Annex XI,** part A Phytosanitary ceritifcates are required for fruits of *Citrus* L. . . . and their hybrids from third countries other than Switzerland. Phytosanitary certificates are required for seeds for sowing of *Citrus* L. . . . from third countries other than Switzerland.

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Pineapple (*Ananas comosus*)	*P. ananatis* may be present inside fruits in their latent, exponential, or stationary phase: if bacteria are present in the last two phases, fruits are symptomatic.	**None**
Bulbs of: Onion (*Allium cepa*), Garlic (*Allium sativum*), Shallot (*Allium cepa* L. *aggregatum* group).	*P. ananatis* may be present inside the bulbs in their latent, exponential, or stationary phase: if bacteria present in the last two phases, bulbs are symptomatic.	**Annex XI, part A** Phytosanitary ceritifcates are required for onions, shallots, garlic... for planting from third countries other than Switzerland
Insect vectors: western corn rootworm (*Diabrotica virgifera virgifera*), tobacco thrips (*Frankliniella fusca*)	Primary inoculum harboured in the midgut and hindgut.	None

Table 6: EU 27 annual imports of fresh produce of main hosts from countries where *Pantoea ananatis* is present, 2016–2020 (in 100 kg) Source: Eurostat accessed on 12 July 2022

Commodity	HS code	2016	2017	2018	2019	2020
Fresh or chilled onions and shallots	0703 10	1,259,432.47	856,331.69	938,113.39	2,999,954.60	1,061,980.96
Fresh or dried pineapples	0804 30	385,892.1	324,754.8	366,287.5	421,152.2	383,364
Fresh or dried mandarins incl. tangerines and satsumas (excl. clementines)	0805 21	No data	551,641.56	910,647.32	896,617.81	1,516,450.28
Melons, incl. watermelons, and papaws “papayas”, fresh	0807	3,744,708	4,560,552	5,024,314	4,963,218	5,683,959
Rice in the husk, “paddy” or rough	1006 10	1,486,593.27	487,620.24	237,309.94	435,443.40	477,979.00
Grain sorghum	1007	259,716.21	208,566.25	5,390,805.97	4,211,546.87	56,305.06
Maize or corn	1005	41,540,442.55	62,792,060.84	88,083,419.20	61,618,008.90	51,163,198.62

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at (13 January 2023) there were no records of interception of *P. ananatis* in the TRACES databases. Due to technical issues it was not possible to access the Europhyt database. However since *P. ananatis* is not a QP, EU member states have no obligation to notify interceptions of the pathogen via Europhyt.

3.4.2. Establishment

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

Yes, the pest is able to become further established in the EU territory on its reported major hosts: onion, rice and maize.

Pantoea ananatis as a plant pathogen has been found in the EU territory. If infected plant material, including seeds, are imported it is very likely that the pest will transfer to a suitable host grown in the EU territory or remain in the environment as an additional member of the microbial community. The ability of the pathogen to survive in different environments and host and non-host plants suggests that the biotic and abiotic factors occurring in the EU are favourable for its further establishment in other areas of the territory. *P. ananatis* is able to survive in different environments, also associated with host and non-host plants, and insects. Therefore, following its entry, its transfer to a suitable host and its establishment may be assisted by its permanence in the environment as an epiphyte/endophyte on several plants, in plant debris, in surface water, in the gut of several insects. The presence of *P. ananatis* in the EU territory as a saprotroph, commensal, opportunist or beneficial organism is certain (De Baere et al., 2004; Gkorezis et al., 2016; Sheibani-Tezerji et al., 2015; Megías et al., 2016, 2017). Nonetheless, there is no specific study on its presence and distribution: this is a key uncertainty.

3.4.2.1. EU distribution of main host plants

So far, the major reported hosts of *P. ananatis* are pineapple, onion and rice. Maize and eucalyptus are gaining more and more importance as host plants (Paccola-Meirelles et al., 2001; Coutinho et al., 2002; Goszczynska et al., 2006). Minor and occasional disease outbreaks are reported on several other plants, namely sorghum, buckwheat, strawberry, oranges, mandarins, Chinese cabbage, ginger, melon, peach, cucumber, Aglaonema and Syngonium. Pineapples are not grown in the EU territory (continental), though cultivations are present on the Canary Islands (https://www.frutas-hortalizas.com/Fruits/Origin-production-Pineapple.html). Rice is grown in humid areas of southern Spain, Portugal, France, northern Italy and Greece. Limited cultivation areas are also present in Hungary, Romania and Bulgaria (https://agridata.ec.europa.eu/extensions/DashboardRice/RiceProduction.html). Maize and onions are cultivated in most EU territory, from the Mediterranean areas, the central-eastern countries, to the Baltic territories. The harvested area of some hosts of *P. ananatis* is presented in Table 7.

Table 7: Harvested area of some of the *Pantoea ananatis* main hosts in EU 27, 2016–2020 (1,000 ha). Source: EUROSTAT (accessed 12 July 2022)

Crop	2016	2017	2018	2019	2020
Sorghum	123.77	135.66	147.85	190.32	217.57
Rice	448.74	440.68	417.37	419.09	427.55
Maize	6,061.45	5,985.90	6,134.91	6,210.36	6,325.30
Onions	169.93	170.68	168.19	176.72	173.09
Strawberries	103.78	103.76	106.42	101.16	83.92

3.4.2.2. Climatic conditions affecting establishment

In the original and first paper describing *P. ananatis* (Serrano, 1928), the pest affected only pineapple in tropical regions of the Philippines (Köppen–Geiger climates Af, Am, Aw). More recently, the pest was found on rice (western Africa, Spain, Italy, Russia, Cambodia, India, Japan, Malaysia, Thailand, Australia), maize (Poland, Argentina, Brazil, Mexico, Ecuador, China, South Africa), onion (USA, Uruguay, Venezuela, Korea), strawberry (Canada, Egypt, China) and other minor crops. Therefore, several environments suit the establishment of *P. ananatis* as a plant pathogen. This is in line with the nature of such bacterium, which is described as a microorganism able to adapt to a large range of environments and habitats. Figure 2 shows the world distribution of Köppen-Geiger climate types (Kottek et al., 2006) that occur in the EU and in countries where *P. ananatis* is present.

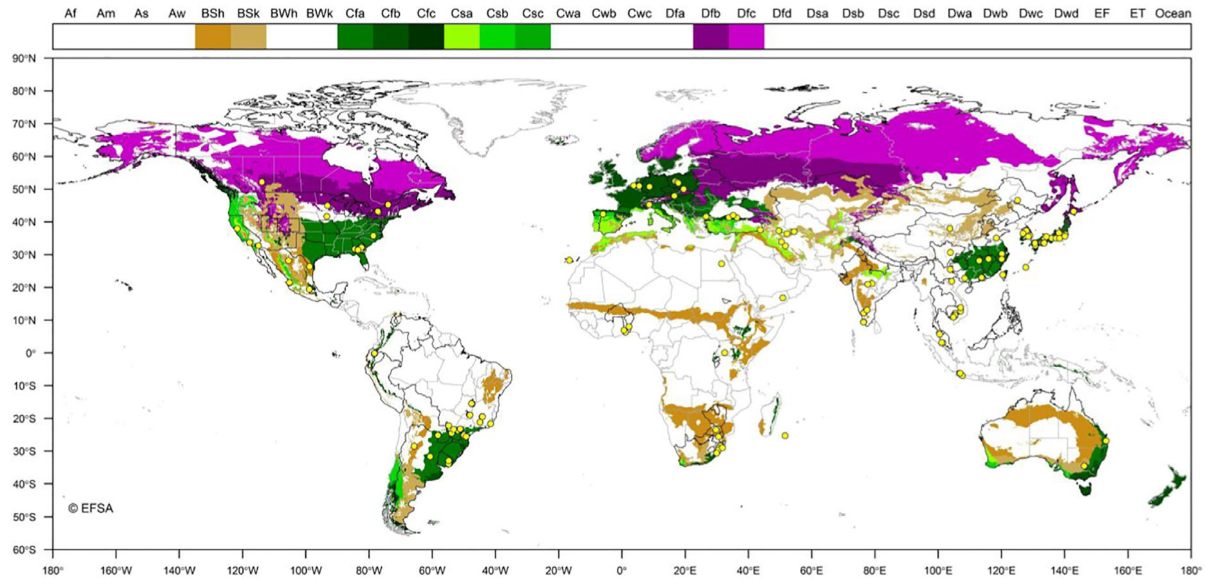

Figure 2: Distribution of Köppen-Geiger climate types BSh, BSk, Cfa, Cfb, Csa, Csb, Csc, Dfb and Dfc that occur in the EU and in third countries where *P. ananatis* has been reported. The legend shows the list of Köppen–Geiger climates. Yellow dots indicate point locations where *P. ananatis* was reported (Appendix B)

3.4.3. Spread

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

Comment on plants for planting as a mechanism of spread.

Yes, the pest is able to spread within the EU territory. Plants for planting, including seeds, are the main means of spread.

Following its further establishment within the EU territory, the pest is able to spread to small, medium and long distances. Main mechanism of spread is represented by infected host plants for planting, including seeds (e.g. seeds of onion, maize and rice, latently infected strawberry crowns or stolons, onion bulbs) (Azegami et al., 1983; Walcott et al., 2002; Rijavec et al., 2007; Zhang et al., 2022). Human-assisted spread is possible through the use of machinery (e.g. any kind of machinery that may be contaminated with plant debris or soil particles associated with the pest) and irrigation with contaminated water. Since the pest is frequently found as an epiphyte on several plants and weeds, rain represent the main means of natural spread (Gitaitis et al., 2002). Additionally, the pest can survive in surface water, which should be considered as a means of natural spread as well (Morohoshi et al., 2007). Insects (e.g. thrips and beetles) are reported to be vectors of *P. ananatis*; nonetheless, there is a key uncertainty if European thrips (e.g. *Thrips tabaci* and *Frankliniella occidentalis*) may be suitable vectors. Conversely, the role as vector for *P. ananatis* has been confirmed for *Diabriotica virgifera virgifera*, the western corn rootworm (Krawczyk et al., 2021), which is present in several EU regions, where maize is grown.

3.5. Impacts

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

The further introduction of *P. ananatis* into the EU territory is expected to have an impact on host plant production, such as on onion. The magnitude of such impact is a key uncertainty and depends on the presence of *P. ananatis* isolates that would express pathogenicity.

P. ananatis, in the areas where it is reported as a plant pathogen, may cause diseases that are usually sporadic, and a relevant impact on crop yield is rarely reported. Serrano (1928), who described the first disease outbreak on pineapple, reported only slight losses, not exceeding 2% of fruits and observed great differences in cultivar susceptibility. The only crop where, repeatedly, major losses have been reported is onion: in USA, Gitaitis and Gay (1997) observed up to 100% crop losses and 30% to 50% in Korea (Kim et al., 2012). Paccola-Meirelles et al. (2001) reported that the high yield losses observed in maize infected by *Phaeosphaeria maydis* (63.16%) where possible only in case of a *P. ananatis* contribution to the symptomatology. Similarly, Xue et al. (2021) reported *P. ananatis* causing discoloration and blight on rice, with an incidence that reached 50%, but in association with *Enterobacter asburiae*, which was identified as main pathogen, whereas *P. ananatis* just a contributor to the disease. On sorghum, occasional disease outbreaks lead to foliar blights up to 50% of leaves (Azad et al., 2000). More recently, up to 20% of fruitlet losses were reported on mandarin in Maharashtra, India (Das et al., 2020). As a post-harvest pathogen of melon, *P. ananatis* was reported to cause up to 87% of losses during storage of fruits (Bruton et al., 1991). So far, in the EU territory, the disease observed on rice and maize did not cause extensive damage (Cortesi and Pizzatti, 2007; Krawczyk et al., 2010). Therefore, it is not expected that *P. ananatis* may have an important economic or environmental impact in the EU territory, with medium uncertainty regarding onion, and high uncertainty regarding rice and maize. In most cases described in the literature, the finding of *P. ananatis* associated with a specific disease were first reports, which weren't followed by any other papers on epidemiology, impact or control. Finally, there is high uncertainty on published data, whether the impact caused by *P. ananatis* outbreaks is more related to the aggressiveness of single strains or to conducive agri-environmental conditions supporting disease development or to the synergistic effect of *P. ananatis* favouring a more important bacterial or fungal pathogen.

3.6. Available measures and their limitations

Are there measures available to prevent pest entry, establishment, spread or impacts such that the risk becomes mitigated?

Although not specifically targeted against *P. ananatis*, existing phytosanitary measures (see Sections 3.3.2 and 3.4.1) mitigate the likelihood of the pathogen's further entry and spread into the EU on some pathways. Potential additional measures are also available to further mitigate the risk of further entry and spread of the pathogen in the EU (see Section 3.6.1).

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants for planting (see Section 3.3.2).

Additional potential risk reduction options and supporting measures are shown in Sections 3.6.1.1 and 3.6.1.2.

3.6.1.1. Additional potential risk reduction options

Potential additional control measures are listed in Table 8.

Table 8: Selected control measures (a full list is available in EFSA PLH Panel et al., 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

Control measure/risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/spread/impact)
Require pest freedom	Seedlings or cuttings of *Eucalyptus* spp., strawberry propagation material (crowns and stolons), bulbs of onion for planting, seeds of onion, rice, maize, buckwheat, and sorghum should be imported from a pest free country, pest free area or pest free production site.	Entry

Control measure/risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/spread/impact)
Growing plants in isolation	Description of possible exclusion conditions that could be implemented to isolate the crop from pests and if applicable relevant vectors. E.g. a dedicated structure such as glass or plastic greenhouses. Seedlings of *Eucalyptus* spp., strawberry planting material, onion for seed production, should be grown under exclusion conditions and under a efficient management of insect pests.	Entry/spread
Managed growing conditions	Eucalyptus seedlings should be grown in pots, and an efficient management of insect pests, especially thripids, should be ensured.	Entry/spread
Crop rotation, associations and density, weed/ volunteer control	Crop rotation, associations and density, weed/volunteer control are used to prevent problems related to pests and are usually applied in various combinations to make the habitat less favourable for pests. The measures deal with (1) allocation of crops to field (over time and space) (multi-crop, diversity cropping) and (2) to control weeds and volunteers as hosts of pests/ vectors. Weed control may reduce the epiphytic populations of *P. ananatis*, thus reducing the available inoculum in the field.	Establishment/impact
Use of resistant and tolerant plant species/ varieties	Resistant plants are used to restrict the growth and development of a specified pest and/or the damage they cause when compared to susceptible plant varieties under similar environmental conditions and pest pressure. • It is important to distinguish resistant from tolerant species/varieties. Clones of *Eucalyptus* spp. and maize that show a degree of tolerance to *P. ananatis* infection are described.	Establishment/impact
Roguing and pruning	Roguing is defined as the removal of infested plants and/or uninfested host plants in a delimited area, whereas pruning is defined as the removal of infested plant parts only without affecting the viability of the plant. Roguing of diseased strawberry and onion plants may reduce the inoculum in the field.	Spread/impact
Biological control and behavioural manipulation	Pest control such as: a) Biological control b) Sterile Insect Technique (SIT) c) Mating disruption d) Mass trapping Reducing the populations of insect vectors may mitigate the spread and impact of *P. ananatis*. Some microbial antagonists, such as *Streptomyces* spp. (Oliveira et al., 2016) and *Bacillus megaterium* (Karagöz, 2017) were reported to inhibit the growth of *P. ananatis in vitro*. Moreover, the peptide Bacitracin A produced by *Bacillus licheniformis* strain HN-5, showed strong *in vitro* bactericidal activity against *P. ananatis* and ability to reduce remarkably disease severity in rice plants in glasshouse experiments (Pengfei et al., 2020). Despite these promising results, none of the microbial antagonists or of their metabolites were tested under field conditions	Spread/impact

Control measure/risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/spread/impact)
	against *P. ananatis*. Phages with ability to retarded the growth of *P. ananatis* on rice plants and in culture medium were also identified by Azegami (2013)	
Chemical treatments on crops including reproductive material	Chemical treatments may reduce the epiphytic populations of the pathogen and its vectors, e.g. *Diabrotica virgifera virgifera* and thripids.	Spread/impact
Chemical treatments on consignments or during processing	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 Dipping melons in a water diluted disinfectant may reduce the epiphytic populations of the pathogen, thus reducing post-harvest losses	Impact
Physical treatments on consignments or during processing	This information sheet deals with the following categories of physical treatments: irradiation/ionisation; mechanical cleaning (brushing, washing); sorting and grading, and; removal of plant parts (e.g. debarking wood). This information sheet does not address: heat and cold treatment (information sheet 1.14); roguing and pruning (information sheet 1.12). Sorting and grading of citrus fruits and peaches may reduce the movement of the pathogen. Sorting and grading of melons and cantaloupes may reduce the losses in post-harvest. Sorting and grading of eucalypt seedlings prior to planting may reduce the entry/spread of the pathogen and the disease in the field.	Entry/spread/impact
Cleaning and disinfection of facilities, tools and machinery	The physical and chemical cleaning and disinfection of facilities, tools, machinery, transport means, facilities and other accessories (e.g. boxes, pots, pallets, palox, supports, hand tools). The measures addressed in this information sheet are: washing, sweeping and fumigation. Facilities, tools, machinery coming in contact with fruits possibly contaminated by the pathogen (e.g. melons, citrus and pineapples) should be thoroughly cleaned and disinfected.	Establishment/spread
Use of non-contaminated water	Chemical and physical treatment of water to eliminate waterborne microorganisms. The measures addressed in this information sheet are: chemical treatments (e.g. chlorine, chlorine dioxide, ozone); physical treatments (e.g. membrane filters, ultraviolet radiation, heat); ecological treatments (e.g. slow sand filtration). Water quality used for irrigation or for cleaning fruits should be regularly checked, in order to detect possible presence of the pest.	Establishment/spread/impact
Waste management	• Treatment of the waste (deep burial, composting, incineration, chipping, production of bio-energy...) in authorized facilities and official restriction on the movement of waste	Spread

Control measure/risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
	Contaminated fruits or plants should be destroyed, but not with deep burial. Methods might be mulching and composting or incineration.	
Heat and cold treatments	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 • Onion seeds may be heat-treated to reduce the seed-associated populations of the pest. But no specific protocol is currently available for *P. ananatis*.	Entry/establishment/ spread
Post-entry quarantine and other restrictions of movement in the importing country	This information sheet covers post-entry quarantine (PEQ) of relevant commodities; temporal, spatial and end-use restrictions in the importing country for import of relevant commodities; Prohibition of import of relevant commodities into the domestic country. 'Relevant commodities' are plants, plant parts and other materials that may carry pests, either as infection, infestation, or contamination. Post-entry quarantine (one season) should be implemented for *Eucalyptus* spp. and strawberry planting material.	Establishment/spread

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 et al., 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

Supporting measure	Summary	Risk element targeted (entry/establishment/ spread/impact)
Inspection and trapping	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5). The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques. Inspection of fruits (e.g. oranges, mandarins, peaches) may allow the visual detection of disease symptoms, therefore supporting a targeting sampling for analysis. Visual inspections of planting material is not effective, since the pest may be harboured endophytically in its latent phase.	Entry
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests. Laboratory testing is a requirement that may allow the detection of the pest in its latent phase in planting material, included seeds. Laboratory testing may also confirm symptoms etiology of diseased plants or plant parts.	Entry/spread

Supporting measure	Summary	Risk element targeted (entry/establishment/spread/impact)
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing. For inspection, testing and/or surveillance purposes the sample may be taken according to a statistically based or a non-statistical sampling methodology. Validated sampling protocols for seeds and seedlings may assist inspection and testing by providing representative samples for lab analyses.	Entry/spread
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5) 1) export certificate (import) 2) plant passport (EU internal trade) A phytosanitary certificate should accompany seeds, seedlings and plantlets of the relevant host plants.	Entry/spread
Certified and approved premises	Mandatory/voluntary certification/approval of premises is a process including a set of procedures and of actions implemented by producers, conditioners and traders contributing to ensure the phytosanitary compliance of consignments. It can be a part of a larger system maintained by the NPPO in order to guarantee the fulfilment of plant health requirements of plants and plant products intended for trade. Key property of certified or approved premises is the traceability of activities and tasks (and their components) inherent the pursued phytosanitary objective. Traceability aims to provide access to all trustful pieces of information that may help to prove the compliance of consignments with phytosanitary requirements of importing countries. Strawberry planting material, eucalypt seedlings, onion seeds and bulbs (intended for propagation), should be produced in certified and approved premises.	Entry/establishment/spread
Certification of reproductive material (voluntary/official)	Plants come from within an approved propagation scheme and are certified pest free (level of infestation) following testing; Used to mitigate against pests that are included in a certification scheme A phytosanitary certificate should be required for *Eucalyptus* spp. seedlings and cuttings, and strawberry planting material originating from countries where *P. ananatis* is known to occur.	Entry/spread
Delimitation of Buffer zones	ISPM 5 defines a buffer zone as "an area surrounding or adjacent to an area officially delimited for phytosanitary purposes in order to minimize the probability of spread of the target pest into or out of the delimited area, and subject to phytosanitary or other control measures, if appropriate" (ISPM 5). The objectives for delimiting a buffer zone can be to prevent spread from the outbreak area and to maintain a pest free production place (PFPP), site (PFPS) or area (PFA).	Spread

Supporting measure	Summary	Risk element targeted (entry/establishment/spread/impact)
	A buffer zone may be delimitated around a PFPP or PFPS or PFA, but it will be difficult to set, since the actual distribution of *P. ananatis* is largely unknown and the dissemination pathways (e.g. insects, surface water) are not fully understood. Additionally, non-pathogenic isolates may be already present in the buffer zones.	
Surveillance	See above	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- During the latent period the pathogen cannot be detected visually in plant material, including seeds.
- The ubiquity and contrasting lifestyles exhibited by *P. ananatis*, make the identification of pathogenic strains very difficult.
- The ubiquity and the biological feature of *P. ananatis* make the establishment of buffer zones unreliable.

3.7. Uncertainty

Key uncertainties that may affect the categorisation:

1) The actual distribution of the pest in the EU territory.
2) The magnitude of the impact caused by the pest on specific hosts.
3) The true nature of *P. ananatis* and its populations, which have been described not only as phytopathogenic, but also as beneficial to plants, or as harmless commensals, or also as members of the microbiota residing in the gut of several insect species.

4. Conclusions

The pest does not satisfy the criteria, which are within the remit for EFSA to evaluate whether the pest meets the definition of a Union QP. *P. ananatis* is probably widely distributed in different ecosystems in the EU. It may impact some specific hosts such as onions while its presence on other hosts such as rice it has been reported as a seed microbiota without causing any impact and can even be beneficial to plant growth. Hence, the pathogenic nature of *P. ananatis* is not fully established (Table 10).

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	Key uncertainties
Identity of the pest (Section 3.1)	The taxonomic identity of *P. ananatis* is clearly defined. The identity of *P. ananatis* as a plant pathogen is not clearly defined.	The pathogenic nature of *P. ananatis* is not defined: depending on its genomics, it might be a pathogen, or a beneficial microorganism, or an antagonistic bacterium, or a saprotroph, or just a commensal microbe.
Absence/presence of the pest in the EU (Section 3.2)	If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed. The pest is reported in some part of the EU territory	The actual distribution of the pathogen in the EU

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*P. ananatis* has been reported as a common member of the microbial communities, e.g. in Spain and Belgium. Therefore, it may be native of some areas of the EU or it has already entered and it may be further introduced and spread within the EU territory. The main pathways for the further entry of the pathogen into, and spread within the EU territory are: onion, rice and maize seeds, strawberry crowns and stolons, eucalypt plantlets. *P. ananatis* is present in the EU, which indicates that both the biotic (host availability) and abiotic (climate suitability) factors occurring in parts of the EU are favourable for the establishment of the pathogen. *P. ananatis* could potentially spread within the EU by both natural and human-assisted means.	None
Potential for consequences in the EU (Section 3.5)	Potential consequences might be expected on onion and rice.	The magnitude of the impact
Available measures (Section 3.6)	Measures are available to mitigate the risk of further entry, establishment, spread and impact.	None
Conclusion (Section 4)	The criteria assessed by EFSA for consideration as a potential quarantine pest are not fully met: 1) The pathogenic nature of *P. ananatis* is not fully established. 2) The pest distribution in the EU territory is most likely wider than currently reported. 3) Environmental and economic impacts on most reported hosts are not expected, except on onions.	
Aspects of assessment to focus on/scenarios to address in future if appropriate	In the near future, the presence of *P. ananatis* environmental populations in the EU territory should be assessed and studied, in order to determine their possible nature as a pathogen, or as an opportunist, or, alternatively, as a plant beneficial microorganism (PGPB) or a common saprotroph.	

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Abbreviations

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

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2021)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2021)
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, 2021)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2021)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2021)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2010).
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, 2021)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2021)
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, 2021)
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, 2021)
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, 2021)

Appendix A – *Pantoea ananatis* host plants/species affected

Host status	Host name	Plant family	Common name	Reference
Cultivated hosts	*Allium cepa*	Alliaceae	Onion	Gitaitis and Gay (1997)
	Ananas	Bromeliaceae	Pineapple	Serrano (1928)
	Aglaonema nitidum	Araceae	Aglaonema	Yazdani et al. (2018)
	Brassica rapa subsp. *pekinensis*	Brassicaceae	Chinese cabbage	Zhang et al. (2019)
	Citrus reticulata	Rutaceae	Mandarin	Das et al. (2020)
	Cucumis melo	Cucurbitaceae	Honeydew melon, Cantaloupe	Wells et al. (1987); Bruton et al. (1991)
	Cucumis sativus	Cucurbitaceae	Cucumber	Lao et al. (2022)
	Eucalyptus spp.	Myrtaceae	Eucalyptus	Coutinho et al. (2002)
	Fragaria x ananassa	Rosaceae	Strawberry	Abdel-Gayed et al. (2022)
	Mangifera indica	Anacardiaceae	Mango	Gutiérrez-Barranquero et al. (2019a)
	Prunus persica	Rosaceae	Peach	Liao et al. (2016)
	Pyrus x sinkiangensis	Rosaceae	Xinjiang pear	Wang et al. (2019)
	Sorghum bicolor	Poaceae	Sorghum	Cota et al. (2010)
	Sorghum sudanense	Poaceae	Sudangrass	Azad et al. (2000)
	Syngodium podophyllum	Araceae	Syngodium	Yazdani et al. (2018)
	Verbena bonariensis	Verbenaceae	Tall verbena	Gitaitis et al. (2002)
	Zea mays	Poaceae	Maize	Paccola-Meirelles et al. (2001)
	Zingiber officinale	Zingiberaceae	Ginger	Dohroo et al. (2013)
Wild weed hosts	*Amaranthus deflexus*	Amaranthaceae	Caruru	Martins et al. (2020)
	Cenchrus echinatus		Capim carrapicho	Martins et al. (2020)
	Digitaria horizontalis		Capim colchao	Martins et al. (2020)
Experimental hosts	*Avena sativa*	Poaceae	Oat	Azad et al. (2000)
	Gossypium spp.	Malvaceae	Cotton	Bell et al. (2007)
	Saccharum officinarum	Poaceae	Sugarcane	Serrano (1928)
	Pleurotus eryngii	Pleurotaceae	King oyster mushrooms	Kim et al. (2007)
	Citrullus lanatus	Cucurbitaceae	Watermelon	Walcott et al. (2003)
Survival as epiphyte/ endophyte in crop plants	*Populus* sp.	Salicaceae	Poplar	Gkorezis et al. (2016)
	Cyperus esculentus	Cyperaceae	Yellow nutsedge	Gitaitis et al. (2002)
	Glycine max	Fabaceae	Soybean	Gitaitis et al. (2002)
	Cynodon dactylon	Poaceae	Bermuda grass	Gitaitis et al. (2002)
	Vigna unguiculata	Fabaceae	Cowpea	Gitaitis et al. (2002)
Survival as epiphyte/ endophyte in weeds	*Acanthospermum hispidum*	Asteraceae	Bristly starbur	Giatitis et al. (2002)
	Amaranthus spinosus	Amaranthaceae	Spiny amaranth	Gitaitis et al. (2002)
	Ambrosia artemisifolia	Asteraceae	Common ragweed	Gitaitis et al. (2002)
	Brachiaria platyphylla	Poaceae	Signalgrass	Gitaitis et al. (2002)
	Brassica spp.	Brassicaceae	Wild radish	Gitaitis et al. (2002)
	Bromus catharticus	Poaceae	Rescue grass	Gitaitis et al. (2002)

Host status	Host name	Plant family	Common name	Reference
	Cassia obtusifolia	Fabaceae	Sicklepod	Gitaitis et al. (2002)
	Cynodon dactylon	Poaceae	Bermuda grass	Gitaitis et al. (2002)
	Desmodium tortuosum	Fabaceae	Florida beggarweed	Gitaitis et al. (2002)
	Digitaria sanguinalis	Poaceae	Crabgrass	Gitaitis et al. (2002)
	Geranium carolinianum	Geraniaceae	Carolina geranium	Gitaitis et al. (2002)
	Gnaphalium spp.	Asteraceae	Cudweed	Gitaitis et al. (2002)
	Jaquemontia tamnifolia	Convolvulaceae	Smallflower morningglory	Gitaitis et al. (2002)
	Mollugo verticillata	Molluginaceae	Green carpetweed	Gitaitis et al. (2002)
	Panicum texanum	Poaceae	Texas signalgrass	Gitaitis et al. (2002)
	Panicum virgatum	Poaceae	Switchgrass	Gagne-Bourgue et al. (2013)
	Paspalus urvillei	Poaceae	Vaseygrass	Gitaitis et al. (2002)
	Richardia scabra	Rubiaceae	Florida pusley	Gitaitis et al. (2002)
	Rumex crispus	Polygonaceae	Curly dock	Gitaitis et al. (2002)
	Stellaria media	Caryophyllaceae	Common chickweed	Gitaitis et al. (2002)
	Thlapsi arvense	Brassicaceae	Stinkweed	Gitaitis et al. (2002)
	Urochloa platiphylla	Poaceae		Duarte et al. (2020)
	Xanthium pennsylvanicum	Asteraceae	Common cocklebur	Gitaitis et al. (2002)

Appendix B – Distribution of *Pantoea ananatis*

Distribution records based on EPPO Global Database (EPPO, 2020, online), CABI CPC (CABI CPC, online).

Region	Country	Sub-national (e.g. state)	Status	
North America	Canada	Nova Scotia	Present, no details	CABI CPC (online)
	Guatemala		Present, no details	CABI CPC (online)
	Haiti		Present, no details	CABI CPC (online)
	Mexico		Present, no details	CABI CPC (online)
	Puerto Rico		Present, no details	CABI CPC (online)
	United States	California	Present, no details	CABI CPC (online)
		Colorado	Present, no details	CABI CPC (online)
		Georgia	Present, no details	CABI CPC (online)
		Michigan	Present, no details	CABI CPC (online)
		New York	Present, no details	CABI CPC (online)
		Texas	Present, no details	CABI CPC (online)
South America	Argentina		Present, no details	CABI CPC (online)
	Brazil	Minas Gerais	Present, no details	CABI CPC (online)
		Parana	Present, no details	CABI CPC (online)
		Santa Catarina	Present, no details	CABI CPC (online)
	Ecuador		Present, no details	CABI CPC (online)
	Guyana		Present, no details	CABI CPC (online)
	Venezuela		Present, no details	CABI CPC (online)
EU (27)	Italy		Present, no details	CABI CPC (online)
	Poland		Present, no details	CABI CPC (online)
	Spain	Canary Islands	Present, no details	CABI CPC (online)
Africa	Benin		Present, no details	CABI CPC (online)
	Burkina Faso		Present, no details	CABI CPC (online)
	Egypt		Present, no details	CABI CPC (online)
	Morocco		Present, no details	CABI CPC (online)
	Nigeria		Present, no details	CABI CPC (online)
	South Africa		Present, no details	CABI CPC (online)
	Togo		Present, no details	CABI CPC (online)
	Zimbabwe		Present, no details	CABI CPC (online)
Asia	Cambodia		Present, no details	CABI CPC (online)
	China	Hainan	Present, no details	EPPO (2020, online)
		Heilongjiang	Present, no details	CABI CPC (online)
		Henan	Present, no details	CABI CPC (online)
		Hubei	Present, no detail	EPPO (2020, online)
		Jiangxi	Present, no details	CABI CPC (online)
		Shandong	Present, no details	CABI CPC (online)
		Shanghai	Present, no details	CABI CPC (online)
		Sichuan	Present, no details	CABI CPC (online)
		Xinjiang	Present, no details	CABI CPC (online)
		Yunnan	Present, no details	CABI CPC (online)
		Zhejiang	Present, no details	CABI CPC (online)
	India	Haryana	Present, no details	CABI CPC (online)
		Himachal Pradesh	Present, no details	CABI CPC (online)
		Kerala	Present, no detail	EPPO (2020, online)
		Maharashtra	Present, no details	CABI CPC (online)
		Punjab	Present, no details	CABI CPC (online)
		Uttar Pradesh	Present, no details	CABI CPC (online)

Region	Country	Sub-national (e.g. state)	Status	
	Japan	Honshu	Present, no details	CABI CPC (online)
		Shikoku	Present, no details	CABI CPC (online)
	Malaysia	Peninsular Malaysia	Present, no details	CABI CPC (online)
		West	Present, no detail	EPPO (2020, online)
	Philippines		Present, no details	CABI CPC (online)
	Russia	Russian Far East	Present, localised	CABI CPC (online)
	South Korea		Present, no details	CABI CPC (online)
	Taiwan		Present, no details	CABI CPC (online)
	Thailand		Present, localised	CABI CPC (online)
	Türkiye		Present, no details	CABI CPC (online)
Oceania	Australia	Queensland	Present, no details	CABI CPC (online)