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SCIENTIFIC OPINION

Scientific Opinion on the risk to plant health of *Xanthomonas citri* pv. *citri* and *Xanthomonas citri* pv. *aurantifolii* for the EU territory[1]

EFSA Panel on Plant Health (PLH)[2, 3]

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ABSTRACT

The Panel conducted a pest risk assessment for *Xanthomonas campestris* (all strains pathogenic to *Citrus)* for the EU territory and an assessment of the effectiveness of present EU requirements against *Xanthomonas* strains pathogenic to citrus. The risk assessment was conducted under the scenario of absence of the current specific EU plant health legislation and the assumption that citrus-exporting countries apply measures to reduce yield and quality losses. Risk reduction options were systematically identified and evaluated. The strains of *X. campestris* pathogenic to citrus have been reclassified as four distinct infraspecific taxa within two species: *X. citri* and *X. alfalfae.* Only two pathovars (*X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*) are responsible for the citrus bacterial canker that presents a major risk for the citrus industry in the EU. Seven entry pathways have been identified and evaluated. The likelihood of entry was rated unlikely for fruit, very likely for fruit plants for planting, moderately likely for ornamental plants for planting and unlikely for leaves and twigs. The uncertainty of probability of entry was rated as high. The probability of establishment was rated as moderately likely to likely with a medium uncertainty because host plants are widely present in EU areas where environmental conditions are suitable. Once established, spread would be likely with a low uncertainty. The impact of the disease, even if control measures are applied, was rated as moderate to major with a medium uncertainty. The disease would cause yield losses in areas where citrus is the main crop, increase the need for control measures and create environmental problems.The combined EU regulations have been shown to be effective in preventing the introduction of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the EU, as no outbreaks of citrus canker in the EU territory have been reported.

KEY WORDS

Xanthomonas citri pv. *citri*, *Xanthomonas citri* pv. *aurantifolii*, citrus canker, European Union, pest risk assessment, risk reduction options

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SUMMARY

Following a request from the European Commission, the Panel on Plant Health has been asked to deliver a Scientific Opinion on the pest risk posed by *Xanthomonas campestris* (all strains pathogenic to *Citrus)* for the EU territory, to identify risk management options and to evaluate their effectiveness in reducing the risk to plant health posed by this harmful organism. In particular, the Panel has been asked to provide an opinion on the effectiveness of the present EU requirements against *X. campestris* (all strains pathogenic to *Citrus*), which are listed in Annexes III, IV and V of Council Directive 2000/29/EC[4] as well as in Commission Decision 2004/416/EC[5] and Commission Decision 2006/473/EC[6], in reducing the risk of introduction of this pest into the EU territory. In addition the Panel has been asked to provide, guidance on the right denomination of this harmful organism. The Panel has been also asked to address the comments submitted in April 2012 by the US phytosanitary authorities in response to the recent EFSA opinion on a US request regarding the export of Florida citrus fruit to the EU (EFSA PLH Panel, 2011). However the comments are not addressed in this opinion as they have been addressed in a separate document (EFSA PLH Panel, 2013).

The strains of *X. campestris* pathogenic to *Citrus* have been reclassified as four distinct taxons within two distinct species. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are the two bacteria responsible for citrus canker disease and the only ones significantly impacting the citrus industry. *X. alfalfae* subsp. *citrumelonis and X. citri* pv. *bilvae* are not responsible for citrus canker.

Citrus bacterial canker (CBC) caused by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, presents a major risk to the EU territory for the citrus industry because the causal agents of the disease have the potential for causing consequences in the risk assessment area once they establish as hosts are present and the environmental conditions are favourable. Citrus is a major crop in Mediterranean countries where the environmental conditions required for the establishment of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are potentially met in many places. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have never been reported in the EU territory.

The Panel conducted the risk assessment following the general principles of the "Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options" (EFSA PLH Panel, 2010) and of the "Guidance on evaluation of risk reduction options" (EFSA PLH Panel, 2012). The Panel conducted the risk assessment considering the scenario of absence of the current requirements against *X. campestris* (all strains pathogenic to *Citrus),* which are listed in Annexes II, III, IV and V of Council Directive 2000/29/EC, as well as in Commission Decision 2004/416/EC, Commission Decision 2006/473/EC and Commission Implementing Decision 2013/67/EU[7]. However it is assumed that citrus-exporting countries apply measures to reduce yield and quality losses.

After consideration of the evidence, the Panel reached the following conclusions:

With regard to the assessment of the risk to plant health for the EU territory:

Under the scenario of absence of the current specific EU plant health legislation and the assumption that citrus-exporting countries apply measures to reduce yield and quality losses, the conclusions of the pest risk assessment are as follows:

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

[5] Commission Decision 2004/416/EC of 29 April 2004 on temporary emergency measures in respect of certain citrus fruits originating in Argentina or Brazil. OJ L 151, 30.4.2004, p. 76–80.

[6] Commission Decision 2006/473/EC of 5 July 2006 recognising certain third countries and certain areas of third countries as being free from Xanthomonas campestris (all strains pathogenic to Citrus), Cercospora angolensis Carv. et Mendes and Guignardia citricarpa Kiely (all strains pathogenic to Citrus). OJ L 187, 8.7.2006, p. 35–36.

[7] Commission Implementing Decision 2013/67/EU of 29 January 2013 amending Decision 2004/416/EC on temporary emergency measures in respect of certain citrus fruits originating in Brazil. OJ L 31, 31.1.2013, p. 75-76.

Entry

For fruit:

- The association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruit imported within the EU from countries where citrus canker is reported. The association with the passenger pathway is rated likely to very likely based on the lack of control measures through regulation and packinghouse processes for domestic markets as well as a lower awareness of the disease by passengers.
- The ability of bacteria to survive during transport, verified by the isolation of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, is rated very likely.
- The probability of the pest surviving existing management procedure is very likely, since cultural practices and chemical treatments (pre- and post-harvest) currently applied at the place of origin cannot eliminate the pathogen and no specific measures are currently in place in the risk assessment area.
- The probability of transfer to a suitable host is rated unlikely, based on the literature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur (i) because of occurrence of climatic conditions suitable for the transfer, (ii) the reports of infections from inoculum available at soil level owig to the short distance between tree canopy and soil in the risk assessment area and (iii) because of th presence of waste near to orchards.

Because transfer is critical and a limiting factor, the probability of entry is rated as unlikely for fruit.

For leaves and twigs, the probability of entry is rated unlikely because:

- The association with the pathway at origin is likely because leaves and cut twigs are imported from where the disease is endemic but the volume of citrus leaves is very low in comparison with citrus fruit imported within the EU from countries where citrus canker is reported;
- The ability to survive during transport is very likely.
- The probability of the pest surviving existing management procedure is very likely, since no management practices are currently undertaken in the risk assessment area.
- The probability of transfer to a suitable host is rated unlikely.

For plants for planting for citrus fruit production and for ornamental rutaceous plants that are natural hosts for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, through both the commercial trade and passengers pathways, the probability of entry is rated as likely because:

- The association with the pathway at origin is rated as likely for plants for planting for citrus production, through both the commercial trade and passengers pathways, because plants for planting have been recorded in the past as a source for outbreaks and based on the expected level importation of plants for planting from countries where citrus canker is reported.
- The association with the pathway at origin is rated as moderately likely for plants for planting for other rutaceous plants, through both the commercial trade and passengers pathways, owing to the lack of recent information on rutaceous ornamental host plants' susceptibility and a real difficulty in evaluating the level of trade under a hypothetically unregulated pathway.
- As for the fruit pathways, the ability to survive during transport is very likely.
- The probability of the pest surviving any existing management procedure is very likely since no specific measure is currently (prohibition excepted) in place in the risk assessment area as it is free of citrus canker. This probability would be even higher in the case of plants or plant parts imported through the passenger pathway.

- The probability of transfer to a suitable host is rated as very likely, based on the intended use of the plant material for planting (rootstocks) or grafting (scions, budwood) as well as on the fact that citrus (for fruit or ornamentals) and other rutaceous hosts are extensively grown in the risk assessment area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of amateur gardeners who are likely to import through passenger traffic.

The uncertainties of probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are rated as high and are due to:

- The role of infected citrus fruit/peel and leaves present in the vicinity of susceptible plants as a source of primary inoculum allowing the transfer to a suitable host remains poorly documented. The two papers published on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of many more experimental data.
- Partial data on the presence and distribution of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country of origin.
- There is globally a lack of knowledge on sources of primary inoculum associated with outbreaks in areas where *X. citri* pv. *citri* was not endemic.
- The rate of infection of citrus fruit imported from countries where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present and the concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments are difficult to assess because they are highly dependent on variable environmental conditions at the place of production and they are also dependent on the technologies implemented by exporting countries in the field and in packinghouses. The numerous interceptions in the EU of consignments containing diseased fruit suggest a lack of total reliability of the integrated measures that are taken in a systems approach for eliminating the risk of exporting contaminated and/or diseased fruit.
- The extent of importation of citrus material via passenger traffic is not well documented.
- The susceptibility of ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus* to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the latent infection and/or endophytic and/or epiphytic presence of *X. citri* pv. *citri* in ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus*.

Establishment

The probability of establishment is rated as moderately likely to likely because host plants are widely present in some areas of the risk assessment area where environmental conditions are frequently suitable. The host is susceptible during most of the year to infection through wounds and for shorter periods through natural openings (two to three growth flushes except for some lemon and lime cultivars), and some severe weather events potentially promoting establishment occur on a regular basis in the risk assessment area. Cultural practices and control measures against fungal diseases currently used in the risk assessment area may reduce the severity of the disease but they cannot prevent the establishment of the pathogen. The pathogen would not require pathological adaptation to become established when it encountered a susceptible host.

Uncertainty on the probability of establishment is rated medium because information on the occurrence of suitable host in the risk assessment area is well documented. However, pieces of information are missing on the type of irrigation systems employed across orchards in the EU and the plant host susceptibility under environmental conditions that occur where citrus are grown in the risk assessment area. Furthermore, uncertainties remain on the efficacy of cultural practices and control measures in use in European groves and nurseries.

Spread

Once established in areas where citrus plants are grown, spread would be likely. Natural dispersal on a low to medium scale would primarily be driven by splashing, aerosols and wind-driven rain. Some weather events such as thunderstorms, which occur infrequently but on a regular basis in Southern Europe, have the ability to spread *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* over longer distances (i.e. approximately up to a kilometre). Human activities would favour spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* whatever the scale considered. This would primarily be through movement of contaminated or exposed plant material, including fruit, and through machinery, clothes, and tools polluted by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* during grove or nursery maintenance operations. Human-driven unintentional spread could also be due to the massive presence of citrus trees in streets and private and public gardens that can serve as a pathway for dissemination of the pest.

Uncertainty on the probability of spread is rated as low. Citrus canker has the ability to spread at small to medium spatial scales in relation to weather events similar to that reported in the pest risk area (e.g. Argentina). Practices and citrus varieties used in the risk assessment area are similar to those used in countries where the disease occurs. Human-assisted spread would undoubtedly contribute to the spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*.

Endangered areas

Citrus plants are widely available as commercial crops in parts of the risk assessment area (Figure 5 in section 3.1.4.2). Citrus plants are commonly grown in Southern Europe, in eight countries: Spain (314 908 ha), Italy (112 417 ha), Greece (44 252 ha), Portugal (16 145 ha), Cyprus (3 985 ha), France (1 705 ha), Croatia (1 500 ha) and Malta (193 ha). Citrus nurseries dedicated to fruit production and ornamentals are located in the same areas as citrus groves (Spain 10 665 000 trees/year; Italy 5 771 000 trees/year; Portugal 844 000 trees/year; Greece 826 000 trees/year and France 819 000 trees/year). Moreover, citrus are commonly available in these countries in city streets and public and private gardens. Citrus production regions in the EU correspond to hardiness zones 8 to 10. Based on the current worldwide distribution of citrus canker, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have the ability to establish in hardiness zones 8 to 12. So, all citrus-growing areas within the EU are considered as the endangered area.

Consequences

Based on the above, the impact of the disease, even if control measures are used, could be moderate to major should *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* enter and establish in the risk assessment area. The disease would cause losses of yield and require costly control measures. It would have negative social consequences in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies would reduce their access to some markets. The occurrence of the disease would lead to increased chemical application in groves and to the use of copper compounds that would create environmental concerns such as copper accumulation in the soil and selection of resistance genes that could spread in the plant associated microflora and beyond.

Once CBC enters the risk assessment area, uncertainties on the assessment of consequences would be rated as medium because, even though eradication would probably be a valuable option, it is uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions occurring in the risk assessment area.

With regard to risk reduction options:

Currently *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are not known to occur in the territory of the EU. Once established, spread of the bacteria is difficult to control, hence risk reduction options to reduce the probability of entry are the main means to maintain the absence of this pest. The enormous investment to prevent outbreaks and for eradication in response to outbreaks of citrus canker made by various countries (Gottwald et al., 2002a; Alam and Rolfe, 2006; Gambley et al., 2009) highlights the importance of maintaining the absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in citrus-producing areas and of the risk reduction options to maintain this absence.

The effectiveness of current EU phytosanitary measures to reduce the risk of introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* ranges from moderate to high. However, the requirements for buffer zones of pest free production sites in areas infested by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are insufficiently detailed.

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of plants for planting for citrus production and of ornamental rutaceous plants (species listed in section 3.1.1.4) is rated as likely. Prohibition of import of host plants for planting is the most reliable option to reduce the risk of entry, with the exception of small consignments of plants for planting for breeding and selection purposes under strict post-entry quarantine conditions (as described in Directive 2008/61/CE).

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of citrus fruit by commercial trade is rated as unlikely, but there is a high uncertainty about its transfer to suitable hosts in the EU territory. To reduce the risk associated with the high uncertainty, the large import volumes and the moderate to major consequences of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, options have been identified to reduce the probability of entry via this pathway. The current measures to prevent entry to the EU are evaluated as effective. As some fruit lots are intercepted at EU borders from time to time, one can consider that exporting countries may have difficulty with always complying with EU regulations. Additional options are suggested to further reduce the risk of entry.

The entry of fruit or other material infected with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, carried by passengers, poses a risk for entry and establishment, but effective risk reduction options have not been identified. Communication to increase public awareness and responsibility is recommended.

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of citrus and rutaceous leaves and twigs through commercial trade is rated as unlikely, but there is a high uncertainty about the transfer of the bacteria to suitable hosts in the EU territory. Currently the import of leaves of *Citrus*, *Poncirus* and *Fortunella* is prohibited by Council Directive 2000/29/EC, but, despite this regulation, there is a large number of interceptions of citrus leaves imported via undeclared packages and passenger baggage.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

The current European Union plant health regime is established by Council Directive 2000/29/EC on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community (OJ L 169, 10.7.2000, p. l).

The Directive lays down, amongst others, the technical phytosanitary provisions to be met by plants and plant products 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, the list of harmful organisms whose introduction into or spread within the Union is prohibited and the control measures to be carried out at the outer border of the Union on arrival of plants and plant products.

Citrus canker is a serious disease of cultivated citrus plants caused by the strains pathogenic to *Citrus* of the bacterium *Xanthomonas campestris* (synonym: *Xanthomonas axonopodis* pv. *citri*). Losses due to citrus canker primarily result from defoliation, premature fruit abscission and blemished fruit, which has a reduced market value as fresh fruit. This pathogen is not known to occur in the EU and therefore it is very relevant to prevent its introduction into the EU through appropriate phytosanitary regulation.

Xanthomonas campestris (all strains pathogenic to *Citrus*) is a regulated harmful organism in the EU, listed in Annex IIAI of Council Directive 2000/29/EU. Annexes III; IV AI and VB of that Directive list requirements for the introduction into the EU of citrus plants, including fruits, which could be a pathway for the entry of this pathogen. In addition, temporary emergency are in place which impose additional requirements for the import of certain citrus fruits from Brazil in connection with *Xanthomonas campestris* (all strains pathogenic to *Citrus*) (Commission Decision 2004/416/EC; OJ L 151, 30.4.2004, p. 76).

In spite of the present import requirements against *Xanthomonas campestris* (all strains pathogenic to *Citrus*), infested citrus fruit is often intercepted during import inspections. In order to carry out an evaluation of the present EU requirements against *Xanthomonas campestris* (all strains pathogenic to *Citrus*), a pest risk analysis covering the whole territory of the EU is needed, which takes into account the latest scientific and technical knowledge for this organism. The work on citrus canker funded by EFSA in the context of the recent Prima Phacie project ('Pest risk assessment for the European Community plant health: A comparative approach with case studies') is expected to be valuable for the preparation of this pest risk analysis.

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

EFSA is requested, pursuant to Article 29(1) and Article 22(5) of Regulation (EC) No 178/2002, to provide a pest risk assessment of *Xanthomonas campestris* (all strains pathogenic to *Citrus),* to identify risk management options and to evaluate their effectiveness in reducing the risk to plant health posed by this harmful organism. The area to be covered by the requested pest risk assessment is the EU territory. In the risk assessment EFSA is also requested to provide an opinion on the effectiveness of the present EU requirements against *Xanthomonas campestris* (all strains pathogenic to *Citrus),* which are listed in Annex III, IV and V of Council Directive 2000/29/EC, as well as in Commission Decision 2004/416/EC and Commission Decision 2006/473/EC, in reducing the risk of introduction of this pest into the EU territory. In addition, guidance on the right denomination of this harmful organism should be included. In its Scientific Opinion EFSA is requested to address the comments submitted in April 2012 by the US phytosanitary authorities in response to the recent EFSA opinion on a US request regarding the export of Florida citrus fruit to the EU (EFSA Journal 2011;9(2):2461).

ASSESSMENT

1. Introduction

1.1. Purpose

This document presents a pest risk assessment prepared by the EFSA Scientific Panel on Plant Health (hereinafter referred to as the Panel) for *Xanthomonas citri* pv. *citri and Xanthomonas citri* pv. *aurantifolii*, in response to a request from the European Commission. The opinion includes identification and evaluation of risk reduction options in terms of their effectiveness in reducing the risk posed by this organism. In addition, guidance on the right denomination of this harmful organism is included. The comments submitted in April 2012 by the US phytosanitary authorities in response to the recent EFSA opinion on a US request regarding the export of Florida citrus fruit to the EU (EFSA Journal 2011; 9(2):2461) are not addressed in this opinion as they have been addressed in a separate document (EFSA PLH Panel, 2013).

1.2. Scope

This risk assessment covers *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*. *X. alfalfae* subsp. *citrumelonis* and *X. citri* pv. *bilvae*, which are not responsible for citrus canker, are not included in this pest risk assessment (see section 3.1.1).

As requested by the European Commission, the pest risk assessment area is the territory of the European Union (hereinafter referred to as the EU) restricted to the area of application of Council Directive 2000/29/EC.

2. Methodology, data and public consultation

2.1. Methodology

2.1.1. Guidance documents

The risk assessment has been conducted in line with the principles described in the document "Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options" (EFSA PLH Panel, 2010). The evaluation of risk reduction options has been conducted in line with the principles described in the above-mentioned guidance (EFSA PLH Panel, 2010), as well as with the "Guidance on methodology for evaluation of the effectiveness of options to reduce the risk of introduction and spread of organisms harmful to plant health in the EU territory" (EFSA PLH Panel, 2012).

In order to follow the principle of transparency as described under Paragraph 3.1 of the Guidance document on the harmonised framework for risk assessment (EFSA PLH Panel, 2010)—"… Transparency requires that the scoring system to be used is described in advance. This includes the number of ratings, the description of each rating …"—the Panel has developed rating descriptors to provide clear justification when a rating is given, which are presented in Appendix A of this opinion.

When statements are based on expert judgement and/or personal communications, justification and evidence are provided to support the statements. Personal communications have been considered only when in written form and supported by evidence and when other sources of information were not publicly available.

2.1.2. Methods used for conducting the risk assessment

The Panel conducted the risk assessment considering the scenario of absence of the current requirements against *X. campestris* (all strains pathogenic to *Citrus)*, which are listed in Annexes II, III, IV and V of Council Directive 2000/29/EC, as well as in Commission Decision 2004/416/EC, Commission Decision 2006/473/EC and Commission Implementing Decision 2013/67/EU. However it is assumed that citrus-exporting countries apply measures to reduce yield and quality losses.

The conclusions for entry, establishment, spread and impact are presented separately. The descriptors for qualitative ratings given for the probabilities of entry and establishment and for the assessment of impact are shown in Appendix A.

2.1.3. Methods used for evaluating the risk reduction options

The Panel identifies potential risk reduction options and evaluates them with respect to their effectiveness and technical feasibility, i.e. consideration of technical aspects which influence their practical application. The evaluation of the efficiency of risk reduction options in terms of the potential cost-effectiveness of measures and their implementation is not within the scope of the Panel evaluation. The descriptors for qualitative ratings given for the evaluation of the effectiveness and technical feasibility of risk reduction options are shown in Appendix A.

2.1.4. Level of uncertainty

For the risk assessment conclusions on entry, establishment, spread and impact, and for the evaluation of the effectiveness of the risk reduction options, the levels of uncertainty have been rated separately. The descriptors for qualitative ratings given for the level of uncertainty are shown in Appendix A.

2.2. Data

2.2.1. Literature search

The Panel made use of the extensive bibliographic collection on citrus canker already gathered for the EFSA Opinions in 2006 and 2011and focused the literature search on publications that had appeared more recently. Literature searches were performed consulting several sources such as ISI Web of Knowledge database including Web of Science, PubMed, Current Content Connect, CABI CAB Abstracts, Food Science and Technology Abstracts and Journal Citation Reports. Searches on the Internet were also carried out.

Among the documents that were consulted to support the risk assessment activity, peer-reviewed publications, PhD theses and technical reports from national authorities were included.

2.2.2. Data collection

For the purpose of this opinion, the following data were collected and considered:

- For the evaluation of the probability of entry and spread of the organism in the EU, the EUROSTAT and FAOSTAT databases were consulted in order to obtain information on trade movements for the relevant pathways.
- For the evaluation of the probability of entry, the EUROPHYT database was consulted, searching for pest-specific and/or host-specific notifications on interceptions. EUROPHYT is a web-based network launched by DG Health and Consumers Protection, and is a sub-project of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. EUROPHYT database manages notifications of interceptions of plants or plant products that do not comply with EU legislation.
- For the weather data, the European Severe Weather Database was consulted.
- For rutaceous plant taxonomy, the Species 2000 (online) and the USDA-GRIN (online) databases were consulted.
- In order to collect data on the number of inspected consignments of citrus fruit, a request was sent to the EU national plant protection organisations (NPPOs).

- For the development of maps expressing the monthly percentage of hours with suitable weather conditions, weather data from agrometeorological station and interpolated climate data from JRC, as described in the previous EFSA opinion on citrus black spot (EFSA, 2008), were used.
- In a document dated April 2012 (USDA, 2012), the US phytosanitary authorities provided the EC with responses to the EFSA opinion on the US request regarding the export of Florida citrus fruit to the EU (EFSA PLH Panel, 2011). Further information was provided and discussed at the technical meeting with USDA APHIS on citrus canker held on 20 March 2013 (EFSA, 2013).

2.3. Public consultation

The Panel has undertaken a public consultation on the draft opinion. Following the endorsement of the draft opinion by the Panel, the public consultation was launched on 31 July 2013 and closed on 12 September 2013. The comments received provided further specific insights and indicated further potential issues, and the Panel considers that these enhanced the quality and clarity of the document. The relevant comments were taken into account and the Scientific Opinion was revised accordingly.

EFSA has made a commitment to publish a technical report on the outcome of the public consultation on the draft opinion. This technical report (EFSA, 2014) summarises the comments received through the public consultation and presents the responses of the Panel to the comments.

3. Pest risk assessment

3.1. Pest categorisation

3.1.1. Identity of pest

3.1.1.1. Taxonomic position and biological properties

Council Directive 2000/29/EC used the *Xanthomonas* nomenclature that was in place before the reclassification of the genus in 1995 (Dye and Lelliott, 1974; Vauterin et al., 1995) and the subsequent international research done later on *Xanthomonas* taxonomy (Vauterin and Swings, 1997; Rademaker et al., 2000; Young et al., 2008; Rodriguez et al., 2012). The strains of *X. campestris* pathogenic to citrus have been reclassified as distinct species and also differ markedly in terms of symptomatology, host range and economic significance (Table 1).

Table 1: Temporal evolution of the taxonomy of xanthomonads pathogenic to rutaceous species and associated diseases

<table>
<tr><td rowspan="6">Taxonomy</td><td>Dye and Lelliott, 1974</td><td colspan="4">Xanthomonas campestris</td></tr>
<tr><td>Vauterin et al., 1995</td><td colspan="4">Xanthomonas axonopodis</td></tr>
<tr><td>Rademaker et al., 2000, 2005</td><td>9.2[(a)]</td><td colspan="2">9.5[(a)]</td><td>9.6[(a)]</td></tr>
<tr><td>Schaad et al., 2005, 2006</td><td>X. alfalfae</td><td colspan="2">X. citri</td><td>X. fuscans</td></tr>
<tr><td>Ah-You et al., 2009
Rodriguez et al., 2012</td><td></td><td colspan="3">X. citri</td></tr>
<tr><td>Infraspecific classification</td><td>pv. citrumelo (subsp. citrumelonis)</td><td>pv. bilvae</td><td>pv. citri (subsp. citri)</td><td>pv. aurantifolii (subsp. aurantifolii)</td></tr>
<tr><td rowspan="3">Diseases</td><td>Disease name</td><td colspan="2">Bacterial spot</td><td colspan="2">Citrus canker [(b)]</td></tr>
<tr><td>Distribution</td><td>Florida</td><td>India</td><td>Most production areas</td><td>South America</td></tr>
<tr><td>Impact</td><td>Negligible</td><td>Negligible</td><td>Major</td><td>Low</td></tr>
</table>

(a): Numbers refer to genetic clusters.
(b): Two forms of canker are usually cited in the literature. Asiatic canker and South American canker refer to pvs *citri* and *aurantifolii*, respectively.

<u>Xanthomonads causing citrus bacterial canker (CBC) symptoms</u>

X. campestris pv. *citri* pathotype A is the causal agent of Asiatic citrus canker. This pathogen groups into genetic cluster 9.5 of *X. axonopodis sensu* Vauterin et al. (1995) (Rademaker et al., 2000). It has been reclassified as *X. citri* pv. *citri* (synonyms *X. citri* subsp. *citri* or *X. axonopodis* pv. *citri*— – Table 1) (Vauterin et al., 1995; Schaad et al., 2006; Ah-You et al., 2009). Variants of *X. citri* pv. *citri*, which are phylogenetically very close but pathologically distinct in terms of host range, have been reported as pathotypes A*/A^{w} (Table 2) (Vernière et al., 1998; Sun et al., 2004; Bui Thi Ngoc et al., 2009, 2010).

X. campestris pv. *citri* pathotype B/C/D has been reported as the causal agent of South American citrus canker (Table 2). Pathotype D had been originally reported in 1981 from Mexico as the causal agent of a leaf and twig spot disease of Mexican lime, but the causal agent has now been identified as *Alternaria limicola* (Rodriguez et al., 1985; Palm and Civerolo, 1994). These strains group into genetic cluster 9.6 of *X. axonopodis sensu* Vauterin et al. (1995) and have been reclassified in 2006 as *X. fuscans* subsp. *aurantifolii* (synonyms *X. citri* pv. *aurantifolii* or *X. axonopodis* pv. *aurantifolii*) (Vauterin et al., 1995; Schaad et al., 2006; Ah-You et al., 2009). However, recent data did not support *X. fuscans* as a separate species (Young et al., 2008) and suggested that it may be a later heterotypic synonym of *X. citri* (Ah-You et al., 2009). This was further confirmed by a pangenomic phylogeny of the genus *Xanthomonas* (Rodriguez et al., 2012).

Table 2: Pathovar, pathotype classification and host range of xanthomonads causing citrus canker

Species	***Xanthomonas citri***			
Pathovar[(a)]	*citri*		*aurantifolii*	
Pathotype	A	A* (A^{w})	B	C
Disease	Asiatic canker		South American canker	
Host range	*Citrus* spp. [(b)] Several other rutaceous genera [(c)]	***C. aurantifolia*** *C. macrophylla* (*C. latifolia*) (*C. sinensis*, *C. paradisi*) [(d)]	***C. aurantifolia*** *C. limon* *C. aurantium* *C. limonia* *C. limettioides* (*C. sinensis*)	***C. aurantifolia*** (*P. trifoliata* x *C. paradisi*)

Bold characters: main host species in field conditions; in brackets: host species rarely infected in the field.

(a): A pathovar is an infra-species taxon. "The term pathovar is used to refer to a strain or set of strains with the same or similar characteristics, differentiated at infrasubspecific level from other strains of the same species or subspecies on the basis of distinctive pathogenicity to one or more plant hosts" (Young et al., 1991; Young et al., 2001).

(b): With differential host susceptibility among species and/or cultivars. Many commercial cultivars range from susceptible to very susceptible (Gottwald et al., 2002a).

(c): Refer to section 3.1.1.4. where the host range is explained.

(d): Reported for strains originating from Iran (Escalon et al., 2013).

<u>Xanthomonads causing watersoaked spots symptoms</u>

X. campestris pv. *citri* pathotype E, the causal agent of citrus bacterial spot in Florida, has a symptomatology markedly different from that of citrus canker (Figure 1). Symptoms consist of flat, watersoaked spots evolving into necrotic lesions and are most often visible on citrumelo rootstock (*Citrus paradisi* × *Poncirus trifoliata*) and its parents (Graham and Gottwald, 1991). Moreover, this bacterium has been reclassified as *X. alfalfae* subsp. *citrumelonis* (syn. *X. axonopodis* pv. *citrumelo* genetic cluster 9.2) (Vauterin et al., 1995; Rademaker et al., 2005; Schaad et al., 2006). *X. alfalfae* subsp. *citrumelonis* should therefore be considered a pathogen distinct from *X. citri* and the associated disease, citrus bacterial spot, a disease distinct from citrus canker. Citrus bacterial spot is a minor pathogen that has no agricultural significance in Florida and that has never been reported from any other country (Graham and Gottwald, 1991; Stall and Civerolo, 1991).

Figure 1: Citrus bacterial spot leaf lesions caused by *Xanthomonas alfalfae* subsp. *citrumelonis*.
(A**)** Leaf lesions on citrumelo (*Citrus paradisi* × *Poncirus trifoliata*) caused by the aggressive strain type (F1-like)—credit Dr James Graham, University of Florida. (B) Close-up showing shothole-like leaf lesions on grapefruit caused by the moderately aggressive strain type (F6-like)—credit Dr Dan Robl, USDA-ARS. (C) Fruit lesions on the rootstock species trifoliate orange (*Poncirus trifoliata*) caused by aggressive strain type (F1-like)—credit Dr James Graham, University of Florida. Fruit lesions are uncommon for this pathosystem (Graham et al., 1992). Lesions caused by *X. citri* pv. *bilvae* in India are morphologically similar to that caused by *Xanthomonas alfalfa* subsp. *citrumelonis*

Similar to *X. alfalfae* subsp. *citrumelonis* in terms of symptomatology, *X. campestris* pv. *bilvae* produces flat, watersoaked spots evolving into necrotic lesions on *Aegle*, *Feronia* and Mexican lime (*Citrus aurantifolia*) (Patel et al., 1953; Bui Thi Ngoc et al., 2010). A single report of this pathogen has been made from India (Patel et al., 1953) and not further confirmed. There are no indications of outbreaks caused by this bacterium worldwide. These strains group into genetic cluster 9.5 of *X. axonopodis sensu* Vauterin et al. (1995) and have been reclassified in 2010 as *X. citri* pv. *bilvae* (Bui Thi Ngoc et al., 2010).

The taxonomic and pathological features of the above-listed bacterial taxa are summarised in Table 1. Visual inspections would allow bacterial spot-like and citrus canker-like symptoms on leaves and fruit to be distinguished (Figures 1 and 2). Bacterial spot lesions are observed primarily on leaves and consist of necrotic, flat spots often with a watersoaked margin. These lesions can evolve as “shot-hole” symptoms. Fruit symptoms caused by *X. alfalfae* subsp. *citrumelonis* are extremely uncommon and are primarily observed on the rootstock species *Poncirus trifoliata*. They consist of necrotic spots often with sunken areas, watersoaked margins and typically chlorotic halos (Graham and Gottwald, 1991). Fruit symptoms caused by *X. citri* pv. *bilvae* also consist of necrotic spots, with crater-like depressions becoming noticeable in the centre of spots on ageing lesions. These fruit symptoms have been reported solely on *Aegle marmelos* (Patel et al., 1953). In contrast, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* induce raised, canker-like lesions on leaves, twigs and fruit with a typical “corky” appearance (detailed symptomatology is provided in section 3.1.1.2). Canker fruit symptoms may be confused by untrained inspectors with citrus scab (*Elsinoe fawcetti*), *Phaeoramularia* leaf and fruit spot disease (*Phaeoramularia angolensis*) or greasy spot (*Mycosphaerella citri*) (Figure 3) (Rossetti, 1981; Civerolo, 1984; Timmer et al., 2000). In the laboratory, all xanthomonads responsible for the above-listed bacterial diseases of citrus can be readily distinguished on the basis of several molecular techniques such as repetitive sequence-based polymerase chain reaction (rep-PCR) (Egel et al., 1991; Rademaker et al., 2005), amplified fragment length polymorphism (AFLP) (Janssen et al., 1996; Bui Thi Ngoc et al., 2010) and multilocus sequence analysis (MLSA) (Young et al., 2008; Almeida et al., 2010; Bui Thi Ngoc et al., 2010). The use of phenotypic tests is no longer recommended.

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* are considered as the two bacteria responsible for citrus canker disease. *X. alfalfae* subsp. *citrumelonis and X. citri* pv. *bilvae* are considered not to be responsible for citrus canker disease (Table 1). The subsequent sections of this document will be restricted to *X. citri* strains causing citrus bacterial canker (CBC). These canker strains are the only ones significantly impacting the citrus industry (Goto, 1992; Jetter et al., 2000; Spreen et al., 2003).

Preferred scientific name(s) *Xanthomonas citri* pv. *citri* (*ex* Hasse 1915) Gabriel et al., 1989; *Xanthomonas citri* pv. *aurantifolii* Ah-You et al., 2009.

<u>Other scientific names</u>

Xanthomonas citri subsp. *citri* Schaad et al., 2006

Xanthomonas axonopodis pv. *citri* (Hasse 1915) Vauterin et al., 1995

Xanthomonas fuscans subsp. *aurantifolii* Schaad et al., 2006

Xanthomonas axonopodis pv. *aurantifolii* Vauterin et al., 1995

Xanthomonas campestris pv. *aurantifolii* Gabriel et al., 1989

Xanthomonas campestris pv. *citri* (Hasse 1915) Dye, 1978

Xanthomonas citri f.sp. *aurantifoliae* Namekata and Oliveira, 1972

Xanthomonas citri (Hasse) Dowson, 1939

Phytomonas citri (Hasse) Bergey et al., 1923

Bacillus citri (Hasse) Holland, 1920

Bacterium citri (Hasse) Doidge, 1916

Pseudomonas citri Hasse, 1915

Figure 2: Asiatic citrus canker lesions on various aerial citrus organs.
(A) Leaf lesions (note the typical chlorotic halo surrounding lesions). (B) Fruit lesions on grapefruit. (C) Lesions on a green shoot. (D) Twig dieback typically observed on highly susceptible cultivars (here makrut lime, *Citrus hystrix*). (E) Canker lesions on the trunk of a young tree. (F) Leaf lesions associated with Asian citrus leafminer (*Phyllocnistis citrella*) galleries. Credit Drs Olivier Pruvost and Christian Vernière, CIRAD

Figure 3: Fruit lesions that could get confused with that of citrus canker by untrained inspectors.
(A) Citrus scrab lesions caused by *Elsinoe fawcettii* on Dancy mandarin (*Citrus reticulata*)—credit Dr Tim Riley, USDA-APHIS. (B) Phaeoramularia fruit spot caused by *Phaeoramularia angolensis* on sweet orange (*Citrus sinensis*)—credit A.A. Seif, ICIPE Kenya

English common name of disease

Preferred generic name: citrus bacterial canker (CBC). More specifically, Asiatic canker and South American canker refer to the disease caused by *X. citri* pv. *citri* and *X. citri* pv. a*urantifolii*.

Other names: bacterial canker of citrus, bacteriosis del limonero, cancrosis de los citricos, cancro citrico, Asiatic canker, canker A, cancrosis A, South American canker, false canker, canker B, cancrosis B, Mexican lime cancrosis, canker C.

Domain:	Bacteria
Phylum:	Proteobacteria
Class:	Gammaproteobacteria
Order:	Xanthomonadales
Family:	Xanthomonadaceae
Genus:	*Xanthomonas*
Species:	*Xanthomonas citri*

3.1.1.2. Symptomatology, biology and life cycle

Symptomatology

Extensive descriptions of the symptomatology and biology of *X. citri* pv. *citri* are available in several published reviews (Civerolo, 1984; Goto, 1992; Gottwald et al., 2002a; Graham et al., 2004). *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* share a similar symptomatology (Rossetti, 1981). All aerial citrus organs are susceptible to *X. citri* pv. *citri* (Figure 2). On leaves, lesions appear as small watersoaked spots, which turn into slightly raised blister-like lesions, the consequence of host cell enlargement (hypertrophy) and division (hyperplasia) in contact with the pathogen (Brunings and Gabriel, 2003). Lesions further evolve into raised, corky, canker-like lesions with a colour varying from beige to dark brown. Young lesions are often surrounded by small watersoaked margins while a chlorotic zone often surrounds aging leaf lesions. The morphology of symptoms on other organs is similar to that described for leaves. Fruit symptoms typically consist of raised and corky lesions. The aspect of fruit symptoms depends on the period of infection and lesions resulting from late infections can be relatively flat and not erumpent or only pustule-like, taking the shape of a pimple or a blister without any rupture of the epidermis (Fulton and Bowman, 1929; Koizumi, 1972; Civerolo, 1984). Such atypical symptoms (i.e. not erumpent or blister-like) can be observed on leaves of partially resistant cultivars (Falico de Alcaraz, 1986; Shiotani et al., 2008) and most frequently on fruit of these cultivars. The yellow halo surrounding lesions generally visible on young fruit is not visible on mature fruit. On twigs, small cankers with a small watersoaked margin are most often observed on herbaceous shoots of susceptible to very susceptible cultivars. No chlorotic halo is visible around twig cankers. More extensive cankers can typically cause twig dieback on very susceptible cultivars. Twig cankers remain visible (and infectious) for long periods on woody branches or trunk, including rootstock (Gottwald et al., 2002a; Graham et al., 2004).

Infection

Biological data are primarily available in the literature for *X. citri* pv. *citri*, but the life cycles of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are expected to be similar. *X. citri* pv. *citri* enters the plant tissue primarily through stomata, as well as wounds caused by wind, thorns, insects, grove or nursery maintenance operations. The estimated minimum and maximum temperature for bacterial multiplication following infection was 12 and 40 °C, respectively, with the most favourable temperature range being 25–35 °C (Dalla Pria et al., 2006). Infection may occur at lower temperatures (higher than 5 °C) and remain latent until temperature increases (Peltier, 1920). The length of the latent period is known to be primarily dependent on temperature, but also on growth stage of plant material, availability of wounds and amount of inoculum available (Koizumi, 1976; Civerolo, 1984). At temperatures highly conducive to disease development (25–35 °C), the length of the latent incubation period ranges from a few days to a week (depending on host, wound availability and inoculum), while it increases at lower temperatures. For example, spray inoculations of several citrus cultivars were performed at a susceptible growth stage with a suspension containing approximately 2×10^8 *X. citri* pv. *citri*/ml (Koizumi, 1976). Inoculated plants were kept in a growth chamber at a constant 21 °C or in a greenhouse whose mean temperature was approximately 20 °C and developed canker lesions 17–21 days after inoculation whatever the host genotype. There are no data on the latent period length on fruit, but its relationship with temperature is obvious. In this optimal temperature range, short leaf wetness durations allow a very efficient exudation of *X. citri* pv. *citri* from canker lesions that are readily available for infection (Timmer et al., 1991; Pruvost et al., 2002). Increasing leaf wetness duration increases disease severity (Dalla Pria et al., 2006). Under field conditions, lesions mostly develop during periods of rainfall (or overhead irrigation), medium to high temperatures and availability of susceptible tissues (vegetative flushes, and young, actively growing fruit). An extended dry season does not inhibit the seasonal development of citrus canker because, when the wet season arrives, new incidences of canker occur, as in the case in the Philippine islands (Peltier and Frederich, 1926). Recent observations of Asiatic citrus canker in Mali (Traoré et al., 2008) confirmed that extended dry periods (i.e. over approximately five to six consecutive months) and no overhead irrigation can lead to severe outbreaks and persistence of high levels of inoculum over the years (Vernière, personal communication, 2013). The bacterium multiplies in the intercellular spaces and induces cell enlargement (hypertrophy) and division (hyperplasia) among contacted host cells producing canker lesions on leaves, stems and fruit (Brunings and Gabriel, 2003). Lesion development and bacterial multiplication are related to host resistance (Koizumi, 1979). Resistance of leaves, stems and fruit generally increases with tissue age (Stall et al., 1982; Vernière et al., 2003). Leaves are most susceptible to stomatal infections when half to two-thirds expanded (Graham et al., 2004). Wound infection of leaves is successful over a much longer period of time (Vernière et al., 2003). Wounds (i.e. galleries) created by the Asian citrus leafminer, *Phyllocnistis citrella* enhance infection (Gottwald et al., 1997; Christiano et al., 2007; Gottwald et al., 2007). The presence of leafminer galleries on Tahiti lime (*C. latifolia*) leaves allows bacterial concentrations up to 1 000 times lower to initiate infections compared with infections of unwounded leaves through natural openings (Christiano et al., 2007).

The most critical period for fruit infection following pressurised spray inoculations is during the first 60–90 days after fruit set (i.e. 20–40 mm in diameter) (Graham et al., 1992; Vernière et al., 2003). But similar to leaves, wound inoculation of sweet orange cv. Pineapple (*C. sinensis*) fruit is successful over a longer period of time (ca. 120–150 days) than spray inoculation (ca. 60–80 days). Any infection that occurs after this time results in the formation of small and inconspicuous pustules (Fulton and Bowman, 1929; Vernière et al., 2003). Lesions did not expand when fruit > 60 mm in diameter were used for inoculations (Graham et al., 1992). Similarly, very young fruit (< 20 mm in diameter) were not so susceptible whatever the method of inoculation (Graham et al., 1992; Vernière et al., 2003). During infection from splash-driven inoculum, the upper surfaces of fruit surrounding the peduncles are more prone to infection (Bock et al., 2011).

<u>Survival in association with host tissue</u>

X. citri pv. *citri* primarily survives in diseased rutaceous tissues such as lesions on leaves, twigs, branches and fruit (Civerolo, 1984; Goto, 1992; Gottwald et al., 2002a; Graham et al., 2004). Culturable population sizes of approximately 10^5 cells of *X. citri* pv. *citri* per lesion were recovered from 18-month-old leaf lesions (Pruvost et al., 2002). *X. citri* pv. *citri* can survive for years in infected tissues that have been kept dry and free of soil (Das, 2003). Moreover, the pathogen can survive in diseased twigs (particularly on lesions formed on angular shoots) up to several years; thus, the pathogen survives from season to season mainly in the cankers on twigs and branches (Goto, 1992; Gottwald et al., 2002a; Graham et al., 2004). A marked decrease in population sizes in lesions was reported in association with temperature decreases in areas where a marked winter season occurs (Stall et al., 1980). In contrast, such a decrease in *X. citri* pv. *citri* population sizes is much more subtle in tropical areas and this decrease is more related to the age of lesions (Pruvost et al., 2002). Lesions on attached leaves and twigs maintain high inoculum density much longer than detached organs (Stall et al., 1980; Pruvost et al., 2002). Survival in diseased leaves that are incorporated into soil occurs for a few months at small population sizes (Gottwald et al., 2002a).

<u>Survival outside host tissue</u>

The ability of *X. citri* pv. *citri* to survive outside of citrus tissues is low: the bacterium survives for shorter periods (Graham et al., 2004). However, as little as two cells of *X. citri* pv. *citri* can produce a canker lesion when enforced in the intercellular spaces of the leaf mesophyll of a susceptible host (Gottwald and Graham, 1992). Most studies that assessed the asymptomatic survival of *X. citri* pv. *citri* were based on enumeration of culturable populations on semi-selective media, on a technique indirectly assessing bacterial population sizes through *X. citri* pv. *citri*-specific bacteriophage populations or through a leaf infiltration technique (Goto, 1992). A VBNC state has been suggested for *X. citri* pv. *citri* in response to copper ions (Del Campo et al., 2009) but the biological significance of VBNC *X. citri* pv. *citri* cells remains poorly understood. *X. citri* pv. *citri* was reported to survive asymptomatically at low population levels on citrus host surfaces or in association with non-citrus weed and grass plants (Goto, 1970, 1972; Goto et al., 1975, 1978; Leite and Mohan, 1987). This includes citrus fruit surfaces on which *X. citri* pv. *citri* could be detected at low population sizes (Gottwald et al., 2009). In nature, *X. citri* pv. *citri* cells that ooze onto plant surfaces can survive in rainwater and irrigation water. Water collected from diseased leaves contains bacterial populations between 10^5 and 10^8 cfu/ml (Goto, 1962; Stall et al., 1980; Timmer et al., 1996; Pruvost et al., 2002).On a larger time scale, *X. citri* pv. *citri* cells primarily survive when (i) they can enter citrus tissue through natural openings or wounds (i.e. initiate infection) or (ii) immobilized in a matrix as conglomerates of cells on plant surfaces as biofilms (Graham et al., 2004; Rigano et al., 2007). A recent study reporting the detection of *X. citri* pv. *citri* cells marked by unstable green-fluorescent protein suggests that planktonic cells of *X. citri* pv. *citri* die quickly on plant surfaces when plant material becomes dry, whereas aggregated cells (i.e. biofilms) remain viable (Cubero et al., 2011). It remains unclear which ratio of *X. citri* pv. *citri* populations associated with citrus tissues represents epiphytic populations versus latent infections (Stall and Civerolo, 1993; Timmer et al., 1996). In areas with a marked winter season, latent infections have been reported on shoots infected late in the autumn just before entering dormancy (Goto, 1992). Saprophytic survival of *X. citri* pv. *citri* in soil in the absence of plant tissue or debris has not been conclusively established and is probably transient and at small population sizes (Goto, 1970; Goto et al., 1975; Graham et al., 1987; Graham and Gottwald, 1989). Attempts to detect surviving *X. citri* pv. *citri* on various inert surfaces such as metal (representing vehicles, lawnmower blades, etc.), plastic (fruit crates), leather (gloves and shoes), cotton cloth (clothing), cotton gloves and processed wood (crates, ladders, etc.), bird feathers and animal fur, in both shade and sun, indicate that the bacterium dies within 24–72 hours depending on the environmental conditions (mainly humidity) (Graham et al., 2000). It was confirmed that the bacterium dies when the surface is dried, but before that there can be a significant time period of risk for transmission (Graham et al., 2000).

Spread

Splash dispersal of *X. citri* pv. *citri* is possible over short distances and can allow within-plant and between-plant localised spread on grove-established and nursery plants (Gottwald et al., 1989; Gottwald et al., 1992). Serizawa et al. (1969) estimated from indoor experiments that splash dispersal on seedlings is < 0.7 m, consistent with experimental data obtained later on (Pruvost et al., 2002). Another study documented infection of citrus (and disease development) through splash dispersal of *X. citri* pv. *citri* originating from asymptomatic sources (contaminated soil, rice straw, weeds) (Goto et al., 1978). Xanthomonads can also spread over small to medium distances as aerosols (Kuan et al., 1986; McInnes et al., 1988). Wind-driven rain readily spreads bacteria, usually over short distances, i.e. within trees or to neighbouring trees when wind speed reaches or exceeds 8 m/s (Serizawa et al., 1969; Serizawa and Inoue, 1975; Stall et al., 1980; Gottwald et al., 1988, 1992). The dispersal of *X. citri* pv. *citri* downwind of a canker-infected tree is not uniform (Bock et al., 2012). The bacterial flux is greater at lower height of the canopy but lateral spread increases with wind speed (Bock et al., 2012). *X. citri* pv. *citri* was successfully isolated from air samples collected at eradication sites in Florida, suggesting that debris generated by chipping machinery can locally spread *X. citri* pv. *citri* (Roberto et al., 2001). Although under normal, non-extreme weather conditions wind blown inoculum was detected up to 32 m from infected trees in Argentina, there is evidence for much longer dispersal in Florida, associated with meteorological events, such as severe tropical storms, hurricanes, and tornadoes (Stall et al., 1980; Gottwald and Graham, 1992; Gottwald et al., 2001). A distance of spread of up to 56 km was found in the county of Lee/Charlotte (Florida) as a result of a hurricane in 2004 (Irey et al., 2006). High wind speed increased both incidence and severity of citrus canker on two-year-old Swingle citrumelo with a dramatic increase following wind > 10–15 m/s (Bock et al., 2010). This was associated with visible leaf injury occurring at wind speed ≥ 13 m/s and the relationship between wind speed and leaf injury could be described by a logistic model (Bock et al., 2010).

The situation in Florida and Brazil was exacerbated by the presence of the Asian citrus leafminer, *Phyllocnistis citrella*, although this insect is not a significant vector but rather promotes infection by creating wounds (see above) (Christiano et al., 2007; Gottwald et al., 1997, 2007; Hall et al., 2010). This insect is widely present in citrus-producing regions of the EU-28 EPPO-PQR database (EPPO, online a). Because *X. citri* pv. *citri* survives for longer periods and at larger populations sizes in canker lesions (see above), the pathogen is more efficiently spread in association with diseased rather than exposed plant material. Long-distance spread of *X. citri* pv. *citri* occurs through the movement of diseased or contaminated propagating material (e.g. budwood, rootstock seedlings, budded trees including ornamental plants) (Das, 2003; Graham et al., 2004). Commercial shipments of diseased/contaminated fruit are also a means of long-distance movement (Golmohammadi et al., 2007), further confirmed by the numerous interceptions of diseased fruit consignments at entrance in the EU-28 based on the EPPO Reporting Service (EPPO, online b). Workers can carry bacteria within and among plantings on hands, clothes, vehicles and equipment/tools (budding, pruning, hedging and spray equipment) (Graham et al., 2004). This type of human-assisted dispersal will occur only within 72 hours because survival on inert surfaces is limited (Graham et al., 2004). There is no record of seed transmission (Das, 2003).

3.1.1.3. Detection and identification

Saprophytic xanthomonads can be occasionally isolated from citrus tissue (Stall and Minsavage, 1990; Behlau et al., 2012a). The reliable identification of citrus canker-causing strains is a key point, because of their quarantine status but also because of multiple pathovars and pathotypes similar in symptomatology but markedly different in host range and agricultural significance. Citrus plant material (and citrus relatives), especially fruit, is routinely inspected for disease symptoms (see above). Most analyses are culture dependent and these are performed on semi-selective (such as KC or KCB) or non-selective media (Graham and Gottwald, 1990; Pruvost et al., 2005). Identification of putative *Xanthomonas* colonies is best achieved by molecular methods. These include sequence-based analyses targeting housekeeping genes. Such analyses target either single gene portions (Parkinson et al., 2007) or best multiple genes in a format known as multilocus sequence analysis (MLSA) (Young et al., 2008; Almeida et al., 2010; Bui Thi Ngoc et al., 2010), which better addresses potential misidentification due to recombination. Other genotyping techniques, such as rep-PCR, AFLP and insertion sequence ligation-mediated PCR (IS-LM-PCR) have the potential to reliably achieve identification (Cubero and Graham, 2002; Bui Thi Ngoc et al., 2008, 2010). Identification can also be achieved by methods originally developed for detection, such as serological techniques or specific PCR-based assays.

Serological tests using polyclonal or monoclonal antibodies have been previously developed and can detect *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* (Civerolo and Fan, 1982; Alvarez et al., 1991). However, monoclonal antibodies raised against *X. citri* pv. *citri* failed to react with some pathotype A* strains (i.e. host range-restricted strains—see below) (Vernière et al., 1998) and could cross-react with unrelated xanthomonads (Alvarez et al., 1991). Moreover, enzyme-linked immunosorbent assays (ELISAs) are inadequate for detecting low bacterial population sizes but could be used from symptomatic material (Alvarez, 2004). Several PCR-based diagnostic tools were developed with the aim of specifically detecting *X. citri* pv. *citri* strains: primers KingF/R (Kingsley and Fritz, 2000), J-RXg/c2 (Cubero and Graham, 2002), Xac01/02 (Coletta-Filho et al., 2006), XACF/R (Park et al., 2006), or *X. citri* CBC-inducing strains, i.e. pvs *citri* and *aurantifolii* : primers 2/3 (Hartung et al., 1993), XCF/R (Miyoshi et al., 1998), 4/7 (Hartung et al., 1996), J-pth1/2 (Cubero and Graham, 2002) and VM3/4 (Mavrodieva et al., 2004). The primers targeted different sequences that were either located on the chromosome or plasmid borne. These sequences had an unknown function (primers 2/3 and 4/7) or were associated with pathogenicity (Xac01/02, J-pth1/2, VM3/4, XACF/R), or else they targeted transcribed or non-transcribed spacers of the rDNA operon (J-RXg/c2, XCF/R), or intergenic non-coding region (KingF/R). The specificity of these PCR primers was recently compared in the light of recent taxonomic data and all PCR primers completely lacked desirable features and suffered from inclusivity (i.e. the ability of the different primers to detect all strains of the target organism) and/or exclusivity (i.e. the capacity to generate negative responses from an extensive range of related but non-target strains including other *Xanthomonas* species or pathovars and supposedly saprophytic xanthomonads isolated from asymptomatic citrus) limitations. Nevertheless, these issues could be improved by using at least two primer pairs (Delcourt et al., 2013). Real-time PCR assays have a number of advantages over conventional PCR in addition to quantifying target DNA, and particularly are more sensitive and can be more specific than conventional PCR when using a TaqMan probe assay, which can detect single nucleotide polymorphisms. Several real-time PCR assays have been developed to detect *X. citri* pv. *citri* strains using non-specific DNA-binding SYBR Green dye (Mavrodieva et al., 2004) or specific fluorescent probe such as TaqMan (Cubero and Graham, 2005; Golmohammadi et al., 2012a). Interestingly, a quantitative real-time reverse transcription PCR TaqMan assay (Q-RT-PCR) targeting *gumD* mRNA detected only viable cells of *X. citri* pv. *citri* and showed a sensitivity level equivalent to that of Q-PCR methods targeting DNA (Golmohammadi et al., 2012a). This tool is particularly useful to accurately diagnose Asiatic canker when the presence of viable bacteria in target samples needs to be confirmed. A new generation of molecular diagnostic techniques has recently emerged, based on isothermal amplification of several of the above-mentioned DNA targets. A nucleic acid sequence-based amplification (NASBA) assay, targeting *gumD* mRNA from *X. citri* pv. *citri*, has been developed (Scuderi et al., 2010). This method is also able to specifically detect viable bacteria in plant material. Loop-mediated isothermal amplification (LAMP) has been applied to the diagnosis of canker (Rigano et al., 2010). This isothermal reaction is applicable to field monitoring, since equipment and facilities are easily portable. The ability to be conducted in the field can be useful in Asiatic canker surveillance programmes.

In addition, pathotype-discriminative primers can be useful to distinguish closely related strains with a different host range, in order to facilitate the global or local epidemiological surveillance of this pathogen. Q-RT-PCR assay followed by allelic discrimination allows to distinguish between A and A*/A^w strains based on the utilisation of two labelled probes that detect a single nucleotide difference in the target sequence (Cubero and Graham, 2005).

The official EPPO diagnostic protocol PM 7/44(1) is available from EPPO website (EPPO, 2005).

3.1.1.4. Host range

Known host species are primarily in the family of Rutaceae although a single unconfirmed report suggested goat weed (*Ageratum conyzoides*, Asteraceae) as a natural host species (Kalita et al., 1997). For the assessment of risk in this opinion, only rutaceous host species will be considered for their potential role in entry, establishment, spread and impact. *Citrus*, *Poncirus*, *Fortunella* and their hybrids are the only common natural host genera and are generally grouped under the name citrus. In addition, citrus canker from natural infections was reported for *Microcitrus australis*, *Naringi crenulata* (syn. *Hesperethusa crenulata*) and *Swinglea glutinosa* (syn. *Chaetospermum glutinosa*) (Koizumi, 1978; Lee, 1918).

Several rutaceous genera have been reported as putative hosts based on lesion development following artificial inoculations: *Acronychia* (*A. acidula*), *Aegle* (*A. marmelos*), *Aeglopsis* (*A. chevalieri*), *Atalantia* (*A. ceylonica*, *A. citrioides* and *A. guillauminii*), *Casimiroa* (*C. edulis*), *Clausena* (*C. lansium*), *Citropsis* (*C. articulata*), *Eremocitrus* (*E. glauca*), *Feroniella* (*F. lucida*), *Limonia* (*L. acidissima*), Lunasia (*L. amara*), *Melicope* (*M. denhamii* and *M. triphylla*), *Microcitrus* (*M. australasica* and *M. garrowayae*), *Micromelum* (*M. minutum*), *Murraya* (*M. exotica*, *M. ovatifoliolata*), *Paramignya* (*P. longipedunculata* and *P. monophylla*), *Tetradium* sp., *Toddalia* (*T. asiatica*) and *Zanthoxylum* (*Z. clava-herculis* and *Z. fagara*) (Jehle, 1917; Lee, 1918; Peltier and Frederich, 1920, 1924; Koizumi, 1978; Hailstones et al., 2005).

Some strains referred to as pathotypes of *X. citri* pv. *citri* (A, A*, A^w) and *X. citri* pv. *aurantifolii* (B and C) have a distinct host range. *X. citri* pv. *citri* pathotype A naturally infects nearly all members of *Citrus*, *Poncirus* and *Fortunella* with differences in host susceptibility. *X. citri* pv. *citri* pathotype A* and A^w primarily infects Mexican lime in natural conditions (Vernière et al., 1998). Strains reported from Florida and originally classified as pathotype A^w caused disease in the field on alemow (*C. macrophylla*) in addition to Mexican lime (Sun et al., 2004). Pathogenicity tests suggested that both A* and A^w strains are pathogenic to alemow and Tahiti lime (*C. latifolia*) although these two species are less susceptible than Mexican lime (Bui Thi Ngoc et al, 2010). Pathotype A^w strains most probably originated from the Indian subcontinent, share a close genetic relatedness with some A* strains previously reported from India and a similar host range with most of A* strains (Bui Thi Ngoc et al, 2010; Escalon et al., 2013; Schubert et al., 2001).

When inoculated on different citrus species, pathotype A* strains are responsible for variable phenotypes – compared to the pathogenically homogenous pathotype A – ranging from no reaction to small, blister-like lesions without epidermis ruptures where bacteria multiplied at population sizes significantly lower than pathotype A strains. Some strains originating from Iran induce small canker-like lesions (with epidermis rupture) when inoculated to grapefruit (*C. paradisi*) and sweet orange, but not Ortanique tangor (*C. reticulata* x *C.sinensis*) (Escalon et al., 2013). The *avrGf1* gene (*xopAG* in the standardized nomenclature of *Xanthomonas* type III effectors) was identified as a determinant of host range restriction, being responsible for the hypersensitive reaction on sweet orange and grapefruit (Rybak et al., 2009; Escalon et al., 2013). It is present in A^w and some A* strains from India and Oman but not in most pathotype A* or in any pathotype A strains (Escalon et al., 2013). The genetic basis of host specificity remains uncompletely understood.

X. citri pv. *aurantifolii* pathotype B naturally infects, by decreasing order of susceptibility, Mexican lime, lemon, sour orange (*C. aurantium*), Rangpur lime (*C. limonia*), sweet lime (*C. limettioides*) and rarely sweet orange (Rossetti, 1977). *X. citri* pv. *aurantifolii* (pathotype C) naturally infects Mexican lime, and to a lesser extent, the hybrid rootstock citrumelo (Jaciani et al., 2009).

3.1.1.5. Examples of impact in the area of current distribution

Fruit yield and quality can be greatly reduced by the disease in a host species- and environment-dependent manner. Early fruit drop contributes to the impact of Asiatic canker primarily on susceptible species or cultivars: Mexican lime (*C. aurantifolia*), makrut lime (*C. hystrix*), grapefruit, most lemon cultivars (*C. limon*), some sweet orange cultivars such as China, Hamlin, Marrs, navels (all selections), Parson Brown, Petropolis, Pineapple, Piralima, Ruby, Seleta Vermelha (Earlygold), Tarocco, Westin, most clementine accessions (*C. clementina*), tangelo cv. Orlando (*C. tangerine* × *C. paradisi*), Natsudaidai (*C. natsudaidai*), some pomelo cultivars (*C. maxima*), Persian and Tahiti lime (*C. latifolia*), sweet lime (Goto, 1992; Gottwald et al., 2002a). Data from Argentina showed that disease incidence on fruit can reach 80 % in grapefruit plots with no chemical control. Similarly, early fruit drop as high as 50 % was reported for sweet orange cv. Hamlin (Stall and Seymur, 1983). On the partially resistant cv. Valencia sweet orange, a study performed in Guatambu, Santa Catarina, Brazil (hardiness zone 10, i.e. a geographically defined area in which a specific category of plant is capable of growing, as defined by climatic conditions, including its ability to withstand the minimum temperatures of the zone; for example, hardiness zone 10 corresponds to an area where the considered plant species can withstand a minimum temperature of –1 °C), a state where *X. citri* pv. *citri* pathotype A has established and is controlled by IPM (integrated pest management), each 1 % of disease incidence increase on fruit corresponds to an estimated loss of 2.16 kg (21.3 oranges) per tree (Brugnara et al., 2012). In Brazil, percentages of harvested sweet orange fruit varied from 44.2 to 92.9 % during three consecutive years in canker-infected orchards with no control, neither copper sprays nor windbreaks (Behlau et al., 2008). Such treatments can increase the yield, but in an endemic situation as in Florida, two additional sprays would be required for fresh fruit while one would be needed for the processed market (Spreen et al., 2003). In addition, windbreaks have to be established and maintained. In California, four additional copper treatments would be expected if the pathogen were to establish (Jetter et al., 2000). Direct damage also involves tree defoliation and/or twig dieback, which are a common consequence of severe infections on highly susceptible cultivars (Gottwald et al., 2002a). Tropical and subtropical environments, where high temperatures and rainfall occur concomitantly, favour severe outbreaks. Because of the quarantine status of the pathogen, an indirect consequence of the disease is the loss of fruit export markets (e.g. the European Union, Australia, etc.) for countries or areas where satisfactory control of the disease cannot be achieved. The annual cost for living with Asiatic canker in Florida (approximately 0.3 million hectares of commercial citrus in the early 2000s) was estimated as US$ 342 million per year (Gottwald et al., 2002a). Scientific evidence was in support of the citrus canker eradication programme settled in Florida and known as the “1900 ft exposure zone” in Florida law (Gottwald et al., 2001; Centner and Ferreira, 2012). The legal consequences of this programme, which unsuccessfully stopped in 2006, were recently reviewed. A court in Florida concluded that the state needed to pay for property destroyed under the eradication programme. This interpretation of the Florida Constitution’s Just Compensation Clause makes it more difficult to administer a successful eradication programme (Centner and Ferreira, 2012). In Australia, an economic analysis of the eradication of a citrus canker outbreak in Queensland in 2004 estimated a potential net benefit of about A$ 70 million (Gambley et al., 2009). In the same country, the economic benefits of averting a national outbreak of citrus canker would be A$ 410 million in relation to the estimated cost of an Australian citrus ban for five years being A$ 2 billion (Alam and Rolfe, 2006). The projected economic cost of eradication in Florida including compensation to cover the loss of income was estimated as US$6 401/acre for Hamlin sweet oranges and US$4 006/acre for Red Seedless grapefruit (Spreen et al., 2003). Although citrus canker is acknowledged as a major pathogen in Asia (i.e. its native area), precise data on its impact are not readily available.

3.1.2. Current distribution

3.1.2.1. Global distribution

The global official distribution of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* from the EPPO-PQR database (EPPO, online a) is given below in Figure 4 and Annex B. In addition, *X. citri* pv. *citri* was reported recently from Louisiana (NAPPO, 2013). The presence of the pathogen in some countries is considered doubtful (i.e. for some reports, Koch postulates have not been fulfilled and/or no bacterial strains are available in culture collections). The geographical distribution of *X. citri* pv. *aurantifolli* is restricted to Argentina, Brazil, Paraguay and Uruguay (Rossetti, 1977).

3.1.2.2. Occurrence in the risk assessment area

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* have never been reported in the risk assessment area.

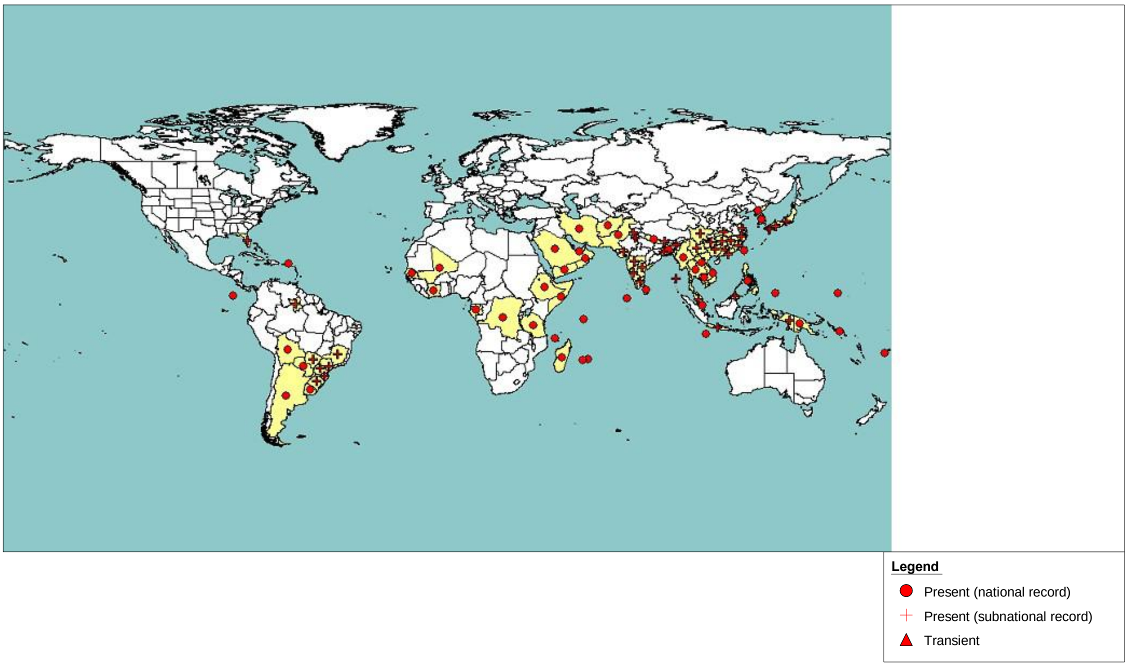

Figure 4: World distribution of *Xanthomonas citri* pv. *citri* and *X. citri* pv. *aurantifolii* as extracted from the EPPO-PQR database on 20 February 2013 (EPPO, online a)

3.1.3. Regulatory status

Council Directive 2000/29/EC

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* are listed as "*Xanthomonas campestris* (all strains pathogenic to *Citrus*)" in Annex II, Part A, Section I, of the Directive, meaning it is a harmful organism "not known to occur in the community and relevant for the entire community, whose introduction into, and spread within, all Member States shall be banned if they are present on plants of *Citrus, Fortunella, Poncirus*, and their hybrids, other than seeds".

A general prohibition of the introduction in all Member States of plants of *Citrus*, *Fortunella*, *Poncirus*, and their hybrids, other than fruit and seeds, from third countries, is formulated by Annex III point 16 of the Directive.

Special requirements for the introduction and movement into and within all Member States of fruit of *Citrus*, *Fortunella*, *Poncirus*, and their hybrids, originating in third countries, are formulated in Annex IV Part A, Section I, points 16.1 and 16.2. The fruit shall be free from peduncles and leaves and the packaging shall bear an appropriate origin mark. In addition, an official statement is required that:

- the fruit originate in a country recognised as being free from *X. campestris* (all strains pathogenic to *Citrus*) or
- the fruit originate in an area recognised as being free from *X. campestris* (all strains pathogenic to *Citrus*), as mentioned on the certificates referred to in Articles 7 or 8 of this Directive.

If the requirements for country or area freedom of *X. campestris* (all strains pathogenic to *Citrus*) cannot be met, an official statement is required to confirm that, in accordance with an official control and examination regime in the exporting country, no symptoms of citrus bacterial canker have been observed in the field of production and in its immediate vicinity since the beginning of the last cycle of vegetation

and

- none of the fruit harvested in the field of production has shown symptoms of citrus bacterial canker

and

- the fruit have been subjected to treatment such as sodium orthophenylphenate, mentioned on the certificates referred to in Articles 7 or 8 of this Directive

and

- the fruit have been packed at premises or dispatching centres registered for this purpose,

or

- any certification system, recognised as equivalent to the above provisions has been complied with.

The procedures and treatments mentioned in these requirements must have been approved by the Commission (Article 18(2)).

According to Annex IV, part B (Article 31), special requirements are requested for fruit of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids originating in Spain, France (except Corsica) Cyprus and Italy during transport through Greece, Corsica (France), Malta and Portugal (excepting Madeira):

- the fruit shall be free from leaves and peduncles, or
- in the case of fruit with leaves or peduncles, official statement that the fruits are packed in closed containers which have been officially sealed and shall remain sealed during their transport through a protected zone, recognised for these fruit, and shall bear a distinguishing mark to be reported on the passport.

According to Annex V, Part A:

- plants of *Citrus*, *Fortunella* and *Poncirus*, and their hybrids, other than fruit and seeds

and

- fruit of *Citrus*, *Fortunella* and *Poncirus*, and their hybrids, with leaves and peduncles, which originate in the community, must be accompanied by a plant passport and be subjected to plant health inspection at the place of production, before being moved within the community.

According to Annex V, Part B:

- Fruit of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids originating outside EU must be subjected to a plant health inspection in the country of origin or the consignor country, before being permitted to enter the EU community.
- Plants intended for planting, including host plants for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, other than *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf. (import of which is prohibited by Annex III), must be subjected to a plant health inspection in the country of origin or the consignor country, before being permitted to enter the EU community.

Except for plants of *Murraya* König, other than fruit and seed, infested by *Diaphorina citri*, there are no special import requirements or prohibitions for fruit, leaves and twigs of host plants for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, other than *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf.

Commission Decision 2006/473/EC

Commission Decision 2006/473/EC, Article 1, lists the countries and areas that are recognized by the EU as being free from *X. campestris* (all strains pathogenic to *Citrus*).

Commission Decision 2004/416/EC

From 2004 to 2012 temporary emergency measures specifying additional requirements for citrus fruit originating in Brazil have been in place (Commission Decision 2004/416/EC). These measures have been repealed by Commission Implementing Decision 2013/67/EU.

Commission Directive 2008/61/EC[8]

Commission Directive 2008/61/EC specifies the conditions under which certain harmful organisms, plants, plant products and other objects listed in Annexes I to V to Council Directive 2000/29/EC may be introduced into or moved within the Community or certain protected zones thereof, for trial or scientific purposes and for work on varietal selections. Plants or plant parts of *X. campestris* (all strains pathogenic to *Citrus*) host plants carrying the pathogen and/or cultures of *X. campestris* (all strains pathogenic to *Citrus*) may have been introduced into the EU. The risk of transfer to suitable hosts depends on the conditions specified for the import of this material and on the premises where the material is to be used.

To summarise, the pathway "plants for planting" is regulated by prohibition of import, and the pathway "fruit" is regulated by special requirements that the fruit come from a pest-free country, pest-free area or pest-free production site.

The number of interceptions of consignments of fruit showing citrus canker symptoms indicates that not all consignments comply with the special requirements and intensive checks are necessary (see section 3.2.2)

[8] Commission Directive 2008/61/EC of 17 June 2008 establishing the conditions under which certain harmful organisms, plants, plant products and other objects listed in Annexes I to V to Council Directive 2000/29/EC may be introduced into or moved within the Community or certain protected zones thereof, for trial or scientific purposes and for work on varietal selections. OJ L 158, 18.6.2008, p. 41–55.

3.1.4. Potential for establishment and spread in pest risk assessment area

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* have the potential for establishment in citrus producing countries of the EU for the following reasons.

3.1.4.1. Availability of suitable host plants

Citrus are widely cultivated in Southern Europe with a production area in 2007 in the EU-28 estimated at 495 105 ha and located in eight countries: Spain (314 908 ha), Italy (112 417 ha), Greece (44 252 ha), Portugal (16 145 ha), Cyprus (3 985 ha), France (1 705 ha), Croatia (1 500 ha), and Malta (193 ha).

Citrus nursery production is less precisely documented. Figures or estimates from the mid-2000s suggest a nursery production dedicated to fruit production and ornamentals of approximately 19 million trees annually (Spain 10 665 000; Italy 5 771 000; Portugal 844 000; Greece 826 000; and France 819 000). These estimates were calculated based on a rate of tree renewal of 7.5 %. Moreover, citrus are commonly available in these countries in city streets and public and private gardens. A relatively low number of rutaceaous genera other than citrus known to be possibly host citrus canker are present in the risk assessment area. These are *Casimiroa*, *Microcitrus*, and *Zanthoxylum*, the two last ones being present in mainland EU (De Rogatis et al., 1990; Ducci and Malentacchi, 1993; Recupero et al., 2001), while *Casimiroa* was reported only from the Madeira ultraperipheric region of the EU (Fernandes and Franquinho Aguiar, 2001). However, the reported *Microcitrus* species were *M. australasica* and *M. papuana*, the susceptibility to citrus canker of the former species having been established from artificial inoculation experiments (see section 3.1.1.4). None of the available references and sources allows estimating the prevalence of these rutaceous genera, nor does it allow evaluating their spatial proximity to citrus crops.

3.1.4.2. Availability of suitable climate

Originating from Asia, *X. citri* pv. *citri* has been widely disseminated. Based on the current worldwide distribution of citrus canker, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have the potential for establishment in hardiness zones 8 to 13 and 8 to 10, respectively. *X. citri* pv. *citri* has caused outbreaks in these zones for example in China (zone 8: Hubei, Jiangsu, Jiangxi, Sichuan; zone 9: Fujian, Guangdong, Hubei, Hunan, Jiangxi, Sichuan, Yunnan, Zhejiang; zone 10: Fujian, Guangdong, Hong Kong, Sichuan, Yunnan), Japan (zone 8: Honshu, Shikoku, Kyushu; zone 9: Honshu, Shikoku, Kyushu), Argentina (zone 9: Catamarca, Entre Rios, Salta, Tucuman; zone 10: Corrientes, Misiones) and New Zealand (zone 9: Auckland, Taranaki, Tauranga; zone 10: Kerikeri). The citrus production regions in the EU correspond to hardiness zones 8 to 10 (Figure 5). There are many reports of citrus canker establishment in hardiness zones 11 to 13. These are not further described here, as there are no citrus producing-area in the EU corresponding to such hardiness zones.

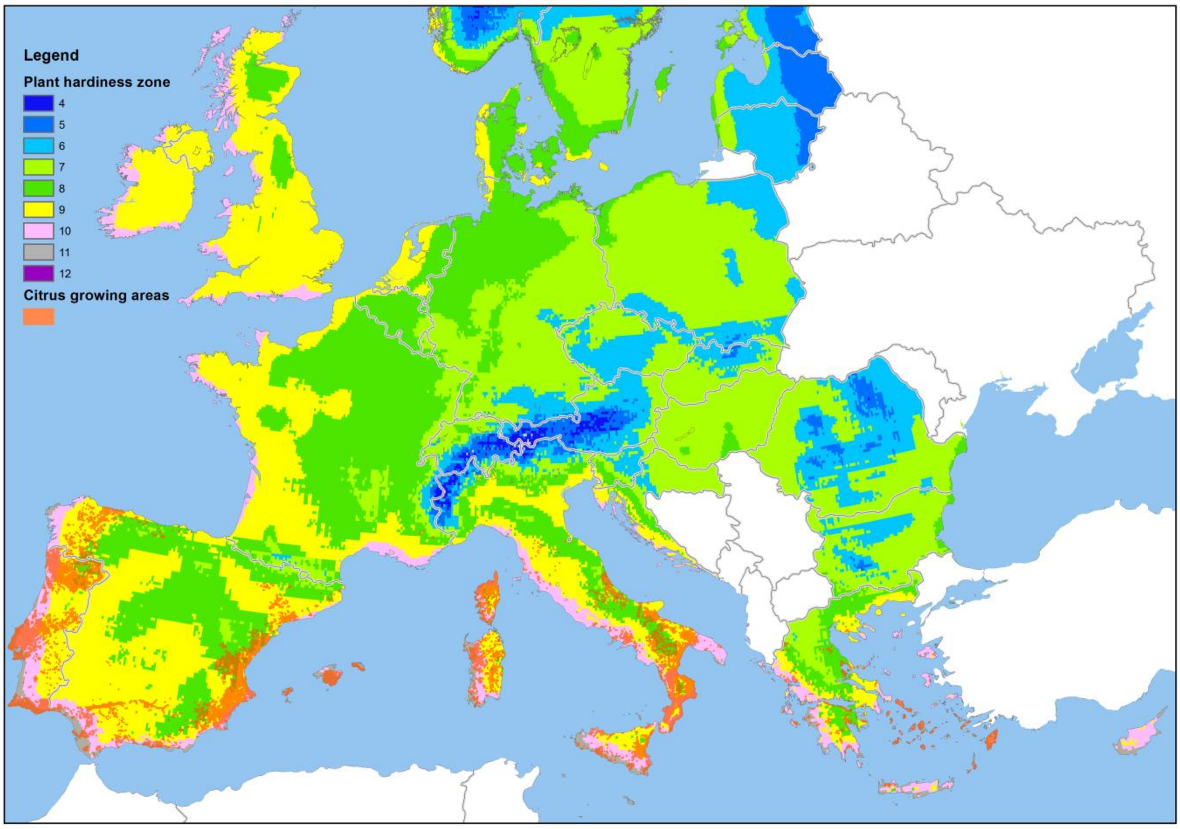

Figure 5: European plant hardiness zones and main citrus-growing areas
(NAPPFAST, online; JRC, online; Leip et al., 2008) The citrus-growing areas of Malta, Cyprus and Croatia are not included on the map

3.1.4.3. Cultural practices conducive to disease development

Citrus trees are grown in monoculture (orchards and nurseries) with susceptible species most of time. Citrus groves in the EU are often established using rather high plantation densities (e.g. 400–500 trees/ha for mandarins and clementines). The prevailing cultivation practices ensure vigorous trees, a factor that also favours the development of citrus canker (Gottwald et al., 2002a). Moreover, overhead irrigation, which exacerbates the spatial and temporal development of the disease through splash dispersal of the pathogen (Pruvost et al., 1999; Gottwald et al., 2002a), is still in common use at least in some parts of the EU and is therefore a factor that can promote establishment in citrus groves. This way of dispersal is of great concern in unprotected nurseries producing young trees to be introduced to new groves.

3.1.4.4. Control by natural enemies

No natural enemies have been reported as having the potential to negatively affect establishment of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. Interactions between *X. citri* pv. *citri* and antagonistic bacteria including *Bacillus subtilis* (Kalita et al., 1996), *Pantoea agglomerans* (Goto et al., 1979), *Pseudomonas syringae* (Ohta, 1983) and *Pseudomonas fluorescens* (Unnamalai and Gnanamanickam, 1984) have been reported *in vitro* and *in vivo*. However, the efficiency of these bacteria in controlling the pathogen has never been proven. *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* interact with several bacteriophages (Goto, 1992; Kuo et al., 1994; Wu et al., 1995). There is no evidence of bacteriophages efficiently controlling citrus canker in citrus groves. Some efficiency was shown from experiments in greenhouses but in nursery settings, bacteriophage treatment only moderately reduced citrus canker and they were shown to be less effective than copper-mancozeb sprays. The combined use of bacteriophage and copper-mancozeb resulted in equal or less control than copper-mancozeb application alone (Balogh et al., 2008).

3.1.4.5. Additional factors facilitating establishment

Citrus leaf miner (*Phyllocnistis citrella*) produces foliar damage, which exacerbates citrus canker and results in an increase of disease incidence (Christiano et al., 2007; Hall et al., 2010). Citrus leaf miner is not a vector of *X. citri* but favours bacterial infection (Belasque et al., 2005). Indeed, adults lay eggs in the underside of developing new leaves and the larvae burrows under the leaf epidermis forming galleries and exposing the leaf mesophyll to the bacteria increasing the susceptibility depending on the developmental stage (Christiano et al., 2007). Citrus leaf miner was first detected in the Mediterranean basin and more specifically in the risk assessment area in 1994; since then it has spread rapidly in most parts of the citrus-producing regions of the EU territory. According to the EPPO PQR database (EPPO, online a) it is present in Spain, Italy, Portugal, Greece, Cyprus, France and other EU countries.

3.1.5. Potential for consequences in the pest risk assessment area

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* cause different degrees of yield and quality losses in citrus orchards in their respective area of distribution (see section 3.1.1.5). Citrus production in the EU is achieved in hardiness zones corresponding to areas worldwide where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are endemic and/or cause outbreaks. Therefore, the Panel concludes that there is a potential for consequences in the risk assessment area.

3.1.6. Conclusion on pest categorisation

CBC caused by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, presents a major risk to the EU territory for the citrus industry because the causal agents of the disease have the potential for causing consequences in the risk assessment area once they establish as hosts are present and the environmental conditions are favourable. Citrus is a major crop in Mediterranean countries where the environmental conditions required for the establishment of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are potentially met in many places. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have never been reported in the EU territory.

3.2. Probability of entry

Citrus represents one of the most important fruit crops in Europe, as it is in the world (see Table 11). *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are not known to be present in the risk assessment area where they are presently considered as quarantine organism. Importation of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf. and their hybrids in the EU is regulated, according to Council Directive 2000/29/EC. For this section, we will provide an analysis of the pathways without taking into consideration any existing EU regulation. However, it is assumed that citrus-exporting countries apply measures to reduce yield and quality losses. The data on interceptions have been used to add precision on the presence of CBC in the countries of origin.

The overall probability of entry has been assessed by the Panel combining for each pathway the ratings of the various steps, with the rule that within each pathway the overall assessment should not be higher than the lowest probability.

3.2.1. Identification of pathways

3.2.1.1. List of pathways

The Panel identified the following pathways for entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU:

- Fruit (commercial trade and import by passenger traffic)

The import of fresh fruit is considered as a pathway because it is the most frequent route for importing citrus material within the risk assessment area. Fresh citrus fruit includes oranges, mandarins, clementines, tangerines, grapefruit, pomelos, lemons, limes and satsumas.

- Plants for planting, for citrus fruit production (commercial trade and import by passenger traffic)

Today, plants for planting materials of *Citrus*, *Fortunella*, *Poncirus* and their hybrids, other than seeds, are prohibited to be introduced into the pest risk assessment (PRA) area except under specific derogation. Without taking the current legislation into account, plants for planting materials of *Citrus*, *Fortunella*, *Poncirus*, and their hybrids is a major pathway, since citrus canker introduction has often been linked to importation of planting material. Should the importation ban on citrus plant propagation material be lifted, it is likely that a significant part of the plant for planting material including plant parts, like budwoods, scions and rootstocks, would be imported in the risk assessment area.

- Ornamental citrus and other rutaceous plants for planting (commercial trade and import by passenger traffic)

Should the current ban on *Citrus*, *Poncirus* and *Fortunella* importation (Directive 2000/29/CE) not be in place, ornamental rutaceous species that would be traded as ornamentals would consist mostly in *Citrus* and related species. Besides this major path, a few other rutaceous plant species which are regarded as potential hosts of *X. citri* pv. *citri* (Lee, 1918; Peltier and Frederich, 1920, 1924; Koizumi, 1978; Reddy, 1997) should also be taken into account.

The pathways “plants for planting for the commercial citrus fruit production” and “ornamental citrus and other rutaceous plants” are clearly separated, as their production routes are different.

- Leaves from citrus and other rutaceous plants (commercial trade and import by passenger traffic)

Leaves from *Citrus*, *Poncirus* and *Fortunella* might be imported for ornamental or cooking purposes. For example, lemon leaves might be added to a potpourri to provide a lemony fragrance. Lemon leaves are also used for cooking purposes, as wraps. Thai and Vietnamese cooking use kaffir lime leaves as a staple ingredient. Besides cooking and ornamental purposes, leaves from rutaceous plants have also been reported to be used in medicine, in rituals and in cosmetic products. The importation of citrus leaves seems to be possible through Internet websites delivering such items, e.g. in the UK.

3.2.1.2. Major pathways

Therefore, the list of major pathways to be further assessed is as follows:

- Citrus fruit, commercial trade
- Citrus fruit and leaves import by passenger traffic
- Citrus plants for planting, commercial trade
- Citrus plants for planting import by passenger traffic
- Ornamental rutaceous plants for planting, commercial trade
- Ornamental rutaceous plants for planting import by passenger traffic
- Citrus and rutaceous leaves and twigs, commercial trade

3.2.2. Entry pathway I: Citrus fruit, commercial trade

Importation of fruit is considered as pathway because of the high volume of citrus commodities imported into risk assessment area. The pathway of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* with imported citrus fruit has been previously analysed in risk assessments by the European Food Safety Authority (EFSA, 2006; EFSA PLH Panel 2011), the United States Department of Agriculture (USDA, 2006, 2007a, b, 2008, 2009a, b, c, 2012) and the EFSA cooperation project on “Pest risk assessment for the European Community plant health: a comparative approach with case studies” (MacLeod et al., 2012). The evidence cited in these documents has been considered by the Panel, and when there are differences in conclusions, these are discussed in the steps below and in the final conclusion for this pathway. For this pathway, citrus fruit were considered as fruit with or without attached peduncles and leaves.

3.2.2.1. Probability of association with the pathway at origin

Outside Europe, outbreaks are regularly reported in citrus groves worldwide, both in countries where the disease has been reported over a long period such as Argentina, Brazil, China, Florida (USA), India, Iran, Pakistan, Saudi Arabia, and in countries where the disease is emerging, such as Burkina Faso, Ethiopia, Mali, Senegal or Somalia (see Appendix B, Table B.1) (Balestra et al., 2008; Traoré et al., 2008; Derso et al., 2009; Leduc et al., 2011; Juhasz et al., 2013). Approximately 2 000 kt of citrus fruit are imported each year in the risk assessment area—more precisely, in 2011, 1 925 kt, among which one-third came from countries where the disease is reported. Such countries are, by importance of citrus fruit importation level, Argentina, Uruguay, Brazil, USA (Florida), China, Pakistan and Vietnam, all with the presence of CBC. Other countries which might be considered as minor in term of trade volume are Bolivia, Thailand, Korea, Iran, Malaysia, Bangladesh, United Arab Emirates, Ivory Coast, Somalia, Mauritius, India, Japan, Sri Lanka and the Philippines (Table 5).

It is very likely that citrus fruit imported from third countries would arrive in the risk assessment risk assessment area during the months of the year most appropriate for establishment in EU areas where citrus are grown (Table 6).

Currently, citrus fruit are checked at the point of entry for CBC infection. Although expected to originate from pest-free areas or places of production based on the current EU legislation, reports from EU Member States describe interceptions of symptomatic fruit (EUROPHYT, on line, Golmohammadi et al., 2007). Records in the EUROPHYT database of interceptions of citrus canker are listed in Table 3 (EUROPHYT, online). Over a 10-year period, EUROPHYT reports up to 209 interceptions, mostly from countries often considered as minor in terms of trade volume: Bangladesh (125), India (29), Pakistan (23) Thailand (4), China (2), Mexico (2) and Sri Lanka (1), the two noticeable exceptions being Argentina (13) and Uruguay (12).

In France, between 1997 to 2009, *X. citri* pv. *citri* was officially diagnosed from 24 consignments mainly originating from Asia (Thailand, China) and also from Argentina (EUROPHYT, online). In Spain, secondary inspections done by local authorities in markets, supermarkets or packinghouses have also identified additional diseased consignments (EUROPHYT, online). It is worth noting that approximately 90 % of the reported interceptions (EUROPHYT reported interceptions, Table 3) have been done by the UK only. This suggests (i) a lack of consistent reporting from some EU countries, and/or (ii) inspection efforts that may be country dependent (see Table C.1 in Appendix C) and (iii) Member State-specific pathways for citrus fruit; most infected fruit detected in the UK originate from Bangladesh, India and Pakistan.

Table 3: *Xanthomonas citri* pv. *citri* interceptions reported in EUROPHYT on fruit consignments over the last 10 years (data extracted from EUROPHYT, (online) on 14 March 2013)

Year	Country	Origin	Number
2012	Germany	Pakistan	1
2012	Spain	Argentina	1
2012	UK	Bangladesh	20
2012	UK	China	1
2012	UK	Pakistan	6
2011	UK	Pakistan	7
2011	UK	Bangladesh	1
2011	UK	Sri Lanka	1
2010	UK	Bangladesh	27
2010	Germany	India	1
2010	Greece	Uruguay	1
2009	France	Argentina	1
2009	Spain	Argentina	2
2009	UK	Bangladesh	22
2009	UK	India	4
2009	UK	Pakistan	3
2009	UK	Thailand	2
2008	UK	Bangladesh	20
2008	UK	India	12
2008	UK	Pakistan	4
2007	Greece	Uruguay	1
2007	UK	Bangladesh	23
2007	UK	India	10
2007	UK	Pakistan	2
2007	UK	Thailand	2
2006	France	China	1
2006	UK	Bangladesh	12
2006	UK	India	2
2005	Spain	Uruguay	10
2004	Spain	Argentina	3
2004	Spain	Mexico [(a)]	2
2003	Spain	Argentina	5

(a): *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* not officially reported to be present in Mexico but symptoms of citrus canker were observed in consignments from Mexico.

Most interceptions originate from minor exporting countries. Among these, the most significant citrus exporter to the EU-28 is Pakistan (small citrus 3 kt, half of which is sent to the UK). In contrast, huge volumes that should be more extensively surveyed originate primarily from Argentina (lemon 159 kt, orange 81 kt, grapefruit 8 kt, small citrus 32 kt), Uruguay (lemon 8 kt, orange 58 kt, small citrus 24 kt) and China (grapefruit 48 kt) (EUROSTAT, online). No interception has been reported yet from Brazil although huge volumes are imported. This can probably be explained by the fact that imported citrus fruit primarily originates from Sao Paulo state, which has in place an eradication strategy for *X. citri* pv. *citri*. However, measures associated with the eradication strategy in Sao Paulo state have recently been relaxed (Belasque et al., 2010). The inspection procedures in place in the USA target a 95 % confidence level and, now, no interception of infected fruit is reported in shipments from the USA. However, in the USA, 0.8 % of the lots from pest-free areas with harvest permits have been rejected because of the presence of *X. citri* pv. *citri* (EFSA, 2013).

Bactericide treatments such as chlorine or sodium orthophenylphenate (SOPP), recommended for disinfection, reduce but do not fully eliminate viable bacteria (Gottwald et al., 2009; Golmohammadi et al., 2007). These treatments which can be applied voluntarily are not effective against *X. citri* pv. *citri* when present in canker lesions. The practice of sorting fruit in the packinghouse contributes to decreasing the number of symptomatic fruit, but it cannot prevent the exportation of apparently healthy but nevertheless contaminated fruit lots.

Citrus fruit are susceptible to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* infections and develop lesions that are variable in size and in number depending on the age of the fruit and the level of susceptibility of the host species and varieties (see section 3.1). The younger the fruit, the more susceptible it is to infection. Goto (1962, 1992) reports that artificial inoculation of citrus fruit is successful in the absence of extreme weather conditions when bacterial concentrations reach or exceed ca. 10^5 cells/ml. However, successful infections can be generated with much lower inoculum concentrations, especially when extreme weather events like storms or hurricanes force *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into stomata or wounds (Bock et al., 2010). Therefore, extreme weather conditions will increase citrus canker incidence and severity (Parker et al., 2008; Bock et al., 2010). Population sizes in fruit lesions range from 10^5 to 10^7 viable *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* strains per lesion in symptomatic susceptible citrus fruit and are low when lesions get older (Stall et al., 1980; Civerolo, 1984; Gottwald et al., 2009) or when high levels of partial resistance occur in the host cultivar (Shiotani et al., 2009).

Population sizes in fruit and leaf lesions are similar (Stall et al., 1980). Although mature (i.e. not expanding) asymptomatic fruit without injuries or blemishes are not known to develop symptoms (USDA, 2007a), this does not mean that the bacteria are absent from such mature fruit. It has been reported that *X. citri* pv. *citri* may also survive on apparently healthy citrus fruit (Gottwald et al., 2009). Although epiphytic *X. citri* population sizes on asymptomatic fruit are difficult to estimate, they are likely to be smaller than 10^4 cells per fruit (Gottwald et al., 2009). When wounded mature fruit were inoculated, bacterial populations were able to survive for several weeks at low population densities (Gottwald et al., 2009). Bactericide treatments such as chlorine or SOPP, recommended for disinfection, reduce but do not fully eliminate viable bacteria from asymptomatic fruit (Golmohammadi et al., 2007; Gottwald et al., 2009). These treatments, which can be applied voluntarily, are not effective against *X. citri* pv. *citri* when present in canker lesions. The practice of sorting of fruit in the packinghouse contributes to decreasing the number of symptomatic fruit.

Recently, the colonization and adherence of *X. citri* pv. *citri* prior to development of canker as biofilms on plant surfaces has been suggested (Rigano et al., 2007; Cubero et al., 2011). Moreover, a VBNC state has been suggested for *X. citri* pv. *citri* in response to copper ions (Del Campo et al., 2009; Golmohammadi et al., 2012a). Plating-based techniques on agar media would thus not detect VBNC populations. The biological significance of these populations is largely unknown because of a lack of data.

The total concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in a consignment will be dependent on the level of fruit, leaf and peduncle infection. This parameter can vary according to several factors.

- The presence of the *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* at the place of production: CBC is widely distributed worldwide (see section 3.1.2). Some places of production may be free of CBC in countries where CBC is reported.

- Cultivar susceptibility: citrus cultivars show markedly different levels of susceptibility to CBC (Table 4 below). For instance, grapefruit (*C. paradisi*) is highly susceptible while mandarin (*C. reticulata*) is moderately resistant (Gottwald et al., 2002a).

- The existence of efficient phytosanitary measures in the area of production in response to requirement by importing countries other than EU: such measures may be applied to varying degrees in the considered country. There are a lot of discrepancies from one country to another with regards to measures envisaged for quarantine purposes.

- The use of integrated pest management strategies: including chemical control and cultural practices. Copper-based bactericides or antibiotics are moderately effective at decreasing disease severity (Gottwald et al., 2002a). Copper sprays had a significant benefit in reducing fruit drop and subsequent losses of fruit destined for juicing (Graham et al., 2004). The effectiveness of copper-based sprays is dependent on the susceptibility of the citrus cultivars to CBC, and the frequency of sprays (Kuhara, 1978; Leite et al., 1987; Goto, 1992). Bacterial copper resistance or tolerance has been reported in Argentina and Brazil, respectively (Rinaldi and Leite, 2000; Canteros et al., 2010; Behlau et al., 2011a, b).

- Cleaning, sorting and treatment of fruit: cleaning and sorting of fruit may allow the removal and destruction of many (but not all) symptomatic fruit. No chemical compounds are known to have a marked negative effect on *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* present in fruit lesions. Treatments, such as the prewash of fruit with water and detergent (SOPP) and treatment with chlorine, performed in packinghouse lines before export, would have a partially negative effect on surface populations of *X. citri* pv. *citri*. However, experiments in Florida in 2006 and 2007 did not result in a statistically significant reduction of bacterial populations (Gottwald et al., 2009), therefore such treatments are possibly not consistently effective. In areas where the pathogen is endemic, orchard management and packinghouse inspection procedures to eliminate symptomatic and asymptomatic fruit has limited effectiveness when fruit disease incidence exceeds 2–5% (Gottwald et al., 2009). CBC-causing bacteria may also survive on apparently healthy citrus organs as epiphytic populations but for transient periods and at population sizes lower than in lesions (Timmer et al., 1996). These epiphytic populations of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* have low a probability of surviving the packing process (Gottwald et al., 2009).

Table 4: Relative susceptibility/resistance to *Xanthomonas citri* pv. *citri* of commercial citrus cultivars and species

Rating	Citrus cultivars
Highly resistant	Calamondin (*C. mitus*); kumquats (*Fortunella* spp.)
Resistant	Mandarins (*C. reticulata*)—Ponkan, Satsuma, Tankan, Satsuma, Cleopatra, Sunki, Sun Chu Sha
Less susceptible	Tangerines, tangors, tangelos (*C. reticulata* hybrids); Cravo, Dancy, Emperor, Fallglo Fairchild, Fremont, Clementina, Kara, King Lee, Murcott, Nova, Minneola, Osceola, Ortanique, Page, Robinson, Sunburst, Temple, Umatilla, Willowleaf (all selections); sweet oranges (*C. sinensis*)—Berna, Cadenera, Coco, Folha Murcha, IAPAR 73, Jaffa, Moro, Lima, Midsweet, Sunstar, Gardner, Natal, Navelina, Pera, Ruby Blood, Sanguinello, Salustiana, Shamouti, Temprana and Valencia; sour oranges (*C. aurantium*)
Susceptible	Sweet oranges—Hamlin, Marrs, Navels (all selections), Parson Brown, Pineapple, Piralima, Ruby, Seleta Vermelha (Earlygold), Tarocco, Westin; tangerines, tangelos—Clementine, Orlando, Natsudaidai, pomelo (*C. maxima*); limes (*C. latifolia*)—Tahiti lime, Palestine sweet lime; trifoliate orange (*Poncirus trifoliata*); citranges/citrumelos (*P. trifoliata* hybrids)
Highly susceptible	Grapefruit (*C. paradisi*); Mexican/key lime (*C. aurantiifolia*); lemons (*C. limon*); and Kaffir lime (*C. hystrix*)

Data source: Gottwald et al., (2002a).

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* are likely to be associated with citrus fruit, with a medium uncertainty due to (i) incomplete data on the presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* strains in the country at origin, (ii) the variation in cultivar susceptibility, (iii) the differences in the pest management measures set up according to the countries exporting citrus fruit, and (iv) differences in packinghouse operational procedures.

3.2.2.2. Probability of survival during transport or storage

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* that survive the packing process would be primarily located in lesions associated with fruit. Concentrations of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* would be correlated with the presence of canker lesions in the consignment. Population sizes in lesions range from 10^5 to 10^7 viable *X. citri* pv. *citri* per lesion and slowly decrease as lesions get older (Stall et al., 1980; Civerolo, 1984). The surface populations of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* that might survive the packing process would probably decline during transport or storage because these bacteria have a limited ability to survive epiphytically. Fruit transportation is under cool conditions (Wills et al., 1998), which have no negative effect on the survival of the bacteria (Goto, 1962). More specifically, shipping temperatures for oranges and mandarins are fairly standard at 1 °C and 4 °C respectively, whereas lemons and limes are normally shipped at 10 °C. Grapefruit temperatures range from 10 to 15 °C, depending on the time of the year and the condition of the trees at harvest. Cooler temperatures provides better decay control while warmer ones protect against chilling injury (Wardowski, 1981). It is thus very likely that *X. citri* pv. *citri* survives transport in fruit canker lesions. Successful bacterial isolations from interceptions even when fruit have been treated by officially approved chemicals demonstrate such survival (Golmohammadi et al., 2007; Vernière et al., 2013). *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are therefore very likely to survive during transport and storage of fruit, with a low uncertainty.

3.2.2.3. Probability of survival of existing pest management procedures

Assuming the absence of EU phytosanitary measures against the introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, pest management procedures to control citrus pests at the place of origin (cultural practices and chemical treatments applied pre- and post-harvest) can reduce the level of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in the orchard and the incidence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in consignments, but it does not eliminate the pathogens. At visual inspection of consignments small lesions may escape detection and symptoms may be confused with other causes. Reliable confirmation of the identity of the bacteria on citrus fruit can be made only after laboratory testing.

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* are therefore very likely to survive the existing pest management procedures, with a low level of uncertainty.

3.2.2.4. Probability of transfer to a suitable host

Most of the EU-28 import fresh citrus fruit (see Table 5 and Appendix C). Some of these citrus fruit originate from countries where citrus canker is widespread: more than 280 kt from Argentina, 90 kt from Uruguay, 83 kt from Brazil and 47 kt from China in 2011 (EUROSTAT, online). Citrus-producing countries of the EU-28 import large amounts of fresh fruit mostly during spring and summer from countries where *X. citri* pv. *citri* is widely present. High quantities of fresh citrus fruit imported into the EU from third countries are re-distributed in the internal market by many Member States (i.e. Netherlands, Belgium, Germany, France, the UK), see Appendix D. In 2008, the Netherlands imported from third countries around 390 kt of sweet orange (one-sixth of which originated from countries where *X. citri* pv. *citri* has established) and 150 kt of grapefruit (one-third of which originated from countries where *X. citri* pv. *citri* has established) and distributed approximately 180 kt of sweet orange and 120 kt of grapefruit to other EU countries, including citrus-producing countries (EUROSTAT, online).

It is very likely that citrus fruit imported from third countries could arrive in the risk assessment area during the months of the year most appropriate for establishment. The seasonal import of citrus fruit into EU citrus-producing countries (Spain, Portugal, Italy, Greece, Malta, Cyprus and France) is reported in Table 6. Furthermore citrus packinghouses are often located within citrus-growing areas.

A few experiments were conducted to assess the transfer of *X. citri* pv. *citri* to a suitable host. Goto et al. (1978) observed some canker leaf lesions on *C. natsudaidai* from splash dispersal (produced by a rainfall simulator) of rice straw contaminated with *X. citri* pv. *citri* at concentrations as low as 10^2 *X. citri* pv. *citri* per gram of straw and concluded that infected plant tissues on soil can provide inoculum for the infection of wounded susceptible seedlings by splash dispersal. *X. citri* pv. *citri* may survive for ca. 120 days on decomposing plant litter, including fruit but at very low population sizes (Civerolo, 1984; Graham et al., 1987; Leite and Mohan, 1990). The probability of transfer of *X. citri* pv. *citri* from infected fruit to citrus trees remains uncertain owing to a lack of research in this area. Only two recent papers reported on the transmission from infected fruit to healthy tree (Gottwald et al., 2009; Shiotani et al., 2009). One study based on three experiments conducted in Florida and one in Argentina concluded on the lack of transmission from cull piles of fruit to surrounding trap plants unless environmental conditions highly conducive to spread were applied (Gottwald et al., 2009). This experiment reported that in one case infection of one leaf was observed in a susceptible trap plant located close to a cull pile of infected fruit (Gottwald et al., 2009). However, the experiments on simulated *X. citri* pv. *citri* dispersal were dealing with dispersal by wind-driven rain and not with direct or drip-splash dispersal of *X. citri* pv. *citri* cells from symptomatic fruit discarded on the orchard floor on to the tree canopy. It is therefore difficult to extrapolate the results to a situation where symptomatic fruit/peels have been discarded underneath or in close proximity to susceptible mature citrus trees. The lower branches of citrus trees can be very close to the soil level (Figure 6), hence creating conditions very similar to the 0 m situation for which an infection was observed by Gottwald et al. (2009) from fruit. Another recent study involved the highly resistant Satsuma mandarin for which low *X. citri* pv. *citri* population sizes are recorded in lesions (Shiotani et al., 2009), making the data difficult to transpose to susceptible cultivars. Therefore, considering current knowledge (see section 3.1.1.2), the transfer of *X. citri* pv. *citri* from infected fruit to citrus hosts is considered as unlikely.

There is no authenticated record of this having happened under natural conditions (Das, 2003). Interestingly, it is useful to stress that there is often a general lack of knowledge on the origin of inoculum associated with new outbreaks in areas where the pathogen was not known to be present. For example, all recent outbreaks in Australia had the origin of inoculum unexplained (Broadbent et al., 1992; Gambley et al., 2009). The Florida outbreak of 1986–1994 started on backyard trees in the Tampa area,; the source of the inoculum is unknown, although probably not a resurgence from outbreaks that occurred decades earlier (Schubert et al., 2001). Similarly, the huge outbreak known as the “Miami outbreak” that was reported in 1995 and had not been eradicated a decade later started from backyard trees, but the precise origin of the inoculum is unknown (Gottwald et al., 1997; Schubert et al., 2001).

The citrus fruit produce waste is the peel: it is this part of the fruit that is infected. Therefore the inoculum is not destroyed but destined for waste. The main intended use of the commodity is consumption. However, some of the fruit that are imported from third countries are used for juice production. During this process, 45 to 60% of their weight remains in the form of peel, rag and seeds. Citrus processing industry by-products can be used to to produce quality compost as an organic fertiliser (Bernal-Vicente et al., 2008). Packinghouses for trade and processing plants in Spain, Italy and Greece are located in citrus producing areas (EFSA, 2008) (see also Figure 6 and Appendix E). Data from season 2003–2004 indicated that approximately 2 500 kt of citrus fruit imported into the EU (62 % of sweet orange) was destined primarily for juice production.

Figure 6: Processing of citrus pulp residues and whole citrus fruit in close proximity of citrus orchards (top panels). Uncontrolled citrus waste discharged in the vicinity of neglected citrus trees (bottom left panel). Sweet orange orchard with low hanging branches and fruit (Valencia, Spain) (bottom right panel)

Moreover, some alternative uses of citrus fruit are industrial (e.g. pectin extraction, cosmetics). By now, no waste treatment is considered by the EU-based industries, as according to EU requirements, only *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*-free citrus fruit are allowed to be imported from third countries into the risk assessment area.

Depending on species/cultivars, citrus fruit production period in the EU is primarily over approximately half a year. At least in Spain, plants process fruit from third countries during the remaining months. Precise amounts are not known.

The Panel considers therefore that the probability of transfer to a suitable host is unlikely, but with a high uncertainty due to i) the paucity of literature and ii) the lack of extensive information on transfer under natural condition and considering:

- The amount of citrus fruit imported within the European citrus-growing area during periods when citrus are susceptible to the disease.
- The transfer of the pathogen to the susceptible hosts remains uncertain, but can be facilitated by (i) the irrigation system applied in some areas (overhead irrigation), (ii) the short distance (quite often the distance is nil, especially with the new dwarf citrus species/varieties) between the infected fruit on the orchard floor and the tree canopy, (iii) the rain events that occur during the import period, and (iv) wind speeds favourable to infection in the citrus-producing Member States during the imported period. According to Gottwald et al. (2001), infection is

facilitated by wind speeds higher than 8 m/s (force 4 on the Beaufort scale) and these speeds occur in the Southern Mediterranean Member States, although infrequently (Annex F).

- The bacteria survive in high populations in canker lesions.
- Thee rare but real probability of transfer from cull piles of fruit to surrounding trap plants unless environmental conditions highly conducive to spread were applied.
- The need of a minimum amount of bacterial cells to produce an infection (Goto, 1962, 1992, Koizumi, 1976), under suitable weather conditions (Dalla Pria et al., 2006) for splash and wind-driven transfer (see Appendix F).
- Failure to trace back the origin of outbreaks in countries where CBC is under surveillance (e.g. Sao Paulo state, Australia); Waste derived from industrial activity (transformation and trade of fruit originating from third countries in EU-based shipping centres) may not always be managed so that it prevents the escape of pathogens to the environment (EFSA, 2008). It cannot be ruled out that this material be transferred in the vicinity of citrus plants. X. citri pv. citri may survive up to 120 days on decomposing plant litter, including fruit (Civerolo, 1984; Graham et al., 1987; Leite and Mohan, 1990).

Table 5: Quantities of citrus fruit imported into the EU27 in 2011, as extracted from EUROSTAT (on line) on 12 April 2013 (quantities given in 100 kg)

Place of origin	Oranges (080510)	Mandarins (080520)	Grapefruit (080540)	Lemons (08055010)	Limes (08055090)	Citrus other (08059000)	Citrus total (0805)
South Africa	3 386 686	577 919	940 061	452 173	279	2 764	5 359 882
Argentina	807 196	321 305	82 759	1 591 131	129	317	2 802 837
Turkey	103 807	512 132	674 189	1 163 387	380	44	2 453 939
Morocco	980 175	865 513	4 966	16 616	47	58	1 867 375
Egypt	1 022 778	11 654	692	2 593	1 312	1	1 039 030
Uruguay	576 096	241 601		82 804			900 501
Israel	110 532	297 200	406 521	2 136	1 900	37 757	856 046
Brazil	268 717	1 024	694	1 588	565 927		837 950
United States	7 848	48 134	579 966	544	220	17	636 729
Peru	98 924	419 253	2 497	16	3 274	172	524 136
China (People's Republic of)	3	1 651	476 075			297	478 026
Mexico	51 358		131 805	627	279 229	218	463 237
Swaziland (Ngwane)	118 791	3 015	149 857				271 663
Tunisia	203 103	13		257			203 373
Zimbabwe	116 450		22 279				138 729
Chile	47 157	15 603	175	32 112	60	57	95 164
Croatia	27	69 598	80				69 705
Jamaica	51 425	2 675					54 100
Dominican Republic	14 515	14	45	12 455	6 976		34 005
Pakistan	772	33 162		4	8	10	33 956
Vietnam	1		25 543		92	5	25 641
Mozambique	5 710		10 164				15 874
Honduras	11 443		609	68	2 560		14 680
Cuba	13 754						13 754
Colombia	4 002				8 320		12 322
Belize	9 211						9 211
Bolivia				8 140			8 140
Australia	2 425	2 200		1	2	22	4 650
Norway	1 242	3 174					4 416
Venezuela					3 981		3 981
Ghana	3 120						3 120
Dominica	637		1 603	5	10		2 255

Place of origin	**Oranges (080510)**	**Mandarins (080520)**	**Grapefruit (080540)**	**Lemons (08055010)**	**Limes (08055090)**	**Citrus other (08059000)**	**Citrus total (0805)**
Thailand	50	10	1871		4	19	1 954
Korea, Republic of (South Korea)		1 366					1 366
Iran, Islamic Republic of	168			127	715	166	1 176
Guatemala					1 050		1 050
Russian Federation (Russia)	236	670	92	14	35	1	1 048
Switzerland	320	605	9	14		4	9 52
Haiti	736						736
Belarus (Belorussia)		566					566
Malaysia					30	464	494
Bangladesh				374	64	26	464
Algeria		236		221			457
United Arab Emirates				323			323
Cote d’Ivoire			317				317
Lebanon	190	35	1	4		0	230
Panama	222						222
Jordan		20		191			211
Serbia		211					211
Bosnia and Herzegovina	205						205
Somalia				52		106	158
Mauritius	24	10	109	0	1		144
Former Yugoslav Republic of Macedonia				126			126
Cameroon				0		112	112
New Zealand		107					107
Suriname (ex Dutch Guiana)	29	9	18		3	15	74
India	2			54	8		64
Japan		53				2	55
Sri Lanka (ex Ceylon)					41	0	41
Madagascar					8	10	18
Syrian Arab Republic (Syria)			17				17
Antigua and Barbuda				11			11
Ecuador					3		3
Philippines						3	3
Kenya					1		1

Table 6: Seasonal import of citrus fruit into EU citrus-producing countries in the period March 2011 to February 2012 as extracted from EUROSTAT (on line) on 12 April 2013 (quantities given in 100 kg)

		Total import from third countires (outside EU)				**Total import from other EU countries including redistributed fruit**			
Import into	**Commodity**	**Spring (III–V)**	**Summer (VI–VIII)**	**Autumn (IX–XI)**	**Winter (XII–II)**	**Spring (III–V)**	**Summer (VI–VIII)**	**Autumn (IX–XI)**	**Winter (XII–II)**
Cyprus	Oranges (080510)		308	468	23	1026	595	915	320
Cyprus	Mandarins (080520)	484			167	11	0	311	513
Cyprus	Grapefruit (080540)		420	0	0	162	469	103	
Cyprus	Lemons (08055010)	259	12 366	493		100	1660	388	5
Cyprus	Limes (08055090)			38		88	327	44	31
Cyprus	Citrus other (08059000)					16	14	20	
Cyprus	Citrus total (0805)	743	13 094	999	190	1 403	3 065	1 781	8 69
France	Oranges (080510)	206 205	84 950	114 583	147 792	119 4816	446 481	576 925	1 372 239
France	Mandarins (080520)	71 218	8 417	33 521	302 348	349 806	22 950	793 231	1 940 643
France	Grapefruit (080540)	28 652	35 679	82 679	75 234	170 945	91 328	135 939	158 363
France	Lemons (08055010)	3 871	23 062	19 452	3 133	285 462	238 356	234 147	318 129
France	Limes (08055090)	6 177	3 912	8 282	12 695	21 875	21 487	17 496	15 356
France	Citrus other (08059000)	124	263	727	968	3 666	3 840	3 594	3676
France	Citrus total (0805)	316 247	156 283	259 244	542 170	2 026 570	824 442	1 761 332	3 808 406
Greece	Oranges (080510)	3 600	7 417	20 751		13 572	2 765	6 781	42 279
Greece	Mandarins (080520)	613		159	1 196	15 984	5 649	13 061	7 868
Greece	Grapefruit (080540)	446	13 612	7 001	2 768	3 801	6 618	1 492	1 973
Greece	Lemons (08055010)	15 092	133 007	75 711	20 971	19 322	27 929	4 672	3 074
Greece	Limes (08055090)					2 107	2 269	626	2 014
Greece	Citrus other (08059000)			5	1	250	1 795	369	269
Greece	Citrus total (0805)	19 751	154 036	103 627	24 936	55 036	47 025	27 001	57 477
Italy	Oranges (080510)	17 022	16 6281	217 522	9 966	490 271	239 006	150 914	250 377
Italy	Mandarins (080520)	6 610	4 635	24 021	10 295	191 969	18 560	306 506	333 183
Italy	Grapefruit (080540)	50 316	92 902	32 640	24 718	26 454	26 436	215 04	17 151
Italy	Lemons (08055010)	3 700	331 893	126 717	1 923	143 600	125 969	117 405	153 036
Italy	Limes (08055090)	4 055	7 105	3 292	1 585	10 498	14 280	8 759	7 429
Italy	Citrus other (08059000)	31	14	6		1 168	182	238	259
Italy	Citrus total (0805)	81 734	602 830	404 198	48 487	863 960	424 433	605 326	761 435
Malta	Oranges (080510)	8 488	2 025	4 352	6 273	10 529	4 828	5 080	4 324

		Total import from third countires (outside EU)				**Total import from other EU countries including redistributed fruit**			
Import into	**Commodity**	**Spring (III–V)**	**Summer (VI–VIII)**	**Autumn (IX–XI)**	**Winter (XII–II)**	**Spring (III–V)**	**Summer (VI–VIII)**	**Autumn (IX–XI)**	**Winter (XII–II)**
Malta	Mandarins (080520)	262			396	4 175	420	1 825	2 347
Malta	Grapefruit (080540)		94		36	345	365	385	160
Malta	Lemons (08055010)	26				728	816	914	348
Malta	Limes (08055090)					65	106	44	18
Malta	Citrus other (08059000)					3	63	1	36
Malta	Citrus total (0805)	8 776	2 119	4 352	6 705	15 845	6 598	8 249	7 233
Spain	Oranges (080510)	1 575	302 475	479 660		16 096	115 019	206 168	88 057
Spain	Mandarins (080520)	1 043	13 977	2 947	415	5 525	8 525	14 123	61 244
Spain	Grapefruit (080540)	1 708	25 299	697	2 129	2 067	17 353	11 461	6 287
Spain	Lemons (08055010)		272 105	71 559		618	20 376	18 825	16 392
Spain	Limes (08055090)	6 864	8 196	2 768	7 673	2 813	4 024	6 288	5 636
Spain	Citrus other (08059000)			5	29	128	626	194	517
Spain	Citrus total (0805)	11 190	622 052	557 636	10 246	27 247	165 923	257 059	178 133
Portugal	Oranges (080510)		154 794	205 339		152 060	94 930	59 808	56 364
Portugal	Mandarins (080520)	786	15 835	521		21 031	12 874	55 714	70 728
Portugal	Grapefruit (080540)	1 110	17 996	3 120		795	1 049	702	2 292
Portugal	Lemons (08055010)		16 951	15 102	0	7 412	26 983	18 241	5 935
Portugal	Limes (08055090)	2 562	3 659	793	2 146	2 790	4 948	3 217	3 265
Portugal	Citrus other (08059000)					8 048	1 130	774	29
Portugal	Citrus total (0805)	4 458	209 235	224 875	2 146	192 136	141 914	138 456	138 613

3.2.3. Entry pathway II: Citrus fruit and/or leaves import by passenger traffic.

The pathway of entry of CBC-causing bacteria with imported citrus fruit has been previously analysed in risk assessment documents made by the European Food Safety Authority (EFSA, 2006; EFSA PLH Panel, 2011), the United States Department of Agriculture (USDA, 2006, 2007a, b; 2008, 2009a, b, c, 2012) and the EFSA cooperation project on "Pest risk assessment for the European Community plant health: a comparative approach with case studies" (Prima Phacie) (MacLeod et al., 2012). As for pathway I, the evidence cited in these documents has been considered by the Panel, and when there are differences in conclusions these are discussed in the steps below and in the final conclusion for this pathway. For this pathway, citrus fruit was considered as fruit alone as well as fruit with attached peduncles and leaves.

Public awareness about importation of fruit or plant parts is considered to be limited, hence offering the opportunity for entry within the risk assessment area.

3.2.3.1. Probability of association with the pathway at origin

Although it should be considered that most of the conditions are similar to pathway I (citrus fruit, commercial trade) (see section 3.2.2), the Panel considers that fruit and/or leaves imported through the passenger traffic may have been obtained at markets in areas where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present and therefore are less likely to have been submitted to pest management (especially post-harvest treatments at the packinghouses) or sorting procedures at the country of origin. The worldwide presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* and the susceptibility of citrus fruit have already been described (see section 3.2.2). The likelihood of association with the pathway at origin, when compared with commercial fruit trade, is also higher because some countries where the disease is present are often visited by tourists who buy fruit and/or leaves on local open markets.

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* are likely to very likely to be associated with citrus fruit and/or leaves imported through the passenger pathway at origin, with a medium uncertainty as information and data are missing on interceptions on fruit along the passenger trafic.

3.2.3.2. Probability of survival during transport or storage

As stated for the citrus fruit, commercial trade pathway, *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* cells that survive are located mostly in lesions associated with fruit. One could expect that fruit transportation with passengers is likely to be at temperatures between 18 and 30 °C, with a mean around 21 °C, and within a shorter period of time than for commercial citrus fruit trade. Under such conditions, it is thus very likely that *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* survive transport, with a low level of uncertainty.

3.2.3.3. Probability of survival of existing pest management procedures

Besides the fact that no treatment fully eliminates viable bacteria (Gottwald et al., 2009) and that such treatments are not effective against *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* when present in canker lesions, it is very likely that fruit and/or leaves imported through the passenger traffic would not have been submitted to post-harvest procedures such as disinfection and sorting in the packing house.

Inspections to see whether passengers carry citrus fruit with them when arriving at EU airports from countries where CBC is present are not systematic. There is no information available about how frequently passengers carry citrus fruit when arriving into the EU from CBC- infected Third Countries and how likely it is for such passengers to be identified, so that pest management procedures could be potentially applied.

Data on citrus fruit interceptions on individual international passengers are available from two regions of Australia (Central East Region: 8 557 citrus fruit seized, January 2010 to March 2011; South Eastern Region: 4 892 citrus fruit seized, January 2010 to April 2011; Australian Government, 2011).

Considering that most international passengers arriving in Australia fly to these central/south-eastern regions, and since there are about 2 million international passengers per month (Australian statistics; this would roughly imply 1 million incoming passengers), a conservative estimate of about one passenger out of 1 000 carries one citrus fruit. This figure can be considered as a low estimate if substantial numbers of international passengers fly to Australian airports from outside the central/south-eastern regions and also taking account of the fact that some citrus fruit may not be noticed.

Based on this information, the Panel considers that the probability of surviving pest management procedures is rated as very likely, with low uncertainty despite the lack of information on this pathway, by analogy with the commercial fruit pathway.

3.2.3.4. Probability of transfer to a suitable host

It is very likely that citrus fruit and/or leaves imported from third countries by air passengers would arrive in the risk assessment area during the months of the year most appropriate for establishment in EU areas where citrus are grown.

Therefore, considering that:

- the association with the pathway at origin is very likely, owing to the high numbers of air traffic passengers entering the EU, especially from countries where citrus canker is present, and the lack of control measures to avoid infected fruit and leaves importation;
- there is lack of awareness among traffic passengers about the disease;
- the ability of the bacteria to survive during transport is very likely;
- the probability of the pest surviving existing pest management procedures is very likely, with a low level of uncertainty;
- the probability of transfer to a suitable host is considered to be unlikely, based on the available literature, but with a high level of uncertainty;

the Panel considers that one cannot rule out the transfer to a suitable host, although such an event remains unlikely. The Panel also stresses the high level of uncertainty for this pathway, owing to the lack of data available on the one hand and to the variation of conditions suitable for plant infection within the risk assessment area on the other hand.

3.2.4. Entry pathway III: Citrus plants for planting, commercial trade

3.2.4.1. Probability of association with the pathway at origin

The plant propagative material is considered to be a major source of primary inoculum in areas where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is not established or prevalent (Gottwald et al., 2002a). The bacteria primarily survive in canker lesions, which are quite common on shoots of susceptible cultivars (Gottwald et al., 2002a). They have also been found in association with leaves or budwood material. The possibility of regeneration of a citrus cultivar by shoot tip grafting on *in vitro* plants under sterile conditions offers a means of producing healthy plant material (Navarro et al., 1991).

Although it is generally accepted that the bacteria are unable to survive for long period outside lesions or in contact with soil (Graham et al., 1989), they survive for several years in lesions on woody branches (Goto, 1992; Gottwald et al., 1992). Twig lesions are also known to perpetuate the survival of the inoculum in areas where the disease is endemic (Graham et al., 2004).

It is somewhat difficult to estimate precisely the quantity of plant material for planting that would enter into the EU, since the pathway is currently prohibited (Council Directive 2000/29/EC, Annex III). For this purpose, it is useful to provide figures from institutions recovering and maintaining healthy citrus germplasm, such as the "Instituto Valenciano de Investigaciones Agrarias" (Spain) (FAO/IBPGR, 1991) to supply European citrus growers with healthy citrus propagating material. Currently, importation of citrus plants or plant parts from third countries is possible only through certified quarantine stations: the main origin of the imported planting material in the EU is Australia, Morocco, South Africa, and the USA, with a total of 78 importations since 2003 (Table 7), with minor importations from Argentina, Chile, Brazil, Israel, Japan, Turkey and Vietnam.

Table 7: Number of importation events of plant material (exclusively twigs for grafting) in the EU since 2003 (Navarro, 2013, personal communication; Legrand, 2013, personal communication)

From	To quarantine facilities in Spain (oranges and mandarins)	To quarantine facilities in France (citrus hybrids)
Chile	1	–
South Africa	26	–
USA	29	–
Australia	13	–
Israel	2	–
Vietnam	2	–
Brazil	2	–
Turkey	1	–
Japan	1	–
Argentina	1	–
Morocco	–	10

Nonetheless, in agreement with MacLeod et al. (2012) and taking into consideration the wide area cultivated with citrus in the EU, the Panel considers that, should the present trade restrictions be removed, a major volume of citrus plant propagation material would be imported into the EU citrus-growing regions.

The total concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in a consignment of citrus plants for planting would be dependent on the rate of infection. This parameter can vary according to several factors:

- citrus cultivars: citrus cultivars show markedly different levels of susceptibility to *X. citri* pv. *citri* (Gottwald et al., 2002a);
- the existence of quarantine measures in the area of origin;
- the use of integrated pest management strategies: including chemical control, cultural practices;
- cleaning and sorting of material practices: sorting of apparently healthy plants within a contaminated lot or pruning of diseased twigs can sometimes be achieved before shipment.

It should be noted that imported plant propagating material as an unregulated pathway is less likely to have been submitted to sorting procedures, pest management strategies or the quarantine process in the area of origin. High concentrations of inoculum would be correlated with the presence of canker lesions in the consignment.

Therefore, considering that:

- the disease occurs in many countries in the world;
- plant for planting material (budwood and whole plants) are a major source of inoculum, as *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* survive at high population densities in canker lesions;
- whole plants would probably bear juvenile organs, possibly allowing for latent infections;

- the expected volumes of plant for planting material of *Citrus*, *Fortunella*, *Poncirus* and their hybrids that would be imported in the European Union under the scenario of absence of regulation is not precisely known;

the Panel considers that it is likely that *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* would be associated with the pathway at origin, with a medium level of uncertainty, as local conditions (e.g. level of contamination of the country, separation of areas for production and nurseries and isolation of mother plants) are important for contamination of planting material.

3.2.4.2. Probability of survival during transport or storage

Plant propagation material (seedlings, budwood, scions and grafted plants or material issued from *in vitro* propagation) are transported and stored under conditions that do not alter the survival of the plant itself (air transport in cool boxes). Such conditions have no negative effect on the survival of *X. citri* pv. citri and *X. citri* pv. *aurantifolii* (Goto, 1962). It is thus very likely that *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* will survive transport. Latent populations of bacteria could be maintained under these conditions and will keep multiplying later on in suitable conditions then produce symptoms (see section 3.1.1.2). Furthermore, *X. citri* pv. *citri* exponential multiplication primarily precedes lesion development (Graham et al., 1992) and *X. citri* pv. *citri* population sizes in canker lesions are known to remain stable or slightly decrease over time (Stall et al., 1980; Pruvost et al., 2002; Bui Thi Ngoc et al., 2010). Multiplication of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* would occur only in the case of latent infections, which would primarily be related to the presence of young vegetative flushes on plants. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to survive during transport and storage of plants and plant parts, with a low level uncertainty.

3.2.4.3. Probability of survival of existing pest management procedures

No preharvest or postharvest method is known to supress or markedly affect *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* populations in canker lesions or in latently infected tissues (Gottwald et al., 2002a). Sorting of apparently healthy plants within a contaminated lot or pruning of diseased twigs can sometimes be achieved before shipment, but they do not guarantee a complete elimination of inoculum. In the case when plants in the consignment bear juvenile organs (leaves, twigs), high population sizes of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* can be present as latent infections and these are visually undetectable.

Budwood may be disinfected using treatments such as sodium hypochlorite or SOPP. However, the level of efficiency of such treatments has not been precisely reported for asymptomatic material, but it is probably partial, and is recognised as weakly effective for symptomatic material.

No pest management procedures are currently taken within the risk assessment area. Therefore, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to survive pest management procedures on plants for planting of *Citrus*, *Poncirus* and *Fortunella*, with a low level of uncertainty.

3.2.4.4. Probability of transfer to a suitable host

Plant material is intended for planting. Consequently, its end use could result in transfer to a suitable host or habitat. The long survival period associated with leaf or twig lesions, i.e. the lifespan of the leaf, or several years for branches, allows exposure of the inoculum to several climatic events, which allow bacterial growth and dispersal (see section 3.3.2). *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to transfer to a suitable host from plants for planting material, including plant parts (e.g. budwood material) of *Citrus, Poncirus, Fortunella* or their hybrids.

Imported planting material would be typically either plant for planting material or budwood material for grafting. However, if used for budwood propagation, contaminated or exposed material produced from this mother material could be distributed on a wider scale.

The primary source of inoculum in outbreaks in countries where citrus canker strains had been absent or of limited distribution is usually unknown. However when documented, evidence has been provided that citrus propagative material (legally or illegally introduced) had been the source of the related outbreaks. For example, the 1912 outbreak in Northern Territory (Australia) was caused by the importation of citrus plants from China and Japan (Broadbent et al., 1992). The 1991 and 2004–2005 outbreaks in Northern Territory and Queensland, respectively, have not been elucidated, but it is hypothesised that the former one was the result of illegal budwood importation (Broadbent et al., 1992; Gambley et al., 2009). In Florida, the 1910 outbreak was caused by the introduction of trifoliate rootstock from Japan (Schubert et al., 2001). An illegal movement of contaminated material was suspected as the cause of an isolated outbreak in South Florida in 1990, but its precise nature has been impossible to determine (Gottwald et al., 1992). In Brazil, the history of introductions has been poorly documented. The initial outbreak in Sao Paulo state (Presidente Prudente) in 1957 was reported to have occurred first in a small nursery owned by a manager of Japanese origin (Rossetti, 1977).

Infected budwood could probably be grafted in a citrus-producing region of the PRA area and be established in the vicinity of citrus plants in orchards or private gardens. Although much less likely because of the awareness of nurserymen, such imported budwood could be used in nurseries or amateur private gardens. Therefore, the intended use of the commodity would aid transfer to a suitable host or habitat.

Taking into account that:

- citrus species are extensively grown in the EU Mediterranean countries, in commercial orchards and nurseries but also private gardens;
- importation of plant for planting material was identified as a source for outbreaks in the past;
- the intended use of plant propagating material is planting (rootstocks) or grafting (scions, budwood);

the Panel considers that *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to be transferred to a suitable host, with a low level of uncertainty.

Therefore, the Panel considers that the association with the pathway at origin is likely, that the survival during transport or storage, the probability of surviving existing pest management procedures and the probability of transfer to a suitable host are very likely, and the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* through citrus plants for planting import, commercial trade, under the scenario of no regulation in place, is likely.

3.2.5. Entry pathway IV: Citrus plants for planting import by passenger traffic

For air traffic passengers, the level of awareness of the risk of introduction of citrus bacterial canker in EU is considered as low at present.

3.2.5.1. Probability of association with the pathway at origin

The plant propagative material is considered to be a major source of primary inoculum in areas where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is not established or prevalent (Gottwald et al., 2002a). The bacterium primarily survives in canker lesions, which are quite common on shoots (Gottwald et al., 2002a). It has been found in association with leaves or budwood material. If it is generally accepted that the bacteria is unable to survive for long period outside lesions or in contact with soil (Graham et al., 1989), they survive for many years in lesions from woody branches (Goto, 1992; Gottwald et al., 1992). Twig lesions on young shoots are also known to perpetuate the survival of the inoculum in areas where the disease is endemic (Graham et al., 2004).

It is difficult to estimate precisely the quantity of plant material for planting that would enter into the EU, since the pathway is regulated now. Based on Australian passenger control data, the assumption is made that the quantity of plant material imported through passenger traffic is likely to be low to very low. Nevertheless, it is relatively easy to travel with budwood material and/or *in vitro* propagation material: thousands of contaminated citrus budwood were illegally imported into California in 2004 from Japan by a nurseryman (CDFA, 2005).

The total concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in citrus plants entering the EU would be dependent on the rate of infection. This parameter can vary according to several factors:

- citrus cultivars: citrus cultivars show markedly different levels of susceptibility to *X. citri* pv. *citri* (Gottwald et al., 2002a);
- the existence of quarantine measures in the area of origin;
- the use of integrated pest management strategies, including chemical control, cultural practices;
- cleaning and sorting of material practices: sorting of apparently healthy plants within a contaminated lot or pruning of diseased twigs can sometimes be achieved before travel.

It should be noted that imported plant propagating material in a unregulated pathway is less likely to have been submitted to sorting procedures, pest management strategies or quarantine processes in the area of origin. High concentrations of inoculum would be correlated with the presence of canker lesions in the consignment.

Therefore, considering that:

- the disease occurs worldwide;
- plants for planting material (budwood and whole plants) is a major source of inoculum, as *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* survive at high population densities in canker lesions;
- plant material not intending for planting (plant material collected in the field, in gardens etc.) may be used by passengers for planting;
- whole plants would probably bear juvenile organs, possibly allowing for latent infections;
- the expected volumes of plant material (to be used as planting material even if not grown as planting material) of *Citrus*, *Fortunella*, *Poncirus* and their hybrids importation in the European Union under the scenario of absence of regulations is not precisely known;

the Panel considers that it is likely that *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* would be associated with the pathway at origin, with a medium level of uncertainty as local conditions (e.g. level of contamination of the country, plant material intended for planting but not grown as planting material, separation of areas for production and nurseries, isolation of mother plants) are important for contamination of planting material.

3.2.5.2. Probability of survival during transport or storage

As described for pathways II and III, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to survive during transport and storage of plants and plant parts, with a low level of uncertainty.

3.2.5.3. Probability of survival of existing pest management procedures

No pre-harvest or post-harvest method is known to suppress or markedly affect *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* populations in canker lesions or in latently infected tissues. In an unregulated pathway, and for occasional importation by amateurs, it is very likely that no management procedures would be implemented. Furthermore, there is no management procedure currently implemented in the risk assessment area. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are therefore very likely to survive pest management procedures on plants for planting of *Citrus*, *Poncirus* and *Fortunella*, with a low level of uncertainty.

3.2.5.4. Probability of transfer to a suitable host

Imported planting material would be typically either plants for planting material or small quantities of budwood material for grafting, which would most likely not be distributed widely. However, if used for budwood propagation, contaminated or exposed material produced from this mother material could be distributed on a wider scale.

The primary source of inoculum in outbreaks in countries where citrus canker strains had been absent or of limited distribution is usually unknown. However when documented, evidence has been provided that citrus propagating material (legally or illegally introduced) had been the source of the related outbreaks (see section 3.2.4.4, pathway III).

Budwood could probably be grafted in a citrus-producing region of the PRA area and be established in the vicinity of citrus plants in orchards or private gardens. Although much less likely because of the awareness of nurserymen, such imported budwood could be used in nurseries or amateur private gardens. Therefore, the intended use of the commodity would aid transfer to a suitable host or habitat.

Therefore, taking into account:

- that citrus species are extensively grown in the EU Mediterranean countries, in commercial orchards and nurseries but also private gardens;
- that importation of plant for planting material was identified as the source for outbreaks in the past;
- the intended use of plant propagating material is planting (rootstocks) or grafting (scions, budwood);
- the lack of awareness of amateur gardeners, who may introduce plant and planting material through passenger traffic;

the Panel considers that *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to be transferred to a suitable host, with a low level of uncertainty.

3.2.6. Entry pathway V: Ornamental rutaceous plants for planting, commercial trade

Besides citrus plant for planting intended for fruit production, rutaceous species are widely used in Europe as ornamental plants in private gardens, parks and other public areas. The genera *Citrus*, *Poncirus*, *Fortunella* and the species *Microcitrus australis*, *Swinglea glutinosa* and *Naringi crenulata* have been shown to be natural host for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* (section 3.1.1.4).
Other species of *Microcitrus* and other rutaceous genera are known as putative hosts, showing lesion development only after artificial inoculation (*Acronychia acidula*, *Aegle marmelos*, *Aeglopsis chevalieri*, *Atalantia ceylonica*, *A. citrioides* and *A. guillauminii*, *Casimiroa edulis*, *Clausena lansium*, *Citropsis articulata*, *Eremocitrus glauca*, *Feroniella lucida*, *Limonia acidissima*, Lunasia *amara*, *Melicope denhamii* and *M. triphylla*, *Microcitrus australasica* and *M. garrowayae*, *Micromelum minutum*, *Murraya exotica*, *M. ovatifoliolata*, *Paramignya longipedunculata* and *P. monophylla*, *Tetradium* sp., *Toddalia asiatica* and *Zanthoxylum clava-herculis* and *Z. Fagara*, see also section 3.1.1.4). As for citrus plant for planting for citrus fruit production, the pathway is considered as relevant .

3.2.6.1. Probability of association with the pathway at origin

The presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* being associated to ornamental citrus plants (*Citrus*, *Fortunella and Poncirus* species and their hybrids) is considered as likely, as stated already for plants for planting for citrus fruit production (see section 3.2.4.1). Besides *Citrus*, *Fortunella* and

Poncirus species, other rutaceous species have also been reported to be susceptible hosts for citrus canker, based on development of lesions following natural infections or artificial inoculations (see section 3.1.1.4). Most of such information relies on old data, but no recent investigation on the susceptibility of alternative hosts is available. There is also a lack of information about latent infections or endo- and/or epiphytic presence of *X. citri* pv. *citri* in association with ornamental rutaceous hosts, despite the report of atypical symptoms presumably caused by the bacteria (Peltier and Frederich, 1920).

Depending on commercial opportunities and EU consumers' demands, susceptible plant species (see section 3.1.1.4) could be imported in the future. Ornamental rutaceous plants could be produced in nurseries where *X. citri* pv. *citri* occurs.

The total concentration of inoculum in a consignment would be dependent on the level of infection, i.e. the presence of canker lesions.

It can be hypothesized that, with no regulation in place, this pathway would concern small quantities, but represent high value plant material, such as budwood or bonsai.

Imported *Murraya* plants are primarily bonsai, but they are also used as hedges in public or private gardens, being used as traditional medicine.

Based on the current information available, the Panel considers that the association with the pathway at origin is likely for the genera *Citrus*, *Poncirus*, *Fortunella* and the species *Microcitrus australis*, *Swinglea glutinosa* and *Naringi crenulata*, with low uncertainty. For the genera listed in section 3.1.1.4 as putative hosts the association with the pathway at origin is rated moderately likely, with a high uncertainty, due to the lack of recent information on host plant susceptibility.

3.2.6.2. Probability of survival during transport or storage

As stated for pathway III, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to survive during transport and storage of plants and plant parts, with a low level of uncertainty.

3.2.6.3. Probability of survival of existing pest management procedures

No pre-harvest or post-harvest method is known to suppress or markedly affect *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* populations in canker lesions or in latently infected tissues. Sorting of apparently healthy plants within a contaminated lot or pruning of diseased twigs can sometimes be achieved before shipment but this does not guarantee complete elimination of inoculum. In the event that plants in the consignment bear juvenile organs (leaves, twigs), high population sizes of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* strains can be present as latent infections and these are visually undetectable. Furthermore, there is no management procedure currently implemented in the risk assessment area. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to survive on ornamental rutaceous plants that are reported to be *X. citri* pv. *citri*- or *X. citri* pv. *aurantifolii*-susceptible host species, with a low level of uncertainty.

3.2.6.4. Probability of transfer to a suitable host

Ornamental rutaceous plants (other than bonsai) may be intended for planting. Consequently, the use of contaminated plants could result in a transfer to a suitable host or habitat.

If the imported plants are used as bonsai, topiaries or mother plants for propagation in nurseries, then the risk of transfer is high. Diseased or contaminated ornamental plants could act as a source of inoculum if present in a citrus-producing area. Diseased ornamental rutaceous species could be settled in the vicinity of more susceptible host species in nurseries and nearby orchards or private gardens.

Therefore, taking into account that:

- rutaceous ornamental species are extensively grown in the EU Mediterranean countries, in nurseries but also in private gardens or public avenues or squares;
- several rutaceous plant species are susceptible to *X. citri* pv. *citri* or *X. citri* pv. *aurantifoli*, but lesion development may vary among plant species*;*
- importation of plant for planting material was identified as the source for outbreaks in the past;
- the intended use of plant propagating material is planting (rootstocks) or grafting (scions, budwood);

the Panel considers that *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to be transferred to a suitable host, with a high level of uncertainty.

3.2.7. Entry pathway VI: Ornamental rutaceous plants for planting import by passenger traffic

As stated for pathway V, there is an increasing interest in Europe over ornamental rutaceous plant species, similar or different from the *Citrus*, *Fortunella and Poncirus* species banned for importation in the EU. Some of these plants are used as ornamental plants for gardens, hedges or bonsai (RHS, 1996; Mioulane, 2013). Since this pathway is of interest for amateur gardeners, the pathway targeting importation of ornamental rutaceous plants for planting through passenger traffic is considered as relevant.

3.2.7.1. Probability of association with the pathway at origin

Several countries where the disease is present are tourist destinations. The total concentration of imported inoculum will be dependent on the level of infection. This parameter can vary according to several factors, including the susceptibility of the plant species, existing management procedures, for example cleaning and sorting of material. It is anticipated that, owing to a lack of awareness by amateurs, such procedures would be limited. High concentrations of citrus canker strains would be correlated with the presence of canker lesions.

It can be hypothesised that, with no regulation in place, this pathway would concern small quantities, but represent high value plant material, such as budwood or bonsai. The origin of these plants is not readily available, but based on data from France (Hostachy, personal communication, 2013) and information from the Internet, the main origin is Asia.

As mentioned for the pathway V, the association of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* with ornamental plants for planting is likely for the genera *Citrus*, *Poncirus*, *Fortunella* and the species *Microcitrus australis*, *Swinglea glutinosa* and *Naringi crenulata* with low uncertainty, and moderately likely for the genera listed in section 3.1.1.4 as putative hosts, with a high level of uncertainty.

3.2.7.2. Probability of survival during transport or storage

As considered previously for pathway V, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to survive during transport and storage of plants and plant parts, with a low level of uncertainty.

3.2.7.3. Probability of survival of existing pest management procedures

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* are also very likely to survive on ornamental rutaceous species that are reported to be susceptible hosts. Plants introduced through passenger traffic are not likely to have been submitted to any pest management procedure.

3.2.7.4. Probability of transfer to a suitable host

Ornamental rutaceous plants are plant material intended to be planted. Despite the fact that ornamental citrus are sometimes grown indoors, their outdoor use directly could result in transfer to suitable host or habitat.

Diseased or contaminated ornamental plants could act as a source of inoculum if present in a citrus-producing area. Diseased ornamental rutaceous species could be settled in the vicinity of more susceptible host species in nurseries and nearby orchards or private gardens.

Therefore, taking into account that:

- rutaceous ornamental species are extensively grown in EU Mediterranean countries, in nurseries, orchards but also private gardens or public avenues or squares;
- importation of plant for planting material was identified as the source for outbreaks in the past;
- the intended use of plant propagating material is planting (rootstocks) or grafting (scions, budwood);
- for amateur gardeners, their lack of awareness of plant diseases, hence increasing the introduction of infected plants and planting material through passenger traffic;

the Panel considers that *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to be transferred to a suitable host, with a high level of uncertainty.

3.2.8. Entry pathway VII: Citrus and rutaceous leaves and twigs, commercial trade

Importation of leaves which could be sometimes attached to small branches is considered as a pathway, even though the importation is small volume owing to the very specific end use of these plant parts for Asian cooking purposes. Imported leaves and twigs of citrus and other ornamental rutaceous plants are mostly kaffir lime (*C. hystrix*) (ABC News, 2012; MVCB, 2012).

216 import interceptions of citrus leaves have been notified by Member States between 2003 and 2012 (Table 8). Such interceptions mostly result from limited surveys of undeclared packages and passenger baggage and reflect only a fraction of the total import of citrus leaves. In seven of these cases *X. axonopodis* pv. *citri* was reported: one in 2008, five in 2009 and one in 2010. The distribution of notifications by Member State and by year shows a strong correlation between Member States and the years of interception. Most interceptions of citrus leaves were reported by Nordic Member States, notably Germany, the UK and the Netherlands; one interception was reported by a Mediterranean Member State. This may be partly explained by differences in interception schemes at borders between Member States, the possibly larger import volume of citrus leaves in Nordic Member States where Asian communities are frequent, and the potential to grow *C. hystrix* in Mediterranean countries.

The number of interceptions found in these limited survey programmes suggest a substantial rate of illegal import of citrus leaves. The number of lots infected with *X. citri* indicate that *X. citri* may enter the EU on this pathway.

Table 8: Number of intercepted lots of citrus leaves by Member States between 2003 and 2012 (data extracted from EUROPHYT, (online) on 14 March 2013)

Year	Austria	Czech Republic	Germany	The Netherlands	Spain	Sweden	UK	Total
2003			2					2
2004			17				1	18
2005			5		1		31	37
2006		1	29	1		12	26	69
2007			5			2	2	9
2008		4	6			1	2	13
2009		1	6	11			1	19
2010		1	6	25			3	35
2011	1			3			4	8
2012				4			2	6
Total	1	7	76	44	1	15	72	216

3.2.8.1. Probability of association with the pathway at origin

Detached leaves are imported from Asiatic countries where CBC is endemic.

It is very likely that citrus leaves imported from third countries would arrive in risk assessment area during the months of the year most appropriate for establishment in EU areas where citrus are grown. Citrus have persistent foliage and several flushes of leaves can occur during the year. Kaffir lime leaves are sold via the Internet, either fresh or freeze dried.

The importation of citrus detached leaves is currently banned in the EU. So no data are available on the volume of legal importation. However, lots of citrus leaves are intercepted frequently in the EU (Table 8) and also other countries report on illegal entry, e.g. in 2012 in Australia an illegal consignment of kaffir lime leaves (*C. hystrix*) was intercepted and found infected by *X. citri* pv. *citri* (ABC News, 2012).

No information on the effect of bactericide treatments, such as chlorine or SOPP, on detached leaves is available. These treatments, which can be applied voluntarily, are not effective against *X. citri* pv. *citri* when present in canker lesions.

Citrus leaves and twigs are susceptible to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* infections, and develop lesions variable in size and in number, depending on when the infections occur along the plant development and the level of susceptibility of the host species. The younger the leaf and the twig are, the more susceptible they are to infection (see section 3.1.1.2).

The total concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in a consignment will be dependent on the level of leaf and branch infection. This parameter can vary according to several factors that are similar to those that affect fruit: (i) the presence of the *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* at the place of production, (ii) cultivar and plant species susceptibility, (iii) the existence of efficient phytosanitary measures in the area of production, (iv) the use of integrated pest management strategies and (v) cleaning, sorting and treatment of leaves and twigs.

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* are likely to be associated with citrus leaves and twigs, with a medium uncertainty owing to (i) the variation in plant species resistance and (ii) the occurrence of pest management measures set up in the countries exporting citrus leaves and twigs. *C. hystrix*, which is the major species used in cooking, is highly susceptible to *X. citri* pv. *citri* (Table 4).

3.2.8.2. Probability of survival during transport or storage

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* would be primarily located in lesions associated with leaves and twigs. Concentrations of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are correlated with the presence of canker lesions in the consignment. Population sizes in lesions range from 10^5 to 10^7 viable *X. citri* pv. *citri* per lesion and slowly decrease with lesions getting older (see section 3.1.1.2). *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are therefore very likely to survive during transport and storage of leaves and twigs, with a low uncertainty in fresh leaves. However, kaffir lime leaves are often dried before shipping and strong drying would probably affect bacterial survival.

3.2.8.3. Probability of survival of existing pest management procedures

No management practices are currently undertaken in the risk assessment area against other pests that prevent the entry of *X. citri* pv. *citri* on leaves and twigs, as it is forbidden to import the plant parts. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are therefore very likely to be associated with citrus leaves and twigs, with a low level of uncertainty.

3.2.8.4. Probability of transfer to a suitable host

Importation of leaves and twigs is currently illegal and the volume is impossible to assess. The volume is probably low because of the specific end uses of leaves and twigs for Asian cooking. However, import (although illegal) already exists (see Table 8) and would probably increase in the absence of regulation.

X. citri pv. *citri* may survive for ca. 120 days on decomposing plant litter, but at very small population sizes (Civerolo, 1984; Graham et al., 1987; Leite and Mohan, 1990). For specific conditions see sections 3.1.1.2 and 3.2.2.4. The transfer to a suitable host would involve the presence of infected litter and waste of leaves and twigs near growing host plants. Since the leaves are likely to be used by restaurants and private households, leaf waste may be placed in gardens, where trees may become infested and serve as a source for establishment.

It should be noted that the main end use for citrus leaves is cooking. Because most of the imported leaf material for cooking is imported as dry leaves, mostly into Northern European countries, and considerable limitations are expected for the transfer of the bacteria from infected leaves to citrus trees as (i) the need for disposal in the close vicinity of susceptible trees, in conjunction with (ii) conducive climatic conditions favouring either splash and/or wind-driven transfer, the Panel considers that the probability of transfer to a suitable host is unlikely, but with a high uncertainty owing to (i) the paucity of literature and (ii) the lack of extensive information on transfer under natural conditions.

3.2.9. Conclusions on the probability of entry

The above-mentioned components of probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the risk assessment area are presented in the table for each pathway and an overall rating for the probability of entry is provided below, together with its justification. Under a scenario of absence of any *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* official EU regulation, the probability of entry has been rated as unlikely for the fruit pathway, unlikely for the leaves and twigs pathway, likely for the plants for planting for citrus fruit production pathway and moderately likely for the plants for planting for ornamental citrus and other rutaceous pathways.

For fruit:

- The association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruit imported within the EU from countries where citrus canker is reported. The association with the passenger pathway is rated likely to very likely based on the lack of control measures through regulation and packinghouse processes for domestic markets as well as a lower awareness of the disease by passengers.

- The ability of bacteria to survive during transport, verified by the isolation of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, is rated very likely.
- The probability of the pest surviving existing management procedure is very likely, since cultural practices and chemical treatments (pre- and post-harvest) currently applied at the place of origin cannot eliminate the pathogen and no specific measures are currently in place in the risk assessment area.
- The probability of transfer to a suitable host is rated unlikely, based on the literature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur (i) because of occurrence of climatic conditions suitable for the transfer, (ii) the reports of infections from inoculum available at soil level owig to the short distance between tree canopy and soil in the risk assessment area and (iii) because of th presence of waste near to orchards.

Because transfer is critical and a limiting factor, the probability of entry is rated as unlikely for fruit.

For leaves and twigs, the probability of entry is rated unlikely because:

- The association with the pathway at origin is likely because leaves and cut twigs are imported from where the disease is endemic but the volume of citrus leaves is very low in comparison with citrus fruit imported within the EU from countries where citrus canker is reported;
- The ability to survive during transport is very likely.
- The probability of the pest surviving existing management procedure is very likely, since no management practices are currently undertaken in the risk assessment area.
- The probability of transfer to a suitable host is rated unlikely.

For plants for planting for citrus fruit production and for ornamental rutaceous plants that are natural hosts for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, through both the commercial trade and passengers pathways, the probability of entry is rated as likely because:

- The association with the pathway at origin is rated as likely for plants for planting for citrus production, through both the commercial trade and passengers pathways, because plants for planting have been recorded in the past as a source for outbreaks and based on the expected level importation of plants for planting from countries where citrus canker is reported.
- The association with the pathway at origin is rated as moderately likely for plants for planting for other rutaceous plants, through both the commercial trade and passengers pathways, owing to the lack of recent information on rutaceous ornamental host plants' susceptibility and a real difficulty in evaluating the level of trade under a hypothetically unregulated pathway.
- As for the fruit pathways, the ability to survive during transport is very likely.
- The probability of the pest surviving any existing management procedure is very likely since no specific measure is currently (prohibition excepted) in place in the risk assessment area as it is free of citrus canker. This probability would be even higher in the case of plants or plant parts imported through the passenger pathway.
- The probability of transfer to a suitable host is rated as very likely, based on the intended use of the plant material for planting (rootstocks) or grafting (scions, budwood) as well as on the fact that citrus (for fruit or ornamentals) and other rutaceous hosts are extensively grown in the risk assessment area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of amateur gardeners who are likely to import through passenger traffic.

Assessment of probability of entry and uncertainty for relevant entry pathways

Pathway		Probability of association with the pathway at origin		Probability of survival during transport or storage		Probability of survival of existing pest management procedures		Probability of transfer to a suitable host	
		Probability	Uncertainty	Probability	Uncertainty	Probability	Uncertainty	Probability	Uncertainty
Fruit	Commercial trade	Likely	Medium	Very likely	Low	Very likely	Low	Unlikely	High
	Passengers	Likely to Very likely	Medium	Very likely	Low	Very likely	Low	Unlikely	High
Plants for planting for citrus fruit production	Commercial trade	Likely	Medium	Very likely	Low	Very likely	Low	Very likely	Low
	Passengers	Likely	Medium	Very likely	Low	Very likely	Low	Very likely	Low
Ornamental Citrus and other rutaceous plants	Commercial trade	Likely for natural hosts Moderately likely for putative hosts	Low for natural hosts High for putative hosts	Very likely	Low	Very likely	Low	Very likely	High
	Passengers	Likely for natural hosts Moderately likely for putative hosts	Low for natural hosts High for putative hosts	Very likely	Low	Very likely	Low	Very likely	High
Leaves and twigs	commercial trade and passengers	Likely	Medium	Very likely	Low	Very likely	Low	Unlikely	High

Rating of probability of entry

Rating for entry	Justification
Unlikely for fruit	The probability of entry is rated unlikely for fruit because: The transfer to a suitable host is rated unlikely, owing to the lack of records of transfer of bacteria from fruit to plants as well as on the limited topical literature available; however, some data from Japan indicate that infections occur from inoculum available at the soil level The association with the pathway at origin is likely, owing to the high volume of citrus fruit imported within the EU, especially from countries where citrus canker is present and there are numerous reports of interceptions The ability of the bacteria to survive during transport is very likely, established by the isolation of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* The probability of the pest surviving existing pest management procedures is very likely, since no cultural practices and chemical treatments (pre- and post-harvest) currently applied at the place of origin can eliminate the pathogen and no measures are currently established within the risk assessment area
Likely for plants for planting for citrus production and rutaceous plants that are natural hosts	The probability of entry is rated likely for plants for planting for citrus production and rutaceous plants that are natural hosts because: The association with the pathway at origin is rated as likely for plants for planting for citrus production, through both the commercial trade and passengers pathways, because plants for planting have been recorded in the past as a source for outbreaks and based on the expected level importation of plants for planting from countries where citrus canker is reported The ability of the bacteria to survive during transport is very likely The probability of the pest surviving any existing management procedure is very likely since no specific measure is currently in place in the risk assessment area The probability of transfer to a suitable host is rated as very likely, based on the intended use the plant material for planting (rootstocks) or grafting (scions, budwood) as well as on the fact that citrus hosts are extensively grown in the risk assessment area, in commercial orchards as well as in private and public areas
Moderately likely for other rutaceous species	The probability of entry is rated moderately likely for other rutaceous species because: There is a lack of recent information on the rutaceous ornamental host plants susceptibility and a real difficulty in evaluating the level of trade under the scenario considering that there is no regulation in place Citrus and rutaceous ornamental species are extensively grown in EU Mediterranean countries, in commercial orchards and nurseries but also in public avenues, squares and private gardens The ability of the bacteria to survive during transport is very likely Importation of plants for planting material was identified as a source for outbreaks in the past The intended use of plant propagating material is planting (rootstocks) or grafting (scions, budwood) the lack of awareness of amateur gardeners susceptible to importing plant and planting material though passenger traffic

Unlikely for leaves and twigs	The probability of entry is rated unlikely for leaves and twigs because: The association with the pathway at origin is likely because leaves and cut twigs are imported from Asia where the disease is endemic but the volume of citrus leaves is very low in comparison with citrus fruit imported within the EU from countries where citrus canker is reported The ability of survive during transport is very likely The probability of the pest surviving existing management procedures is very likely, since no management practices are currently undertaken in the PRA area The probability of transfer to a suitable host is rated unlikely

3.2.10. Uncertainties on the probability on entry

The uncertainties of probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are rated as high and are due to:

- The role of infected citrus fruit/peel and leaves present in the vicinity of susceptible plants as a source of primary inoculum allowing the transfer to a suitable host remains poorly documented. The two papers published on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of many more experimental data.
- Partial data on the presence and distribution of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country of origin.
- There is globally a lack of knowledge on sources of primary inoculum associated with outbreaks in areas where *X. citri* pv. *citri* was not endemic.
- The rate of infection of citrus fruit imported from countries where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present and the concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments are difficult to assess because they are highly dependent on variable environmental conditions at the place of production and they are also dependent on the technologies implemented by exporting countries in the field and in packinghouses. The numerous interceptions in the EU of consignments containing diseased fruit suggest a lack of total reliability of the integrated measures that are taken in a systems approach for eliminating the risk of exporting contaminated and/or diseased fruit.
- The extent of importation of citrus material via passenger traffic is not well documented.
- The susceptibility of ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus* to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the latent infection and/or endophytic and/or epiphytic presence of *X. citri* pv. *citri* in ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus*.

3.3. Probability of establishment

3.3.1. Availability of suitable hosts in the risk assessment area

Citrus are widely available as commercial crops in Southern Europe with a production area in the EU-28 estimated at 494 913 ha in 2007 and located in eight countries (see Table 9): (1) Spain (314 908 ha); (2) Italy (112 417 ha); (3) Greece (44 252 ha); (4) Portugal (16 145 ha); (5) Cyprus (3 985 ha); (6) France (1 705 ha); (7) Croatia (1 500 ha); and (8) Malta (193 ha).

Table 9: The citrus production area (in hectares) in the EU in 2007. Data extracted from EUROSTAT (on line) on 21 February 2013

Country/region	Orange varieties	Lemon varieties	Small-fruited citrus varieties	All citrus varieties [(a)]
European Union (27 countries)	279 048	62 854	151 510	493 413
Croatia	200	100	1 200	1 500
Cyprus	1 554	665	1 766	3 985
France	28	22	1 654	1 705
Provence-Alpes-Côte d'Azur	1	5	1	8
Corsica	27	17	1 648	1 692
France, not allocated	0	0	3	4
Greece	32 439	5 180	6 631	44 252
Kentriki Ellada, Evvoia	6 531	1 969	0	8 500
Ipeiros	3 993	0	0	3 993
Peloponnisos	17 347	1 730	3 379	22 458
Nisia Aigaiou, Crete	883	308	213	1 405
Crete	3 410	277	356	4 044
Other Greek regions	266	885	2 598	3 750
Malta [(b)]				193
Italy	73 785	16 633	21 997	112 417
Piemonte	0	0	0	0
Liguria	7	17	3	28
Tuscany(NUTS 2006)	6	0	0	6
Lazio (NUTS 2006)	399	82	178	660
Abruzzo	178	0	0	178
Molise	9	0	9	18
Campania	689	954	634	2 278
Puglia	3 462	146	4 059	7 668
Basilicata	4 640	39	2 093	6 774
Calabria	17 273	967	10 774	29 015
Sicily	43 731	14 338	3 106	61 176
Sardinia	3 387	86	1 138	4 612
Portugal	12 416	494	3 235	16 145
Norte	734	52	133	920
Centro (PT) (NUTS 95)	401	27	54	482
Lisboa e Vale do Tejo (NUTS 95)	256	196	37	490
Alentejo (NUTS 95)	1 585	11	247	1 844
Algarve	9 437	206	2 763	12 407
Spain	158 824	39 859	116 225	314 908
Principado de Asturias	0		0	1.00
Extremadura	278	0	38	317
Cataluña	2 080	20	10 777	12 877
Comunidad Valenciana	76 593	9 127	90 878	176 599
Îles Balears	660	397	98	1 156
Andalucía	64 158	5 646	9 999	79 804
Región de Murcia	14 514	24	4.433	43 509

Canary Islands (ES)	538	104	0	643

(a): Calculated by summing the area for all orange, lemon and small-fruited citrus varieties.
(b): Data for the citrus production area in Malta are provided according FAOSTAT (online) for the year 2011.The detailed production figures are as follows: tangerines, mandarins, clementines (6 ha); grapefruit including pomelo (1 ha); lemons and limes (38 ha); oranges (95 ha); other citrus fruits (53 ha).

Most of the cultivated areas are planted with citrus cultivars that are susceptible (sweet oranges, lemons) or weakly to moderately susceptible to citrus canker (tangerines and mandarins group).

In **nurseries** (propagating material of citrus for fruit production and ornamentals, figures are not easily available and were mostly estimated as number of plants based on a rate of tree renewal of 7.5 % (Aubert and Vullin, 1997)).

- Greece: 825 813 plants in 2006 and 542 300 in 2007 (estimation, Holeva, personal communication, 2013);
- France: 818 568 plants in 2005 (estimation, Hostachy, personal communication, 2013);
- Portugal: 844 000 plants (estimated according to Aubert and Vullin (1997);
- Spain: 10 665,000 plants (estimated according to Aubert and Vullin (1997);
- Italy: 5 771 000 plants (estimated according to Aubert and Vullin (1997).

In most places where citrus are grown, plant densities are high enough to allow local spread and thus establishment. Citrus are evergreen host species (except *P. trifoliata* which is deciduous but mostly used as a rootstock). Leaves can therefore maintain primary inoculum within lesions in addition to the branches during the establishment period until favourable conditions are met for new infections and dispersal (presence of young susceptible tissues, temperatures, association of wind and rainfall events—see section 3.1). For the mandarin and sweet orange groups, tree leaf flushing periods with production of leaf flushes occur during spring (March to May) and at the beginning of summer (July) and early autumn (September). In contrast and under suitable conditions, some lemon cultivars can produce up to six growth flushes per year (Praloran, 1971).

Similarly, citrus bloom occurs once a year early April to early May in Mediterranean conditions (Colombo, 2004), but some species, such as lemons or limes, can produce up to four blooms. Therefore, citrus fruit are at a susceptible growth stage at times when the temperature is more suitable to infection.

Harvest periods vary according to citrus species and cultivars. For instance, the harvest season for the two sweet orange cultivars New Hall and Valencia Late varies from the end of October to the end of May in Spain, respectively, while the harvest season for clementines and satsumas stretches from September to the beginning of February.

Low volumes of *Murraya* plants are traded primarily in the Netherlands (and France to a lesser extent) as bonsai, but they can be used as hedges in public or private gardens. However, the susceptibility of this host is not fully established (i.e. no record of natural infections worldwide—see section 3.1.1.4).

Citrus hosts (mostly sour oranges—C. *aurantium*) are commonly present along the streets and in the parks of Mediterranean Member States and Portugal. Citrus are also grown in private and public gardens in both rural and urban regions.

Very few non-crop host genera have been reported in the EU-28: *Microcitrus* and *Zanthoxylum* are present in Italy (Ducci and Malentacchi, 1993; Recupero et al., 2001). The reported *Microcitrus* species were *M. australasica* and *M. papuana*, the susceptibility to citrus canker of the former species having been established from artificial inoculation experiments (see section 3.1.1.4). None of the available references and sources allows estimation of the prevalence of these rutaceous genera, nor does it allow evaluation of their spatial proximity to citrus crops. Other rutaceous genera are present in the risk assessment area but their host status is unknown at present.

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* complete their disease cycle on citrus without the need for an alternative host (Gottwald et al., 2002a), rending its achievement possible in the risk assessment area.

X. citri pv. *citri* is not transmitted by an insect vector from plant to plant. However, the citrus leaf miner (*Phyllocnistis citrella*, CLM) larvae wound the young growing citrus tissues (leaves and stems) when creating galleries which markedly increase the number of infection sites and tissue susceptibility. CLM has been widely distributed around the Mediterranean Basin since the 1990s (Argov and Rössler, 1996, EPPO PQR database – EPPO, online a).

3.3.2. Suitability of environment

Originating from where tropical conditions are prevalent, *X. citri* pv. *citri* was widely disseminated over the twentieth century and was able to establish in subtropical conditions (e.g. South Africa, New Zealand) (Doidge, 1929; Dye, 1969). The citrus production regions in the EU correspond to hardiness zones 8 to 10 (Figure 5). Based on the current worldwide distribution of citrus canker, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have the ability to establish in hardiness zones 8 to 13 and 8 to 10, respectively.

X. citri pv. *citri* can overwinter in leaf and twig lesions (Goto, 1992; Gottwald et al., 2002a; Pruvost et al., 2002; Graham et al., 2004). Even though the temperature for bacterial multiplication following infection is about between 12 °C and 40 °C (Dalla Pria et al., 2006), bacteria can survive negative temperatures as cultures may be conserved during freezing. Infection may occur at temperatures more than 5 °C and remains latent until the temperature increases (Peltier, 1920).

Some severe weather events exist in the risk assessment area based on data from the European Severe Weather Database (Brooks et al., 2003; Dotzek et al., 2009). It can be large hailstorms (i.e. hailstones observed to have a diameter (in the greatest dimension) of 2.0 cm or more, or smaller hailstones that form a layer 2.0 cm thick or more on flat parts of the earth's surface). Heavy rain (i.e. damage caused by excessive precipitation is observed, or no damage is observed but precipitation amounts exceptional for the region in question have been recorded, or one of the following limits of precipitation accumulation is exceeded: 30 mm in one hour, 60 mm in six hours, 90 mm in 12 hours, 150 mm in 24 hours) is also documented. Tornadoes (i.e. a vortex, typically between a few metres to a few kilometres in diameter, extending between a convective cloud and the earth's surface, which may be visible by condensation of water vapour or by material (e.g. dust or water) being lifted off the earth's surface) also occur on a relatively frequent basis over areas where citrus trees are grown, at least non-commercially (as defined in section 3.3.1). Table 10 provides some data. Such severe weather events favour the creation of wounds and/or infection and can therefore promote the establishment of *X. citri* pv. *aurantifolii* and *X. citri* pv. *citri*.

Table 10: Number of severe weather events occurring over land in countries where citrus is grown (from 1 January 2000 to 30 April 2013 as provided by the European Severe Weather Database (European Severe Weather Database, online)

Country	Large hail	Heavy rain	Tornadoes
Croatia	63	203	25
Cyprus	19	23	10
France [(a)]	29	123	15
Greece	162	140	34
Italy	549	1 131	205
Malta	9	19	3
Portugal	42	68	38
Spain	295	447	59
Total	1 168	2 154	389

(a): Restricted to Corsica and Côte d'Azur.

In addition to irrigation applied during the dry periods of the year, in the citrus-producing Member States, citrus groves and nurseries are located in coastal areas, next to rivers (Agustí, 2002), and in these areas the relative humidity is higher than that inland.

3.3.3. Cultural practices and control measures

3.3.3.1. Plantation density

Citrus trees are grown in monoculture (orchards and nurseries) with susceptible species being sometimes planted over large areas. In most places where citrus are grown, plant densities are sufficient to support establishment and the development of a local outbreak if primary infection occurred. Citrus density in plantations depends on climatic conditions and different citrus types. Currently, plantation density can vary from about 333 to 420 trees/ha for sweet oranges and clementines in the Mediterranean Basin, corresponding to 7×4 m or 6×4 m spacings for instance (Tucker and Wheaton, 1978). High-density citrus plantations, aimed at improving the effectiveness and profitability of the system and addressing land use and disease management issues, yields planting up to 1 000 trees/ha, and is experienced in different regions of the risk assessment area (Stover et al., 2008; Bordas et al., 2012). The current plantation densities (e.g. 400–500 trees/ha for mandarins and clementines) and higher ones allow natural dispersal of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* and therefore favours establishment. The prevailing cultivation practices enable vigorous trees and favour greater leaf flushes, i.e. development of tissues.

3.3.3.2. Control of other pests and diseases

No natural enemies have been reported as having the potential to negatively affect establishment of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. Antagonistic bacteria or bacteriophages have been reported to interact experimentally with *X. citri* pv. *citri* (Unnamalai and Gnanamanickam, 1984; Goto, 1992; Kuo et al., 1994) but there is no evidence of an efficient control under natural conditions.

Few management practices are currently undertaken in the risk assessment area against other pests that prevent the establishment of *X. citri* pv. *citri*. Copper-based treatments are applied to control *Alternaria* brown spot in areas of Spain, Italy and Greece where it is present and Mal Secco in Italy (Elena, 2006; Migheli et al., 2009; Vicent et al., 2009). When applied, these copper programmes may reduce but not prevent the establishment of citrus canker.

3.3.3.3. Irrigation practices

Practically all the commercial citrus orchards existing in the European Union are irrigated nowadays during the dry periods of the year (Carr, 2012). However, the type of irrigation system employed is not uniform across EU citrus orchards. In this sense it should be noted that irrigation management and the system employed might influence the incidence of citrus canker disease, by affecting the release and dispersal of bacteria, the local canopy micro-environment and the leaf decomposition at ground level. Overhead irrigation is still applied at least in some parts of the EU where it is used for frost protection as well as irrigation. This way of dispersal, although limited, can be of great concern in unprotected nurseries producing young trees to be introduced to new groves. Owing to the huge amount of water and the influence of microclimate, overhead irrigation and flooding practices will decrease. This will reduce the impact of irrigation on *X. citri* pv. *citri* development.

<u>Different types of irrigation systems</u>

The irrigation systems used in EU citrus orchards are: surface irrigation, sprinkler irrigation and micro-irrigation (see Stewart and Nielsen (1990) for details about each method).

Surface irrigation
In this irrigation system, the irrigation water is applied at one edge of a farm and flows across the soil surface by gravity. Irrigation water is generally applied at a frequency of 13–25 days. In this case, most of the fallen citrus leaves will be mostly wetted, which will increase the citrus leaves' decay.

Sprinkler irrigation
In these systems water is supplied in a pressurised network and emitted from sprinkler heads mounted on either fixed or moving supports. In European citrus orchards only set sprinkler irrigation systems are found. Set systems are those in which the sprinklers are placed on a fixed grid or spacing. The entire orchard floor is wetted and the water is applied over the tree canopy, so the irrigation water completely wets the tree canopy, similar to a rainfall event. Irrigation water applications are generally applied at a frequency of 7–20 days.

In addition to irrigation water applications, set sprinkler systems can be also used for frost protection.

This system will favour release and dispersal of the bacteria.

Micro-irrigation
It includes the method more commonly known as drip or trickle irrigation and other low-pressure systems. In European citrus orchards two main types of micro-irrigation systems are found. *Drip irrigation*, where water is allowed to drip slowly to the soil through an emitter with a low discharge rate, and *trickle micro-irrigation* where water is applied by sprayers located underneath the tree canopy 45–70 cm above the soil of the orchard where part of the bottom part of the canopy is also directly wetted by the irrigation system.

<u>Regional differences in citrus irrigation</u>

It should be noted that the data available on this aspect are particularly scarce, but differences in irrigation practices exist among regions. They are described below for some countries.

Spain
The Spanish citrus orchards are mostly irrigated either by flooding irrigation or by drip irrigation using low-pressure operating emitters located at the soil surface. In the Valencia region, according to Pons (2008), 67 % of the entire citrus orchards are irrigated using drip systems, while 32 % is under flood irrigation. Sprinkler systems are only used in the remaining 1 % of Valencia citrus orchard plantations, where they are employed to also provide for some frost protection. However, this sprinkler system is not overhead and wets only the bottom part of the tree canopy.

In the southern citrus irrigation areas of Spain (Andalusia and Murcia), where citrus orchards plantations are generally newer (particularly in Andalusia), drip irrigation systems are more predominant, with 81 % of the citrus orchards using drip systems and the remaining 19 % using flooding irrigation (MAGRAMA, 2013).

Italy
In Sicily the predominant irrigation system is a sort of micro-irrigation (trickle irrigation) that uses low-pressure sprayers that often wet most of the orchard floor (Liberati, 2008). Irrigation is applied in turns of 8–25 days and irrigation applications might range from 20 to 60 mm at each irrigation application. Drip irrigation is applied in the remaining 10 % of the irrigated citrus area. Overhead sprinkler systems are used in some areas of Sicily and particularly in the regions of Calabria and Campania, but the percentage of the irrigated citrus area with overhead sprinkler systems in these two regions is only 6 % (Consoli, 2010).

Portugal
In Portugal, most of the commercial irrigated citrus orchards are located in the Algarve region. According to Norberto (2011), in this region, 88 % of the citrus orchards are irrigated by drip irrigation, 8 % by trickle micro-sprinklers applied below the tree canopy at about 100 cm height from the soil surface, and 4 % of the citrus orchards are flooding irrigated.

Greece
According to a recent review by Shirgure (2012), micro- and flooding irrigation are the two main types of irrigation systems used in the citrus-growing areas of Greece. In the Argolis country, south-

eastern Peloponnese, with a total citrus area of 12 500 ha: 1 000 ha are with flood irrigation (8 %), 300 ha with drip irrigation (2.4 %) and 11 200 ha with low-pressure sprayers (89.6 %). In this predominant type of irrigation system, the sprayers are located at a height of 40 cm above the orchard floor, one sprayer per tree at a distance 40–80 cm from the trunk and the water drops are ejected up to a height of 60 cm wetting in most cases the lower parts of the tree canopies. During winter months, sprayers are used for the protection of citrus trees from frost over an area of 2 000–3 000 ha.

Cyprus
In Cyprus, traditionally farmers have used the flooding method to irrigated citrus orchards. However, following pilot projects, modernisation took place, and drip-irrigated areas reached 26 %. The remaining 74 % of the irrigated citrus orchards are still under surface flooding irrigation, wetting the entire orchard floor (Mehmet and Ali Biçak, 2002).

Malta
In Malta the most reliable source of information comes from the study by Attard and Azzopardi (2005). They review the irrigation systems used and the water use efficiency in irrigated Maltese agriculture. Drip irrigation use has been steadily increasing in recent years, and 46 % of the citrus irrigated is nowadays drip irrigated (National Statistics Office, Malta, 2010). On the other hand, 52 % of the irrigated citrus orchards are still flood irrigated. The remaining 2 % of the orchards are irrigated according to systems other than flood and drip irrigation.

3.3.3.4. Other cultural practices and control measures

In different citrus-producing EU countries, healthy citrus plants for fruit production are produced through certification programmes (e.g. Spain, France, Italy) (Navarro et al., 2002). Such programmes prevent the establishment of citrus canker through certified nurseries. However, in some EU regions, such programmes are not fully operational.

As citrus are perennial hosts, no crop rotation is undertaken which would destroy the crop annually. However, pruning of the trees may reduce the presence of disease inoculum. Pruning will also create wounds in the tissues and/or induce the development of new flushes, therefore possibly promoting infection. Pruning regularity will depend on citrus species and different sorts of pruning will be done prior to bloom: e.g. for shaping the tree after planting, for opening up the tree structure and removing unwanted new shoots. Rootstock sucker elimination can be also practiced at other times.

Fertilisers are applied which favour longer and more intense flush periods. This will generate a greater volume of young susceptible tissues.

3.3.4. Other characteristics of the pest affecting the probability of establishment

Xanthomonads are organisms that reproduce asexually (i.e. organisms that do not need to find a compatible sexual partner and have a strong potential to multiply exponentially within relatively short time periods). In suitable conditions, *X. citri* pv. *citri* can complete its life cycle from infection to production of inoculum within a week (Vernière et al., 2003). It means that the pathogen can reproduce its life cycle many times during the host growing period, which is conducive to polycyclic epidemics (Gottwald et al., 1988, 1989).

Survival of *X. citri* pv. *citri* in diseased tissues is up to several years in twigs or branches or for the lifespan of the leaves. Then, when climatic conditions are favourable, the cycle of the bacterium is related to the development cycle of the host (inoculum proliferation corresponds to the growth and fructification period of the plant). Population sizes of *X. citri* pv. *citri* fluctuate with temperatures with a decrease in areas where a marked winter season occurs (Stall et al., 1980).

Its ability to survive outside of the citrus host (non-citrus host, soil, inert surfaces) is most likely very limited, although recent data warrant further research (see section 3.1.1.2).

Pathogenic variants, called pathotypes, based on differential host range, have been reported with some strains being specialists with restricted host range and most of them being generalists infecting all the citrus commercial cultivars (see section 3.1.1.4). Copper resistance genes have been identified on *X. citri* pv. *citri* plasmids (Canteros et al., 2010; Behlau et al., 2013). It has also been shown that copper resistance genes are naturally present within the citrus-associated bacterial microflora in areas exposed to high copper treatment pressure and have the ability to be integrated into the genome of *X. citri* pv. *citri* by horizontal gene transfer (Behlau et al., 2012b). Major pathogenicity genes are also plasmid borne and could be exchanged among strains by horizontal gene transfer (El Yacoubi et al., 2007). Streptomycin-resistant *X. citri* pv. *citri* strains were found both in streptomycin-treated citrus orchards and in untreated orchards in Jeju island (South Korea) where streptomycin is registered to control citrus canker (Hyun et al., 2012). Streptomycin resistance can be transferred by bacterial conjugation experimentally and such resistance acquisition could take place in orchards.

In addition, strains of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* would be introduced with their citrus host in the risk assessment area. New hosts encountered by the pathogen in the risk assessment area during the establishment process will also be citrus (*Citrus*, *Poncirus* or *Fortunella* species). This pathogen would be pre-adapted to its new host environment and would not face any host adaptation barriers that would constrain its establishment.

One citrus canker lesion on leaves can host approximately between 10^6 and 10^7 bacteria, whatever the lesion size, but can show a significant decrease when exposed to a marked winter season, such as in Argentina or Japan (Koizumi, 1977; Stall et al., 1980). The release of *X. citri* pv. *citri* populations ranges from 10^4 to 10^6 bacteria/ml (Timmer et al., 1991; Pruvost and Gagnevin, 2002). Minimum bacterial population densities to induce a canker lesion are 10^2 to 10^3 and 10^4 to 10^5 cells/ml through wounds and stomata, respectively (Goto, 1962; Gottwald and Graham, 1992). However, once they have entered the leaf tissues, a single bacterial cell is theoretically able to induce a lesion, further confirmed by experimental data which determined that as few as two bacterial cells were required to cause a single lesion (Gottwald and Graham, 1992). Thus, in suitable climatic conditions, one leaf lesion would be sufficient for establishment on susceptible hosts.

Outside the lesions, the levels of populations are much lower. Low epiphytic populations primarily associated with asymptomatic tissues have limited survival capabilities over time (see section 3.1.1.2). It is unlikely that infected culled fruits act as an efficient source of primary inoculum, although a study suggests that such an event could occur but with a very low likelihood (Gottwald et al., 2009). Recently, biofilm formation on plant surfaces has been suggested and supports their role in colonisation and adherence of *X. citri* pv. *citri* prior to development of canker disease (Rigano et al., 2007; Cubero et al., 2011). Moreover, a reversible VBNC state has been suggested for *X. citri* pv. *citri* in response to copper ions (Del Campo et al., 2009; Golmohammadi et al., 2012b), but the biological significance of VBNC *X. citri* pv. *citri* cells remains poorly understood.

3.3.5. Conclusion on the probability of establishment

The probability of establishment is rated as moderately likely to likely because host plants are widely present in some areas of the risk assessment area where environmental conditions are frequently suitable. The host is susceptible during most of the year to infection through wounds and for shorter periods through natural openings (two to three growth flushes except for some lemon and lime cultivars), and some severe weather events potentially promoting establishment occur on a regular basis in the risk assessment area. Cultural practices and control measures against fungal diseases currently used in the risk assessment area may reduce the severity of the disease but they cannot prevent the establishment of the pathogen. The pathogen would not require pathological adaptation to become established when it encountered a susceptible host.

Assessment of the components of the probability of establishment and uncertainty

Availability of suitable host(s)		**Suitability of environment**		**Application of cultural practices and control measures to prevent establishment**	
Probability	**Uncertainty**	**Probability**	**Uncertainty**	**Probability**	**Uncertainty**
Likely	Low	Likely	Medium	Moderately likely	Medium

Rating of probability of establishment

Rating for establishment	**Justification**
Moderately likely to likely	The likelihood of establishment is rated moderately likely to likely because: • Host plants are widely present in the risk assessment area, both as commercial crops, private gardens, parks, streets, etc. • Environmental conditions would not prevent establishment • The host is susceptible during most of the year for infection through wounds and for shorter periods through natural openings (two to three growth flushes except for some lemon and lime cultivars) • Cultural practices and control measures against fungal diseases currently used in the risk assessment area would partially act as a barrier to establishment • Some severe weather events potentially promoting establishment occur on a regular basis in the risk assessment area • The pathogen would not require pathological adaptation for becoming established when it would encounter a susceptible host

3.3.6. Uncertainties on the probability of establishment

Uncertainty on the probability of establishment is rated medium because information on the occurrence of suitable host in the risk assessment area is well documented. However, pieces of information are missing on the type of irrigation systems employed across orchards in the EU and the plant host susceptibility under environmental conditions that occur where citrus are grown in the risk assessment area. Furthermore, uncertainties remain on the efficacy of cultural practices and control measures in use in European groves and nurseries.

3.4. Probability of spread after establishment

Spread is considered to occur by natural and human-assisted modes and referring to expansion of the infestation front and how quickly the front moves and having new foci created at a distance from the current infestation. There is no known vector (besides humans) for *X. citri* pv. *citri* (Graham et al., 2004).

3.4.1. Spread by natural means

Natural spread of *X. citri* pv. *citri* has been reported to occur mainly by splash dispersal inoculum in water droplets and by wind transportation of bacterial cells in water droplets and in pieces of infected tissues (leaves and broken twigs), which allows efficient spread over relatively short distances in nurseries and orchards (Gottwald et al., 1989; Pruvost et al., 1999; Graham et al., 2004).

Citrus trees are grown in monoculture with susceptible species most of the time, and citrus groves are often established using rather high planting densities (e.g. 400–500 trees/ha). Cultivation practices that enable vigorous trees are applied in intensive groves in Europe, which is favourable to the spread of citrus bacterial canker. Overhead irrigation is sometimes in practice in groves and nurseries and favours symptom development and dispersal of inoculum (Gottwald et al., 2002a). Wind-driven rain readily spreads bacteria over short distances, i.e. within trees and to neighbouring trees when the wind speed exceeds 8 m/s as soon as rainfall occurs (Serizawa et al., 1969; Serizawa and Inoue, 1975). These climatic conditions occasionally occur in sites of citrus production (Figure 7 and Appendix F). Furthermore, the flushing period of leaf growth of most cultivated varieties occurs when climatic conditions favourable for dispersal may occur (spring and late summer to the beginning of autumn). Data shown in Appendix F (means over 2 500 km^2 grids) are consistent with the occasional occurrence of local climatic conditions favourable to spread such as thunderstorms (Figure 8).

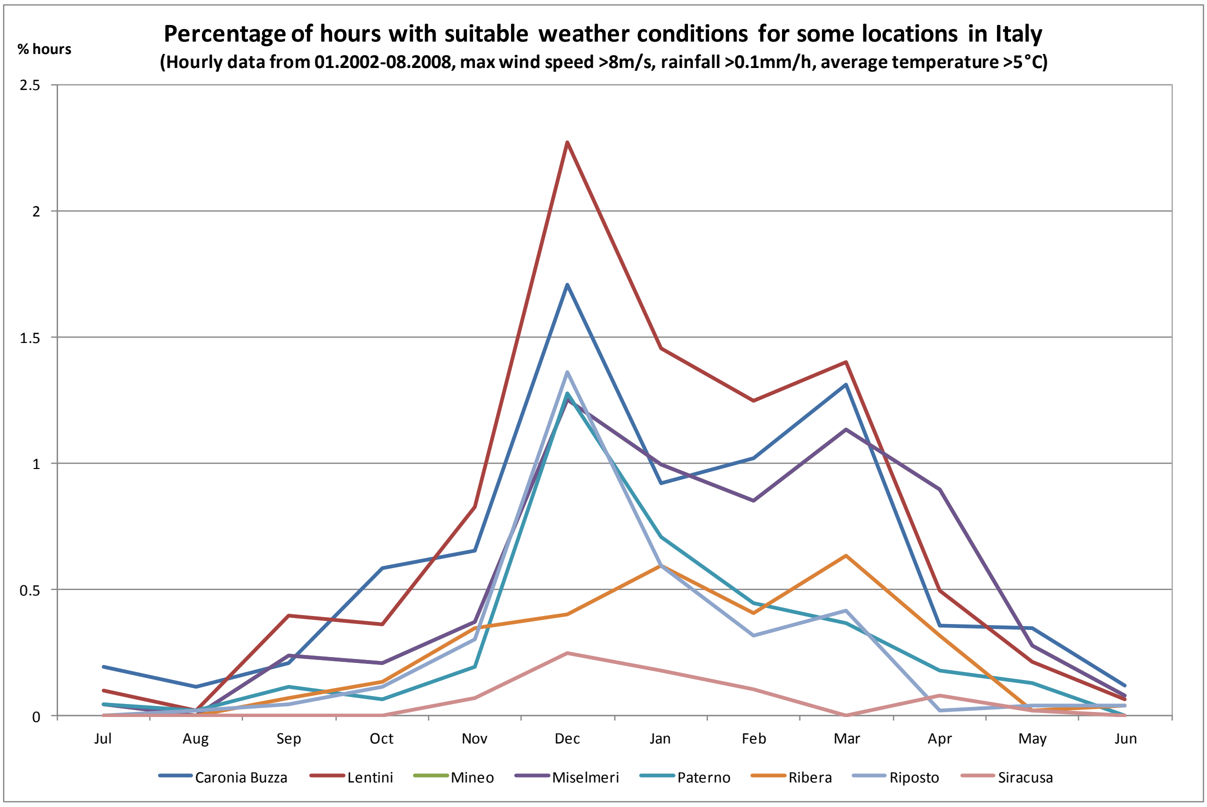

Figure 7: Monthly percentage of hours with suitable weather conditions (wind speed > 8 m/s, rainfall > 0.1 mm/h, average temperature > 5 °C) in some locations in the citrus-growing area in Italy (average from January 2002 to August 2008)

Aerosols can also spread xanthomonads over small to medium range distances (Kuan et al., 1986; McInnes et al., 1988). *X. citri* pv. *citri* was successfully isolated from air samples collected at eradication sites in Florida, suggesting that chipping machinery can locally spread *X. citri* pv. *citri* (Roberto et al., 2001). Adults of the Asian citrus leafminer (*Phyllocnistis citrella* Stainton) are not a vector for *X. citri* pv. *citri* (Belasque et al., 2005). Transportation of *X. citri* pv. *citri* on a very localised scale can be achieved through feeding larvae (Graham et al., 2004).

Storms have the potential to spread *X. citri* pv. *citri* over larger distances. Although under average conditions wind-blown inoculum was detected up to 32 m from infected trees in Argentina, there is evidence for much longer dispersal in Florida, associated with meteorological events, such as severe tropical storms, hurricanes and tornadoes (Stall et al., 1980; Gottwald and Graham, 1992; Gottwald et al., 2001). A distance of spread of up to 56 km was found in the county of Lee/Charlotte (Florida) as a result of a hurricane in 2004 (Irey et al., 2006). High wind speed increases both incidence and severity of citrus canker on two-year-old Swingle citrumelo with a dramatic increase following wind speeds > 10–15 m/s (Bock et al., 2010). This was associated with visible leaf injury evident when wind speed was ≥ 13 m/s, and the relationship between wind speed and leaf injury could be described by a logistic model (Bock et al., 2010).

Based on the European Severe Weather Database (online), events allowing spread over medium distances (i.e. wind-driven rain with wind speeds ≥ 25 m/s) occur on a regular basis, although not frequently, in the risk assessment area ($n = 88$; see Figure 8). Similarly, tornadoes ($n = 389$ from 1 January 2000 until 30 April 2013) have been recorded in the risk assessment area (Table 10).

It is likely that such severe weather conditions occurring in the risk assessment area could allow dispersal between orchards.

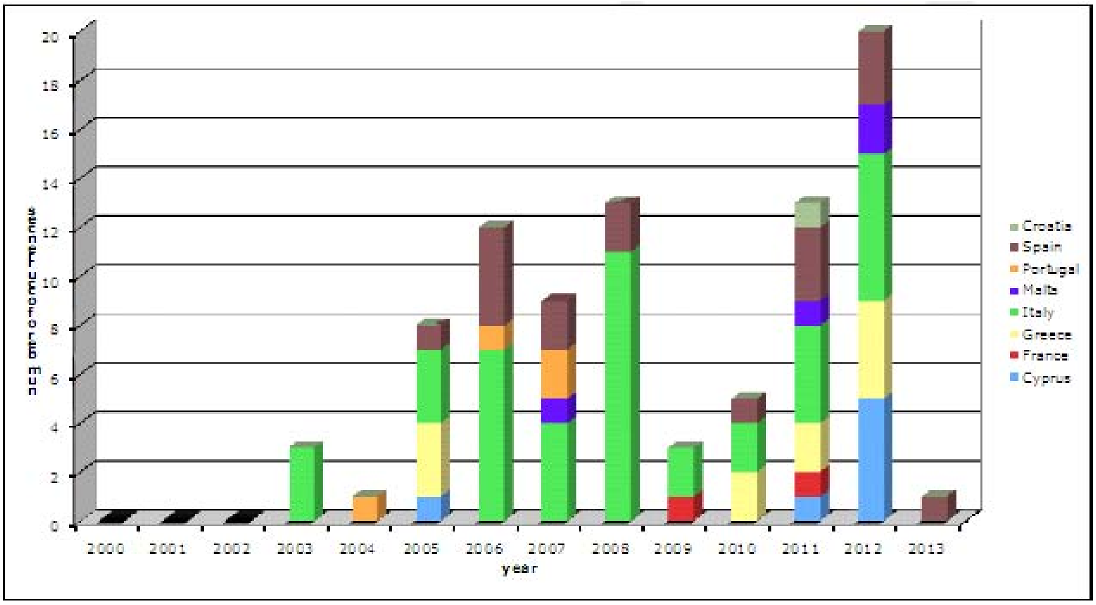

Figure 8: Number of occurrences of wind-driven rain with a recorded wind speed ≥ 25 m/s occurring over land in areas where citrus is grown (from 1 January 2000 to 30 April 2013 as provided by the European Severe Weather Database (European Severe Weather Database, online). Occurrences for France are restricted to Corsica and Côte d'Azur

3.4.2. Spread by human assistance

X. citri pv. *citri* and *X. citri* pv. *aurantifolii* are likely to spread in the risk assessment area by human assistance. *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* can transiently survive on inert surfaces and can be locally or regionally transported by clothes, shoes, orchard machinery and harvesting equipment (Gottwald et al., 1992, 2002a; Graham et al., 2004). Grove maintenance equipment was associated to secondary spread in a Florida outbreak (Gottwald et al., 1992). Over long distances, and especially across national borders, *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are readily spread by infected vegetative propagating material during trade. Uncontrolled movement of contaminated or exposed plant propagating material is at high risk and would probably result in rapid spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the risk assessment area.

Trade in fruit represents a high volume of commodities that circulate within the risk assessment area (see Appendix D). Fruit are imported in citrus-producing areas (see Appendix D).

3.4.3. Containment of the pest within the risk assessment area

The occurrence of wind-driven rains could spread the pathogen. Human-driven unintentional spread could happen because of the massive presence of citrus trees in streets and private and public gardens. *X. citri* pv. *citri* is listed as 'dual use technology and organism' (Council Regulation EC 394/2006[9]) for its putative use as a bio-terrorism agent. But, it does not preclude of how likely intentional movement of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* by persons can be achieved in the risk assessment area.

3.4.4. Conclusion on the probability of spread

Once established in areas where citrus plants are grown, spread would be likely. Natural dispersal on a low to medium scale would primarily be driven by splashing, aerosols and wind-driven rain. Some weather events such as thunderstorms, which occur infrequently but on a regular basis in Southern Europe, have the ability to spread *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* over longer distances (i.e. approximately up to a kilometre). Human activities would favour spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* whatever the scale considered. This would primarily be through movement of contaminated or exposed plant material, including fruit, and through machinery, clothes, and tools polluted by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* during grove or nursery maintenance operations. Human-driven unintentional spread could also be due to the massive presence of citrus trees in streets and private and public gardens that can serve as a pathway for dissemination of the pest.

Rating of probability of spread

Rating for spread	Justification
Likely	The probability of spread is rated as likely because: • Wind-driven rains that are required for small-scale dispersion occur during period when citrus are the most susceptible to infection • Summer storms happen in citrus-growing areas that make possible the spread of the pest and erase the potential barriers to spread between orchards • Susceptible hosts are present in groves and in streets, private estates and public parks as well, which forms a continuous network in the citrus-growing areas of the EU • Human activities would favour spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* whatever the considered scale. This would primarily be through movement of infected plant material and through machinery, clothes, and tools polluted by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* during grove or nursery maintenance operations

3.4.5. Uncertainties on the probability of spread

Uncertainty on the probability of spread is rated as low. Citrus canker has the ability to spread at small to medium spatial scales in relation to weather events similar to that reported in the pest risk area (e.g. Argentina). Practices and citrus varieties used in the risk assessment area are similar to those used in countries where the disease occurs. Human-assisted spread would undoubtedly contribute to the spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*.

[9] Council Regulation (EC) No 394/2006 of 27 February 2006 amending and updating Regulation (EC) No 1334/2000 setting up a Community regime for the control of exports of dual-use items and technology Official Journal of the Europen Communities L 74, 13.3.2006, p. 1–227.

3.5. Conclusion regarding endangered areas

Citrus plants are widely available as commercial crops in parts of the risk assessment area (Figure 5 in section 3.1.4.2). Citrus plants are commonly grown in Southern Europe, in eight countries: Spain (314 908 ha), Italy (112 417 ha), Greece (44 252 ha), Portugal (16 145 ha), Cyprus (3 985 ha), France (1 705 ha), Croatia (1 500 ha) and Malta (193 ha). Citrus nurseries dedicated to fruit production and ornamentals are located in the same areas as citrus groves (Spain 10 665 000 trees/year; Italy 5 771 000 trees/year; Portugal 844 000 trees/year; Greece 826 000 trees/year and France 819 000 trees/year). Moreover, citrus are commonly available in these countries in city streets and public and private gardens. Citrus production regions in the EU correspond to hardiness zones 8 to 10. Based on the current worldwide distribution of citrus canker, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have the ability to establish in hardiness zones 8 to 12. So, all citrus-growing areas within the EU are considered as the endangered area.

3.6. Assessment of consequences

3.6.1. Pest effects

Susceptible citrus species are grown in all Mediterranean countries of the EU (see section 3.1.4.1) where citrus production represents a major agricultural production. Citrus production regions in the EU correspond to hardiness zones 8 to 10. Based on the current worldwide distribution of citrus canker, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have the ability to establish in hardiness zones 8 to 13. So, the all citrus-growing areas in the EU can be considered as the endangered area. Spain with more than 300 000 ha of citrus is the biggest exporter of fresh citrus fruit of high quality in the world (see Table 11).

Where citrus canker occurs, the quantity and quality of the fruit production is impaired owing to defoliation, premature fruit drop, dieback, blemishes on fruit and general tree decline. Although the internal quality of the infected fruit is not affected, the blemished fruit are not marketable for fresh consumption. Based on scientific evidence, fruit drop is the primary factor in anticipated yield losses (Koizumi, 1985; Graham and Gottwald, 1991). Under conditions highly conducive to disease development, it is not uncommon that approximately 50 % of the fruit and leaves of susceptible cultivars be infected. Early fruit drop as high as 50 % was reported for sweet orange cv. Hamlin in groves with no control (Stall and Seymour, 1983). Furthermore, the level of susceptibility by cultivar translates into greater yield losses for some citrus cultivars over others (Graham et al., 1992; Gottwald et al., 1993). According to Stall and Seymour (1983), a disease incidence of 83–97 % on grapefruit fruit was reported in Argentina during 1979–1980. In addition, severely infected young trees may be delayed in reaching their full growth (Goto, 1992).

Table 11: Total citrus fruit export (0805) by country in 2011 (in 100 kg) as extracted from FAOSTAT, (on line) on 12 April 2013 (countries with export exceeding 10 000 000 kg)

Exporting country	Total citrus fruit export in 100 kg
Spain	36 153 484
Turkey	14 823 544
South Africa	14 640 107
USA	11 596 111
Egypt	10 784 767
China	9 015 567
Netherlands	5 296 502
Argentina	5 071 027
Mexico	5 057 887
Greece	4 734 841

Pakistan	3 645 785
Italy	2 988 043
Israel	2 202 860
Chile	1 581 653
Australia	1 484 811
Lebanon	1 275 538
China, Hong Kong SAR	1 048 784
Brazil	1 007 613
Germany	948 721
France	871 457
Peru	843 497
Nicaragua	752 631
Lithuania	688 677
Poland	667 630
United Arab Emirates	639 643
India	589 475
Cyprus	498 926
United Kingdom	497 678
Portugal	484 282
Belgium	477 626
Iran	434 900
Zimbabwe	298 656
Ecuador	291 350
Czech Republic	278 659
Croatia	261 061
Tunisia	239 833
Thailand	193 077
Bhutan	189 283
Jordan	167 998
Saudi Arabia	161 940
Georgia	138 364
Denmark	118 081
Slovenia	108 080
Austria	107 920
Guatemala	107 540
Dominican Republic	106 492
Vietnam	105 048

3.6.2. Control of citrus bacterial canker

Once introduced, CBC cannot be controlled without phytosanitary measures. Moreover, the absence of marked resistance to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in commercially major citrus varieties used in the risk assessment area (Goto, 1992; Gottwald et al., 2002a), the occurrence of host plants in private gardens or amenity land, the lack of effective plant protection products apart from copper-based compounds and the documented development of *X. citri* pv. *citri* resistance to copper (Behlau et al., 2011a, 2012a, b) suggest that the pathogen would be controlled in the risk assessment area with difficulty even with the use of phytosanitary measures.

In practice, the most commonly used control measures involve integrated pest management systems, based on cultural control, sanitary methods and chemical treatments with copper-based bactericides. However, copper treatment only reduces *X. citri* populations (Timmer, 1988; Dewdney and Graham, 2012) and is moderately effective on susceptible cultivars, which is the case for cultivars grown in Europe. Eradication of diseased and exposed trees has been shown as the best option in several countries where the pathogen has not become endemic or is maintained at a very low incidence (e.g. Australia, Brazil, USA—Jetter et al., 2000; Spreen et al., 2003; Alam and Rolfe, 2006; Bassanezi et al., 2008). Environmental conditions prevailing in the risk assessment area are favourable to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* but not as much as in tropical environments, and therefore eradication could potentially be an option, although its success would be very much dependent on the task force and money available for eradication activities and how prompt and strict the latter are. Nevertheless, even in non-tropical environments (e.g. New Zealand), observations have confirmed that the bacterium can survive for long periods (Dye, 1969). In addition, since the pathogen has hosts outside groves (see section 3.1.1.4), eradication programmes eliminating these hosts may have negative effects on plant biodiversity locally. However, this negative effect would be limited as these hosts are not native plants and of low density in the risk assessment area.

Chemical control of CBC involves preventive sprays of copper-based chemicals (McGuire, 1988) with the aim of reducing inoculum build-up on new flushes and of protecting aerial plant parts and particularly expanding fruit surfaces from infection. The timing and number of copper sprays to effectively control the disease depend on the susceptibility of the citrus variety, the physiological age of the tree, the climatic conditions and the other control measures applied (Stall et al., 1981; Stapleton and Medina, 1984; Leite and Mohan, 1990). Bacterial copper resistance or tolerance has been reported in Argentina and Brazil, respectively (Rinaldi and Leite, 2000; Canteros et al., 2010; Behlau et al., 2011a, b). Although not likely, the development of plasmid-borne copper resistance in saprophytic bacteria from the phyllosphere may be transferred to *X. citri* pv. *citri or X. citri* pv. *aurantifolii*. These plasmid transfers occur on plant surface and in plant tissues within *Xanthomonas* and the plant-associated microflora (Manceau et al., 1986).

3.6.3. Environmental consequences

Since many applications of copper compounds are usually needed in control programme, accumulation of copper in the soil may occur, contributing to environmental pollution. Copper-based product reduction is therefore desirable. Furthermore, in alkaline soils with a high calcium content, as in the coastal areas of Spain, the effects of copper toxicity are increased (Rooney et al., 2006).

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* have not been implicated in affecting other organisms providing "regulating" or "sustaining services". However, the damage caused on trees in citrus orchards or on ornamental citrus trees can be considered as an impact on (i) "organisms providing provisionary services", affecting genetic resources and food provisions, and (ii) "organisms providing cultural services", i.e. having an aesthetic impact. Regarding impact on biodiversity, no native species that are hosts of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are grown as commercial crops in the risk assessment area. Moreover, *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* do not induce plant death. Thus, changes in native community composition are not expected. However, from the aspect of microbial diversity, the pest is able to transfer genetic traits to other bacterial strains (Brunings and Gabriel, 2003; El Yacoubi et al., 2007; Canteros et al., 2010). *X. citri* pv. *citri* carries type IV secretion systems, which are located not only on the chromosome but also on plasmids which makes them self-mobilising for transfer into other bacteria resident on the same host, some of which may lack the ability to cause citrus canker. *In planta*, horizontal transfer of a plasmid harbouring a type IV secretion system and a type III effector involved in pathogenicity was shown from a citrus canker strain to a non-pathogenic *X. citri* strain, restoring its pathogenicity (El Yacoubi et al., 2007). Since the type IV secretion system is directly involved in the pathogenicity of other gram-negative bacteria, it is possible that *X. citri* pv. *citri* might use this system to secrete effector molecules in addition to those injected by type III secretion systems (Brunings and Gabriel, 2003). In addition, copper resistance genes have been identified on the *X. citri* pv. *citri* plasmids (Canteros et al., 2010; Behlau et al., 2013). In the event that these plasmids are mobilised to other bacterial residents, the latter may become more prevalent.

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* would be primarily present in commercial crops, private gardens/amenity land, which are not usually regarded as ecologically sensitive. Commercial citrus are not rare, vulnerable or keystone species. However, several citrus-producing areas in the EU-28 (e.g. Spain, Corsica) are the home of major resources of citrus germplasm that supply pest-free propagating material worldwide.

As the most appropriate and likely control strategy would be based on eradication (removal of diseased and exposed trees, quarantine areas, etc.) destruction of orchards would be unavoidable, in the event of disease outbreaks. Thus, the physical modification of habitats would depend on the size of the eradication area. *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* have not been implicated in changes in nutrient cycling or modification of natural successions or disruption of trophic and mutualistic interactions, i.e. in ecosystem functions themselves (MacLeod et al., 2012).

Concerning non-crop hosts, native species reported as present in the risk assessment area would be members of the *Microcitrus* and *Zanthoxylum* genera. It may be possible to observe limited and reversible decline in these species, and these are not regarded as ecologically sensitive, rare, vulnerable or keystone species and there susceptibility to citrus canker is not clearly established.

3.6.4. Conclusion on the assessment of consequences

Based on the above, the impact of the disease, even if control measures are used, could be moderate to major should *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* enter and establish in the risk assessment area. The disease would cause losses of yield and require costly control measures. It would have negative social consequences in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies would reduce their access to some markets. The occurrence of the disease would lead to increased chemical application in groves and to the use of copper compounds that would create environmental concerns such as copper accumulation in the soil and selection of resistance genes that could spread in the plant associated microflora and beyond.

Rating	Justification
Moderate to Major	The consequences are rated as moderate to major because: • Within commercial groves the direct effect of the disease would be high. It would cause losses of yield and require costly eradication measures to control the disease. This may also cause negative social impacts since the disease is not readily controllable in smallholdings and family gardens • Environmental conditions prevailing in the risk assessment area are favourable to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* but not as much as tropical environments, and therefore eradication could be a possible option, although its success would be very much dependent on the task force and money available for eradication activities and how prompt and strict the latter are • Copper usage would create environmental concerns such as copper accumulation in soil and selection of resistance genes that could spread

	in the plant-associated microflora and beyond • Citrus breeders are located in the risk assessment area (Spain, Corsica, etc.) and produce citrus germplasm that supply pest-free propagating materials worldwide. The presence of citrus canker in their vicinity would reduce their access to some markets • Crop production standards are reduced

3.6.5. Uncertainties on the assessment of consequences

Once CBC enters the risk assessment area, uncertainties on the assessment of consequences would be rated as medium because, even though eradication would probably be a valuable option, it is uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions occurring in the risk assessment area.

3.7. Conclusions on the pest risk assessment

Under the scenario of absence of the current specific EU plant health legislation and the assumption that citrus- exporting countries apply measures to reduce yield and quality losses, the conclusions of the pest risk assessment are as follows:

<u>Entry</u>

For fruit:

- The association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruit imported within the EU from countries where citrus canker is reported. The association with the passenger pathway is rated likely to very likely based on the lack of control measures through regulation and packinghouse processes for domestic markets as well as a lower awareness of the disease by passengers.
- The ability of bacteria to survive during transport, verified by the isolation of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, is rated very likely.
- The probability of the pest surviving existing management procedure is very likely, since cultural practices and chemical treatments (pre- and post-harvest) currently applied at the place of origin cannot eliminate the pathogen and no specific measures are currently in place in the risk assessment area.
- The probability of transfer to a suitable host is rated unlikely, based on the literature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur (i) because of occurrence of climatic conditions suitable for the transfer, (ii) the reports of infections from inoculum available at soil level owig to the short distance between tree canopy and soil in the risk assessment area and (iii) because of th presence of waste near to orchards.

Because transfer is critical and a limiting factor, the probability of entry is rated as unlikely for fruit.

For leaves and twigs, the probability of entry is rated unlikely because:

- The association with the pathway at origin is likely because leaves and cut twigs are imported from where the disease is endemic but the volume of citrus leaves is very low in comparison with citrus fruit imported within the EU from countries where citrus canker is reported;
- The ability to survive during transport is very likely.
- The probability of the pest surviving existing management procedure is very likely, since no management practices are currently undertaken in the risk assessment area.

- The probability of transfer to a suitable host is rated unlikely.

For plants for planting for citrus fruit production and for ornamental rutaceous plants that are natural hosts for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, through both the commercial trade and passengers pathways, the probability of entry is rated as likely because:

- The association with the pathway at origin is rated as likely for plants for planting for citrus production, through both the commercial trade and passengers pathways, because plants for planting have been recorded in the past as a source for outbreaks and based on the expected level importation of plants for planting from countries where citrus canker is reported.
- The association with the pathway at origin is rated as moderately likely for plants for planting for other rutaceous plants, through both the commercial trade and passengers pathways, owing to the lack of recent information on rutaceous ornamental host plants' susceptibility and a real difficulty in evaluating the level of trade under a hypothetically unregulated pathway.
- As for the fruit pathways, the ability to survive during transport is very likely.
- The probability of the pest surviving any existing management procedure is very likely since no specific measure is currently (prohibition excepted) in place in the risk assessment area as it is free of citrus canker. This probability would be even higher in the case of plants or plant parts imported through the passenger pathway.
- The probability of transfer to a suitable host is rated as very likely, based on the intended use of the plant material for planting (rootstocks) or grafting (scions, budwood) as well as on the fact that citrus (for fruit or ornamentals) and other rutaceous hosts are extensively grown in the risk assessment area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of amateur gardeners who are likely to import through passenger traffic.

The uncertainties of probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are rated as high and are due to:

- The role of infected citrus fruit/peel and leaves present in the vicinity of susceptible plants as a source of primary inoculum allowing the transfer to a suitable host remains poorly documented. The two papers published on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of many more experimental data.
- Partial data on the presence and distribution of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country of origin.
- There is globally a lack of knowledge on sources of primary inoculum associated with outbreaks in areas where *X. citri* pv. *citri* was not endemic.
- The rate of infection of citrus fruit imported from countries where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present and the concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments are difficult to assess because they are highly dependent on variable environmental conditions at the place of production and they are also dependent on the technologies implemented by exporting countries in the field and in packinghouses. The numerous interceptions in the EU of consignments containing diseased fruit suggest a lack of total reliability of the integrated measures that are taken in a systems approach for eliminating the risk of exporting contaminated and/or diseased fruit.
- The extent of importation of citrus material via passenger traffic is not well documented.
- The susceptibility of ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus* to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the latent infection and/or endophytic and/or epiphytic

presence of *X. citri* pv. *citri* in ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus*.

Establishment

The probability of establishment is rated as moderately likely to likely because host plants are widely present in some areas of the risk assessment area where environmental conditions are frequently suitable. The host is susceptible during most of the year to infection through wounds and for shorter periods through natural openings (two to three growth flushes except for some lemon and lime cultivars), and some severe weather events potentially promoting establishment occur on a regular basis in the risk assessment area. Cultural practices and control measures against fungal diseases currently used in the risk assessment area may reduce the severity of the disease but they cannot prevent the establishment of the pathogen. The pathogen would not require pathological adaptation to become established when it encountered a susceptible host.

Uncertainty on the probability of establishment is rated medium because information on the occurrence of suitable host in the risk assessment area is well documented. However, pieces of information are missing on the type of irrigation systems employed across orchards in the EU and the plant host susceptibility under environmental conditions that occur where citrus are grown in the risk assessment area. Furthermore, uncertainties remain on the efficacy of cultural practices and control measures in use in European groves and nurseries.

Spread

Once established in areas where citrus plants are grown, spread would be likely. Natural dispersal on a low to medium scale would primarily be driven by splashing, aerosols and wind-driven rain. Some weather events such as thunderstorms, which occur infrequently but on a regular basis in Southern Europe, have the ability to spread *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* over longer distances (i.e. approximately up to a kilometre). Human activities would favour spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* whatever the scale considered. This would primarily be through movement of contaminated or exposed plant material, including fruit, and through machinery, clothes, and tools polluted by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* during grove or nursery maintenance operations. Human-driven unintentional spread could also be due to the massive presence of citrus trees in streets and private and public gardens that can serve as a pathway for dissemination of the pest.

Uncertainty on the probability of spread is rated as low. Citrus canker has the ability to spread at small to medium spatial scales in relation to weather events similar to that reported in the pest risk area (e.g. Argentina). Practices and citrus varieties used in the risk assessment area are similar to those used in countries where the disease occurs. Human-assisted spread would undoubtedly contribute to the spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*.

Endangered areas

Citrus plants are widely available as commercial crops in parts of the risk assessment area (Figure 5 in section 3.1.4.2). Citrus plants are commonly grown in Southern Europe, in eight countries: Spain (314 908 ha), Italy (112 417 ha), Greece (44 252 ha), Portugal (16 145 ha), Cyprus (3 985 ha), France (1 705 ha), Croatia (1 500 ha) and Malta (193 ha). Citrus nurseries dedicated to fruit production and ornamentals are located in the same areas as citrus groves (Spain 10 665 000 trees/year; Italy 5 771 000 trees/year; Portugal 844 000 trees/year; Greece 826 000 trees/year and France 819 000 trees/year). Moreover, citrus are commonly available in these countries in city streets and public and private gardens. Citrus production regions in the EU correspond to hardiness zones 8 to 10. Based on the current worldwide distribution of citrus canker, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have the ability to establish in hardiness zones 8 to 12. So, all citrus-growing areas within the EU are considered as the endangered area.

Consequences

Based on the above, the impact of the disease, even if control measures are used, could be moderate to major should *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* enter and establish in the risk assessment area. The disease would cause losses of yield and require costly control measures. It would have negative social consequences in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies would reduce their access to some markets. The occurrence of the disease would lead to increased chemical application in groves and to the use of copper compounds that would create environmental concerns such as copper accumulation in the soil and selection of resistance genes that could spread in the plant associated microflora and beyond.

Once CBC enters the risk assessment area, uncertainties on the assessment of consequences would be rated as medium because, even though eradication would probably be a valuable option, it is uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions occurring in the risk assessment area.

4. Identification and evaluation of risk reduction options

4.1. Systematic identification and evaluation of options to reduce the probability of entry

In this section risk reduction options (RROs)to reduce the probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are systematically identified and evaluated. For each pathway, each RRO is evaluated as a stand-alone measure, assuming that no other risk reduction options are in effect, either for that pathway or for the other pathways. Systems approaches integrating two or more RROs are identified and evaluated for pathways where possible.

The effectiveness of individual risk reduction options in one pathway on the overall probability of entry (via all pathways) is not discussed, nor is the effectiveness of an individual RRO in one pathway compared with risk reduction option(s) in one or more other pathways. This would require a fully quantitative probabilistic pathway model. For example, the effectiveness of the treatment of consignments of citrus fruit in commercial trade is not compared with the effectiveness of post-entry quarantine for citrus plants for planting, with regard to the reduction of overall probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. However, it should be kept in mind that the overall reduction of probability of entry of *X.* citri pv. *citri* or *X. citri* pv. *aurantifolii* is determined by the combined set of RROs for all pathways.

4.1.1. Pathway I (Citrus fruit, commercial trade)

This pathway concerns citrus fruit imported by commercial trade. Leaves and peduncles may be present with the fruit in the lots.

The probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* along the pathway of "citrus fruit, commercial trade" was assessed as unlikely, with high uncertainty (see overview in section 3.2). This rating is derived under the assumption that phytosanitary requirements by the EU are absent, but recognising that some pest management activities to control *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in citrus groves and to eliminate/reduce *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* during packing procedures may be applied for commercial reasons or in response to requirements by non-EU importing countries. RROs may be considered for this pathway by the EU risk managers in order to reach an acceptable level of risk of entry and the acceptable level of uncertainty (see paragraph 2.3 of the ISPM No 2 (FAO, 2007a)). The effectiveness of these RROs is assessed relative to the "unlikely" probability of entry, with high uncertainty, in the absence of measures.

A. Options for consignments

4.1.1.1. Prohibition

Effectiveness

Prohibition of import of citrus fruit, commercial trade would prevent the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU along this pathway. The effectiveness is assessed as **very high**.

Technical feasibility

The technical feasibility is **very high**, because it can be easily implemented in customs operations and phytosanitary procedures

Uncertainty

The uncertainty on these ratings is assessed as **low**.

4.1.1.2. Prohibition of parts of the host

The presence of all other plant material than fruit (potentially carrying *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, such as leaves and peduncles) in the consignment can be prohibited. This RRO is implemented in the EU for the import of fruit of *Citrus*, *Fortunella* and *Poncirus* and their hybrids, from third countries, by requiring that the fruit shall be free from peduncles and leaves (Council Directive 2000/29/EC Annex IV Part A Section I point 16.1). Leaves and peduncles may be infectious and can spread into citrus-producing areas by natural means from disposed citrus waste. Prohibiting their introduction will reduce the probability of entry.

Effectiveness

The effectiveness for the pathway of citrus fruit, commercial trade is **low** because special requirements for the citrus fruits in the consignment are not part of this RRO, and citrus fruit infected with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* can enter the risk assessment area.

Technical feasibility

The technical feasibility is **very high**, since it is already implemented without any difficulty.

Uncertainty

The uncertainty on these ratings is **low**.

4.1.1.3. Prohibition of specific genotypes

Citrus species vary greatly in the level of susceptibility for *X. citri* pv. *citri* (Section 3.2.2.1), but there are no commercially important citrus varieties with a high level of resistance to *X. citri* pv. *citri*. Therefore, this RRO is **not applicable**.

4.1.1.4. Pest freedom of consignments: inspection or testing

Detection of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments is based on sampling, visual inspection and laboratory testing. Sampling and inspection of the consignment should be performed according to guidelines in the International Plant Protection Convention (IPPC) Standards International Standards for Phytosanitary Measures (ISPM) No 31 (FAO, 2008) and No 28 (FAO, 2007b), respectively. To confirm the presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in symptomatic fruit the sample may be laboratory tested using appropriate methods (see section 3.1.1.3). Inspection and testing of consignments may be applied at the time of export and/or at the time of import. At export, inspection or testing may serve as a stand-alone measure, without other official measures for production, harvest and packaging, or as a measure to verify that other measures have been effective. At import, inspection generally serves to verify that phytosanitary measures have been applied by the exporting country.

Effectiveness

The effectiveness of both visual inspection and laboratory testing for detection of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments of citrus fruit depends mainly on the sampling method and the sample size. No method will provide 100 % effectiveness of detection. The effectiveness of visual inspection is further limited by the possible presence of mildly infected fruits escaping visual detection in the sample. Laboratory tests are available to confirm the presence of the organism in symptomatic fruit, but only the PCR-based screening test with specific primers is considered an effective method for rapid analysis of samples suspected to be contaminated by *X. citri* pv. *citri* (section 3.1.1.3). If symptomatic fruit remains undetected, either because they have escaped sampling or they were not detected by visual inspection of the sample, *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* may remain viable for up to 100 days in storage but the number of viable bacteria decrease with time (Bonn et al., 2009).

The effectiveness of visual inspection is **moderate**. Laboratory testing of symptomatic fruit found in the sample confirms the presence or absence of the organism, but the effectiveness is not altered; it is also assessed as **moderate**.

Technical feasibility

The technical feasibility is assessed as **moderate** owing to the limitations of sampling.

Uncertainty

The uncertainty on the rating of effectiveness is **medium** owing to the influence of the unspecified sampling procedure. The uncertainty for technical feasibility is medium.

4.1.1.5. Pre- or post-entry quarantine system.

Pre- or post-entry quarantine systems are not effective for citrus fruit, commercial trade because additional symptoms would not appear during the quarantine conditions.

The effectiveness is negligible, technical feasibility is high and uncertainty is low.

4.1.1.6. Preparation of the consignment

Preparation of consignments includes several steps, beginning with the handling of harvested fruit and transport to the packing station to closing of boxes or other packaging material prior to export. Specific conditions may be applied during this process to prevent the presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the consignment.

Handling of harvested fruit

Contamination of harvested fruit during transport to the packing station can be prevented by cleaning of containers and vehicles prior to harvesting of the grove.

Packing stations

Management procedures of citrus fruit packing stations play an important role in reducing the incidence of infected and contaminated fruit in consignments. Packing stations should be registered and should employ a system of record keeping, enabling quality control of packinghouse operations and tracking and tracing of consignments to the production site and to information on the pest management programme. General hygienic measures and sanitation of equipment and the use of new or cleaned packaging material are basic requirements for all packinghouses.

Fruit originating from official pest-free areas and official pest-free places of production should be packed at packing stations where measures are in place to maintain the pest-free quality of the fruit, such as the absence of fruit originating from other areas, effective sanitation between handling of different consignments, or a separate area within the packing station reserved for fruit from pest-free areas.

Culling and cleaning of fruit may allow the removal of leaves, peduncles other debris and many (but not all) symptomatic fruit, but fruit with asymptomatic infections or with small lesions will not be eliminated by these procedures.

Fruit transport is under cool (4–15 °C) conditions (Civerolo, 1984; Wills et al., 1998), which have no negative effect on the survival of the bacteria (Goto, 1962). It is thus very likely that *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* survives the transport. However, it is unlikely that the pest prevalence increases during transport or storage, since the exponential multiplication of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* primarily precedes lesion development (Graham et al., 1992) and *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* population sizes in canker lesions are known to remain stable or to slightly decrease over time (Stall et al., 1980; Pruvost et al., 2002; Bui Thi Ngoc et al., 2010).

<u>Effectiveness</u>

Measures during preparation of the consignment to reduce the incidence of infested fruit may be routinely applied by citrus producers in the absence of official phytosanitary requirements. However, the regulation of such measures would result in a standardisation for all fruit imported into the EU and thereby further reduce the probability of entry. The effectiveness of this RRO is assessed as **moderate**, because asymptomatic infected fruit and fruit with small lesions may still pass through these measures even when implemented as official import requirements.

<u>Technical feasibility</u>

The technical feasibility is assessed as **very high**, since such measures are currently implemented in citrus-producing countries.

<u>Uncertainty</u>

The uncertainty on these ratings is **medium**, because of unknown variability in the fraction of infected fruit passing through these measures and whether such measures are applied by all third countries that export citrus fruit to the EU.

4.1.1.7. Specified treatment of the consignment/reducing pest prevalence in the consignment.

During the preparation of consignments of citrus fruit several treatments may be applied that may reduce *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* populations, but methods that completely eliminate *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* from infected fruit are not available (Gottwald et al., 2009; EFSA PLH Panel, 2011). Commonly recommended treatments are washing with solutions of (1) chlorine (two minutes at 200 ppm sodium hypochlorite, pH 6.0–7.5), (2) SOPP (45 seconds to one minute, depending on detergent concentration, SOPP at 1.86–2.0 %) or (3) peroxyacetic acid (PAA) (one minute at 85 ppm of PAA) (Code of Federal Regulations, 2008, Biosecurity Australia, 2009; Council Directive 2000/29/EC). Packinghouses should employ a system to limit the build-up in the treatment tank of extraneous organic matter or any other material that would interfere with the treatment. Packinghouses should have a documented procedure for measuring and monitoring the concentration of active constituents and pH levels in the water to ensure that they do not fall below the minimum recommended rates.

<u>Effectiveness</u>

The effectiveness of this RRO is assessed as **moderate**, because although these post-harvest treatments may reduce the inoculum level, they cannot eliminate *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* present on infected citrus fruit.

<u>Technical feasibility</u>

Technical feasibility is **very high**.

Uncertainty

Uncertainty is **low**.

4.1.1.8. Restriction on end use, distribution and periods of entry

Restriction on period of entry

In the case of citrus fruit, as explained in the section on risk assessment (see section 3) it is not possible to identify periods of the year in the EU when host plants are never susceptible to infection or when weather conditions are never conducive. It is also not possible to define periods of the year when fruit imported into the EU would never be infected. Therefore the *effectiveness* of a restriction on the period of entry of citrus fruit is **negligible**. The *technical feasibility* would be **very high**, and the *uncertainty* is **low**.

Restriction on distribution of imported citrus fruit within the PRA area

Plants susceptible to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are not grown in the entire EU and climatic conditions are not suitable for the disease in the entire EU. Therefore a restriction of the distribution of imported consignments of citrus fruit possibly infected with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* to the parts of the EU where host plants of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are absent, or climatic conditions inhibit the development of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, could be investigated. The basis for this RRO would be the demarcation of endangered and non-endangered areas of the EU with respect to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*.

However, the internal market of the EU, allows for the free trade of citrus fruit in the entire territory of the EU. Consignments of citrus fruit imported in a Member State without citrus production and subjected to import inspection in that Member State may subsequently be traded to citrus-producing areas of the EU without further inspections. For example, in 2009, the Netherlands imported around 450 kt of sweet orange and 170 kt of grapefruit from various countries (including Florida, Argentina, Brazil and Uruguay) and re-exported almost 200 kt of sweet orange and 115 kt of grapefruit to other EU countries, including citrus-producing countries (EUROSTAT, online).

Specific plant health risks associated with the free internal market of the EU may, under the conditions of Council Directive 2000/29/EC, be managed with the concept of a “Protected Zone”. Protected Zones may be established with respect to: (i) pests listed in 2000/29/EC, that are established in one or more parts of the EU, but are not established in the Protected Zone despite favourable conditions for establishment there; (ii) pests that are not endemic or established in the EU, but for which there is a danger that they will establish, given propitious ecological conditions, for particular crops (Article 2 of the Council Directive 2000/29/EC).

Since *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* would qualify according to option (ii), the endangered area of the EU with respect to these pests might be designated as a Protected Zone. The introduction into and movement within this endangered area of specified commodities may be prohibited completely or may be restricted according to special requirements. Within the non-endangered area there would be no restriction on the introduction and movement of citrus commodities.

Several scenarios could be envisaged to restrict the introduction of commodities possibly infected with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the endangered area of the EU, ranging from a full prohibition of import of all host plant commodities to combinations of special requirements for such commodities. This would have to cover the introduction from third countries and from the non-endangered area of the EU. Under all scenarios specific procedures need to be developed to prevent the high rate of movement of consignments of citrus fruit from the non-endangered area (where there would be no requirements with respect to *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*) to the endangered area (see examples of these volumes presented above), taking into account the fact that internal frontiers and border inspection points between endangered and non-endangered areas do not exist in the EU. Should the possibilities for trade between non-endangered and endangered areas be maintained, then in the non-endangered area of the EU the import of consignments satisfying special requirements with respect to *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* would have to be distinguished from import of other consignments. The trade of consignments possibly infected by *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* from the non-endangered to the endangered area of the EU would have to be prohibited. Imported consignments satisfying the special import requirements would have to be officially labelled and their movement officially monitored and registered throughout the traffic within the EU to their final destination, to prevent mixing or repacking of consignments, subject to the complex internal pathways and market structure for citrus fruit within the EU.

Restriction on end use of imported consignments of citrus fruit

Part of the imported citrus fruit consignments is destined for industrial processing (juice, marmalade, etc.). In the non-endangered area of the EU, the officially controlled import, immediate movement to the processing facility and processing of consignments of citrus fruit possibly infected by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* would strongly reduce the probability of transfer to a suitable host. Elements of such official control are, for example, the regular monitoring of storage and processing premises, specification of ports for import, and supervised transport of imported consignments. Those fruit-processing facilities should nevertheless have the capacity to prove that no fruit escapes the processing lines and should employ adapted traceability, containment and waste-processing measures (according to the guidelines for handling of such biowaste in EPPO Standard PM 3/66(2) (EPPO, 2008)). This approach is conceivable on the basis of a derogation from official special import requirements for citrus fruit with respect to absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* for officially registered and approved processing facilities. In the endangered area of the EU, citrus processing plants are located within or near citrus-producing areas, and therefore more stringent containment and control measures would be required to reduce the probability of transfer of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* from fruit-processing facilities to suitable hosts to an acceptable level.

Effectiveness

Restriction on period of entry
The *effectiveness* of a restriction on the period of entry is negligible.

Restriction on distribution
The *effectiveness* of a restriction on distribution of imported fruit is assessed as high, based on the arguments presented above.

Restriction on end use
The *effectiveness* of a derogation approach is assessed as high, based on the arguments presented above.

Technical feasibility

Restriction on period of entry
The *technical feasibility* of a restricted period of entry would be very high.

Restriction on distribution
The *technical feasibility* is assessed as low because of the difficulties in establishing and maintaining the required control and monitoring systems, associated with the designation of Protected Zones with respect to *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, as explained above.

Restriction on end use
The *technical feasibility* of a derogation approach is assessed as high for the non-endangered area and as low for the endangered area of the EU, owing to the difficulties in implementing the required levels of containment and control measures in the endangered area.

Uncertainty

The *uncertainty* on these ratings is low.

B. Options preventing or reducing infestation in the crop at the place of origin

4.1.1.9. Treatment of the crop, field or place of production in order to reduce pest prevalence.

Reduction of prevalence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in citrus groves is generally achieved by an integrated approach, combining chemical control using copper-based bactericides, the planting of windbreaks, and control of leafminers (Leite and Mohan, 1990; Dewdney and Graham, 2012). This integrated approach is primarily achieved for *X. citri* pv. *citri* but it has a similar ability to control *X. citri* pv. *aurantifolii* in countries where both pathogens are present (i.e. South America).

Chemical control

Chemical control of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* involves a preventive spraying schedule of copper-based bactericides (McGuire, 1988) with the aim to reduce inoculum build-up on new flushes and to protect expanding fruit surfaces from infection. The timing and number of copper spays to effectively control the disease depend on the susceptibility of the citrus cultivar, the physiological age of the trees, the climatic conditions and the additional control measures applied. (Stall et al., 1981; Stapleton and Medina, 1984; Leite and Mohan, 1990; Stein et al., 2007; Behlau et al., 2008, 2010). However, copper resistance or tolerance of *X. citri* pv. *citri* has been reported at least in Argentina and Brazil, respectively (Rinaldi and Leite, 2000; Canteros et al., 2010). Copper resistance genes have been identified on the *X. citri* pv. *citri* plasmids (Canteros et al., 2010; Behlau et al., 2013).

Copper bactericides (that are rather bacteriostatic products) were found more effective than non-copper compounds (Stall et al., 1980, 1981; Timmer, 1988). Spray adjuvants were reported to exacerbate the disease (Gottwald et al., 1997). There have been efforts to assay plant extracts (Samavi et al., 2009; Khuntong and Sudprasert, 2008) as alternatives to copper bactericides, but not under field conditions and therefore further investigation is clearly needed to estimate the efficiency of such compounds. Similarly, induced systemic resistance (ISR) compounds were evaluated but found ineffective (Graham and Leite, 2004).

Planting of windbreaks

Since spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is mainly by wind-driven rain, windbreaks to reduce wind speed in citrus groves have been considered as a control measure. Bock et al. (2010) reported that windborne inoculum is epidemiologically significant and measures reducing wind speed minimize disease spread. However, the effectiveness of windbreaks is highly uncertain because experimental studies show conflicting results. A reduction of *X. citri* pv. *citri* due to windbreaks has been reported by Leite and Mohan (1990) and Gottwald and Timmer (1995), but such results could not be confirmed by Behlau et al. (2007, 2008, 2010).

Control of leafminers

The Asian leafminer insect (*Phyllocnistis citrella*) has been implicated in the spread and augmentation of bacterial canker (Gottwald et al., 2007). Although not considered itself as an efficient vector of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, the galleries created by the leafminer provide infection courts for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. Copper spays may be combined with insecticides to control insect injury. Promising results in reducing the number of required broad spectrum sprays for the insect management in both field and nursery settings have been obtained lately by using an attracticide formulation (Stelinski and Czokajlo, 2010). However, this is still under experimentation and cannot yet be recommended as an alternative for insectides.

Other control measures

Biological control measures for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are not available. Preliminary studies on bacteriophages (Jones et al., 2007) and bacteria antagonistic to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, which have identified *Bacillus subtilis* (Kalita et al., 1996), *Pantoea* *agglomerans* (Goto et al., 1979), *Pseudomonas syringae* (Ohta, 1983) and *Pseudomonas fluorescens* (Unnamalai and Gnanamanickam, 1984), suggest that these microorganisms have a potential role in *X. citri* pv. *citri* control, but this approach needs further investigation for field applications. Similarly, exploitation of predation and parasitism for the control of the Asian leafminer, although promising (Xiao et al., 2007), need further validation.

The following measures contribute to reduction of infestation of citrus crops by *X. citri* pv. *citri* (Gottwald et al., 2002a, unless otherwise stated).

- Use of canker-free nursery propagated material.
- Pruning and defoliation of diseased shoots in combination with copper application and burning of the pruned plant material.
- Pruning to be performed under dry weather conditions that do not favour the spread of the bacterium.
- Drip or mist irrigation has been suggested as alternative to overhead irrigation in order to minimize the spread of the pathogen (Pruvost et al., 1999).
- Collection and appropriate safe disposal of residues (leaf litter, fallen fruit, etc) from the orchard.
- Disinfection of the clothes and shoes of workers, the tools/equipment used, the harvesting boxes and all machinery/vehicles that enter the orchards.

Early-warning systems for spotting new outbreaks have been developed in the US (Gottwald et al., 2001) and Japan (Goto, 1992). In Japan, in the forecasting system adopted, the number of overwintered lesions on angular shoots is determined and meteorological data such as temperature, precipitation and wind velocity are monitored from autumn through to early spring; these factors are responsible for the build-up of bacterial populations in citrus groves. Outbreaks of the disease can be predicted 1-2 months in advance (CABI, 2007).

Effectiveness:

Treatments of citrus groves against *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* to reduce the prevalence of the disease may be routinely applied by citrus producers in the absence of official phytosanitary requirements, although the combination of chemical treatments, cultural and other methods may vary among producers. The regulation of such measures would result in their standardization for all imported fruit and thereby further reduce the probability of entry. However, these measures will not eliminate *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in production places and harvest of infested fruit cannot be prevented. The infestation level of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in harvested fruit remains variable, depending on the intensity of the control program and the weather conditions during the growing season, notably the occurrence of storms and heavy rainfall.

The *effectiveness* of the integrated control program is assessed as **moderate**.

Technical feasibility:

The *technical feasibility* is assessed as **very high**.

Uncertainty:

The *uncertainty* on these ratings is **low**.

4.1.1.10. Resistant or less susceptible varieties.

Citrus species vary greatly in the level of susceptibility to *X. citri* pv. *citri* and/or *X. citri* pv. *aurantifolii* (Table 4).

Grapefruit (*C. paradisi*) is highly susceptible and mandarin (*C. reticulata*) is moderately resistant (Das, 2003). All species but Mexican lime (and to a lesser extent lemon for some strains) are resistant to *X. citri* pv. *aurantifolii* (Rossetti, 1977). There are no commercially important citrus varieties with a high level of resistance to *X. citri* pv. *citri*.

Effectiveness

The *effectiveness* of growing resistant or less susceptible varieties to reduce the incidence of infested harvested fruit is assessed as **high to moderate** according to the level of resistance.

Technical feasibility

The *technical feasibility* of growing resistant or less susceptible varieties is assessed as **low** because no resistant citrus varieties are available for fruit production.

Uncertainty

The *uncertainty* on these ratings is **low**.

4.1.1.11. Growing plants under exclusion conditions (glasshouse, screen, isolation).

Growing commercial citrus orchards for fruit production under exclusion could theoretically limit infection by reducing the introduction of external inoculum but may require screening with very fine mesh nets and controlled ventilation. However, such conditions are not applicable to commercial citrus orchards on a large scale.

The *effectiveness* is likely to be **low**, since small rain droplets with bacteria might still be blown through the screen. The *technical feasibility* is **low**, because of the difficulty of implementation in citrus orchards for fruit production over large areas. The *uncertainty* of these ratings is **medium**, owing to the lack of data on the effectiveness of exclusion.

4.1.1.12. Harvesting of plants at a certain stage of maturity or during a specified time of year.

The *effectiveness* of harvesting citrus fruit during a specified time of the year is **negligible**, since *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are present year-round.

The *technical feasibility* is **low**, because of the need to harvest citrus fruit at commercial maturity.

The *uncertainty* for these ratings is **low**.

4.1.1.13. Certification scheme.

Plants for citrus production, produced under a certification scheme, will be initially free from *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. However, these plants can subsequently become infected when planted in an area where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* occurs. The prevalence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is then dependent on the measures discussed in section 4.1.1.9.

Effectiveness

The *effectiveness* of a certification scheme is **low**.

Technical feasibility

The *technical feasibility* is assessed as **low**.

Uncertainty

The *uncertainty* on these ratings is assessed as **medium**.

C. Options ensuring that the area, place or site of production at the place of origin, remains free from the pest

4.1.1.14. Limiting import of host plant material to material originating in pest-free areas

A pest-free area is defined as an area in which a specific pest does not occur, as demonstrated by scientific evidence, and in which, where appropriate, this condition is being officially maintained (FAO, 1995—ISPM No 4). A pest-free area may be an entire country, an uninfested part of a country in which a limited infested area is present, or an uninfested part of a country situated within a generally infested area. Pest freedom of the area must be supported by general surveillance, delimiting surveys to demarcate the area and detection surveys to demonstrate the absence in the area and its buffer zone (for guidance on surveys and surveillance, see EFSA PLH Panel, 2012). Phytosanitary measures must be in place to prevent the movement of potentially infested material into the area and to prevent natural spread of the pest into the area.

Preventive measures such as windbreaks and other cultural measures and leaf miner control must be implemented at the place of production and in the buffer zone.

The fruit harvested in pest-free areas should be handled and packed at packing stations where measures are in place to maintain the pest-free quality of the fruit, such as the absence of fruit originating from other areas, effective sanitation between handling of different consignments, or a separate area within the packing station reserved for fruit from pest-free areas.

Surveys for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* may be restricted to inspection and testing of growing host plants, because the survival of the bacterium outside living host plant tissue is low. Since multiple pathovars and pathotypes show similar symptoms, the survey observations should be confirmed by appropriate diagnostic methods (Davis et al., 2000; Mavrodieva et al., 2004; EPPO, 2005; Coletta-Filho et al., 2006; Derso et al., 2009; Jaciani et al., 2009) and laboratory confirmation of sampled plant material. Automated image analysis systems have been developed, evaluated as comparable to unaided, direct visual estimation by many raters and suggested as an important facet of citrus canker assessment (Bock et al., 2008, 2009a, 2009b). Besides, methods based on the spectral reflectance characteristics of citrus canker have been reported to aid detection of the disease on fruit and plants (Balasundaram et al., 2009; Lins et al., 2009; Sampling techniques have been suggested for more efficient surveillance of an area that contribute to a rational basis for eradication and management of the disease (Parker et al., 2005). Citrus cultivar susceptibility to citrus canker varies and this information should be taken into account in inspection and monitoring programmes (Graham et al., 1992).

Distances from focal tree(s) over which all exposed hosts should be removed and destroyed should be determined on the basis of severe weather events occurring in the area under control (Gottwald et al., 2001).

Predictive models to estimate spread of the disease from areas where *X. citri* pv. *citri* has established in relation to the occurrence of storms or hurricanes have been developed, and their evaluation suggests that they could constitute a tool to predict potential disease spread to pest-free areas (Irey et al., 2006; Gottwald and Irey, 2007).

A sentinel tree survey system has been developed to detect new outbreaks at the earliest possible stage. This method consists of a grid that is formed by dividing each square mile into a 12×12 grid of 144 subsections. A sentinel tree (susceptible cultivar) is selected for repeated (every 30 days) survey in each subsection. In this way, new outbreaks can be identified early and the infected trees quickly destroyed (Gottwald et al., 2001). The system has been implemented in certain areas (e.g. in Florida; Gottwald et al., 2001).

Upon detection of citrus canker on plants or plant products in a certain location, eradication of the pathogen should be the main approach to prevent the establishment and spread of it. Guidelines for pest eradication programmes are described in ISPM No 9 (FAO, 1998). Eradication programmes have been extensively reviewed (Zalom et al., 1999; Gottwald et al., 2001; Schubert et al., 2001, Graham et al., 2004). Such programmes rely on:

- destruction of the infected/infested material;

- determination of the area possibly exposed to the pathogen and destruction of any host (commercial, residential, native) plant in it;
- restriction of movement (containment) of plants, plant products or other articles whose movement out of the quarantine area bears a risk of spreading the pathogen;
- sanitary measures to disinfest any article that may have been in contact with infested material (e.g. machinery, tools, clothes);
- suppression of any regrowth of the destroyed plants;
- prohibition of replanting host plants before successful eradication of the pathogen;
- surveillance system to monitor any possible spread.

Parnell et al. (2009) suggested that eradication programmes may be optimised based on the topographical arrangement of the host landscape.

Effectiveness

When the import of citrus fruit is restricted to material originating in pest-free areas, the probability of introduction of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the risk assessment area would be reduced. The effectiveness depends on the frequency and the confidence level of detection surveys to confirm absence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the pest-free area, and the intensity of phytosanitary measures to prevent entry of plant material (including fruit) into the pest-free area. The design and frequency of surveys to confirm absence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the area should take into account the scattered presence of unmanaged host plants in private gardens and uncultivated areas and the possible presence of latently infected plants, in order to accomplish the required confidence level of the surveys.

The *effectiveness* of pest-free areas is assessed as **very high**, on the condition that procedures for maintaining the pest-free area and its buffer zone are documented and regularly officially evaluated, and the results reported.

Technical feasibility

The establishment and maintenance of a pest-free area for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is technically feasible, but surveys with adequate attention to the distribution of managed and unmanaged host plants in the pest-free area should be performed when designating the pest-free area and its buffer zone. *Technical feasibility* is assessed as **high**.

Uncertainty

The *uncertainty* of the rating for effectiveness is **medium**, because of the possible variation in performance of surveys and other measures to maintain the pest-free area.

4.1.1.15. Limiting import of host plant material to material originating in pest-free production places or pest-free production sites

Designation and maintenance of pest-free production places or pest-free production sites with respect to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* within an infested area has limited possibilities because of the nature and the distance of natural spread (32 m for wind-blown inoculum under normal, non-extreme weather conditions, see section 3.1.1.2). This option requires a buffer zone that is free from symptoms of citrus canker and that is large enough to prevent infestation of the production place by natural means. Intensive monitoring for citrus canker symptoms, possibly employing susceptible sentinel plants, at regular intervals is required both in the buffer zone and in the production site.

Preventive measures such as windbreaks and other cultural measures and leaf miner control must be implemented at the place of production and in the buffer zone.

Effectiveness

The effectiveness of this measure is assessed as **high**, but depends on the size of the buffer zone and the intensity of monitoring.

Technical feasibility

The technical feasibility is considered **high**, because it is already implemented.

Uncertainty

The uncertainty is considered **high**, owing to the unknown rate of invasion from the infested environment and potential presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* at low prevalence or inconspicuous symptoms at the place or site of production.

4.1.1.16. Systems approaches integrating individual RROs.

Systems approaches combining individual RROs may further reduce the probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* along this pathway. The following combination is proposed.

For fruit originating from infested areas, measures to reduce infestation in the field should be combined with handling procedures and treatments during packing to reduce the incidence of infected fruit during handling and packing. Packinghouses should for example keep a register of all processed fruit lots to allow tracking and tracing of infestations. The effectiveness of each of these three measures individually is assessed as moderate, and the *effectiveness* of the integrated approach combining these three measures is assessed as **moderate**. The *technical feasibility* is **high**, and the *uncertainty* is assessed as **medium**.

Table 12: Summary of the applicable risk reduction options identified and evaluated for the pathway "Citrus fruit, commercial trade"

Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	Before shipment	No	Very high	Very high	Low
	Prohibition of parts of the host	Before shipment	Yes	Low	Very high	Low
	Visual inspection for pest freedom	Before shipment and/or at import	Yes	Moderate	Moderate	Medium
	Inspection combined with testing for pest freedom	Before shipment and/or at import	No	Moderate	Moderate	Medium
	Preparation of consignment	Before shipment	No	Moderate	Very high	Medium
	Specified treatment of consignment	Before shipment	Yes	Moderate	Very high	Low
	Restriction on end use, distribution and periods of entry	After import	No	Low for distribution High for end use	Negligible for distribution High for non-endangered area Low for the endangered area	Low
Options for the crop at the place of origin	Treatment of the crop, field or place of production	Before shipment	No	Moderate	Very high	Low
	Resistant or less susceptible varieties	Before shipment	No	Low	High	Low
	Certification scheme	Before shipment	Yes	Low	High	Low
Options ensuring that the area, place or site of production at the place of origin, remains free from the pest	Limiting import of host plant material to material originating in pest-free areas	Before shipment	Yes	Very high	High	Medium
	Limiting import of host plant material to material originating in pest-free production places or pest-free production sites	Before shipment	Yes	High	High	High
Systems approaches	Infested production places: measures in fields combined with handling procedures and treatments during packing	Before shipment	No	Moderate	High	Medium

4.1.2. Pathway II (Citrus fruit and leaves import by passenger traffic)

A. Options for consignments

4.1.2.1. Prohibition

Effectiveness

Prohibition of import of citrus fruit and leaves by passenger traffic would prevent the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU along this pathway. Such a prohibition requires compliance by passengers, which can be influenced by the intensity and clarity of communication of this measure to passengers and the intensity of passenger checks. The *effectiveness* is therefore assessed as **moderate**.

Technical feasibility

The *technical feasibility* is **low**. Although this RRO can be implemented in customs operations with limited technical difficulties and limited training of customs officers to recognise citrus fruit and leaves, the frequency of passenger checks would have to be high in order to effect the prohibition. Results of audits performed in Australia, where such a prohibition is in effect, show that interceptions on passengers are made regularly, despite communication and inspection.

Uncertainty

The *uncertainty* on these ratings is **medium**, owing to lack of accurate data on the effectiveness.

4.1.2.2. Prohibition of parts of the host or of specific genotypes of the host

Not applicable.

4.1.2.3. Phytosanitary certificates and other compliance measures

Not applicable.

4.1.2.4. Pest freedom of consignments: inspection or testing

Effectiveness

The *effectiveness* of visual inspection of citrus fruit and leaves, carried by passengers, for symptoms of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is **low**, owing to possible latent infections and confusion with symptoms by other injuries and pests.

Testing is not applicable, since passengers would not await the result of the test before their further customs procedures.

Technical feasibility

The *technical feasibility* of inspection of citrus fruit and leaves carried by passengers as an option to reduce the risk of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is **low**. With an estimated 0.1 % of passengers carrying on average one citrus fruit (see section 3.2.3.3.) and thousands of passengers arriving daily in the EU, the frequency of passenger checks would have to be high in order to effect the prohibition. Moreover, the inspection would have to be performed by customs officers without background or training in plant health inspections.

Uncertainty

The *uncertainty* on these ratings is **low**.

4.1.2.5. Pre- or post-entry quarantine system.

Not applicable.

4.1.2.6. Preparation of the consignment

Not applicable.

4.1.2.7. Specified treatment of the consignment/reducing pest prevalence in the consignment.

Not applicable.

4.1.2.8. Restriction on end use, distribution and periods of entry

Not applicable.

B. Options preventing or reducing infestation in the crop at the place of origin

Such options are not applicable to citrus fruit and leaves carried by passengers.

C. Options ensuring that the area, place or site of production at the place of origin, remains free from the pest

Such options are not applicable to citrus fruit and leaves carried by passengers.

Table 13: Summary of applicable risk reduction options identified and evaluated for the pathway "Citrus fruit and leaves, passenger traffic"

Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	During customs checks	No	Moderate	Low	Medium
	Visual inspection for pest freedom	During customs checks	No	Low	Low	Low

4.1.3. Pathway III (Citrus plants for planting, commercial trade)

A. Options for consignments

4.1.3.1. Prohibition

Effectiveness

Prohibition of import of plants for planting for citrus fruit production by commercial trade would prevent the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the risk assessment area along this pathway. The *effectiveness* is assessed as **very high**.

Technical feasibility

The *technical feasibility* is known to be **very high**, as it is already successfully implemented in phytosanitary import procedures and customs operations. This prohibition is currently implemented in Council Directive 2000/29/EC, (Annex III of the Directive, point 16).

Uncertainty

The *uncertainty* is assessed as **low**.

4.1.3.2. Prohibition of parts of the host or of specific genotypes of the host

All aboveground parts of host plants may carry *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* and infections remain viable for several years (section 3.1.1.2), therefore this RRO is not applicable to pathways of plants for planting. Effectiveness is negligible, technical feasibility is moderate and uncertainty is low.

4.1.3.3. Pest freedom of consignments: inspection or testing

Effectiveness

The *effectiveness* of inspection of citrus plants for planting for citrus fruit production to reduce the probability of entry is assessed as **low** because of the possibility of latent infections.

The *effectiveness* of testing is assessed as **low**, because testing is performed on parts of plants that were sampled from the consignment. Latently infected plants from the consignment may be included in the sample, but if only non-infested parts of these plants are used for testing, these infected plants go unnoticed. Moreover, if *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* infected plants are present in the consignment at low incidence, sample size affects the probability of including these plants in the sample.

Technical feasibility

The *technical feasibility* is assessed as **moderate** because of the difficulty of obtaining representative samples.

Uncertainty

The *uncertainty* on these ratings is **medium**.

4.1.3.4. Pre- or post-entry quarantine system

Pre- or post-entry quarantine systems may be developed for small consignments in commercial trade of plants for planting for citrus fruit production. Post-entry quarantine is applied for import of citrus nursery stock in EU Member States (see section 3.2.4.1) and in other citrus-producing countries (e.g. Biosecurity New Zealand, 2010; Vidalakis et al., 2010).

Effectiveness

The effectiveness of pre- and post-entry quarantine systems depends on the level of containment established by the quarantine facilities, the quarantine period, and the methods and intensity of inspection and testing during the quarantine period. For pre-entry quarantine systems in a country where *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* is present, very high standards for containment by the quarantine facilities would be required to guarantee *X. citri* pv. *citri*- and *X. citri* pv. *aurantifolii*-free consignments. Under these conditions the *effectiveness* is assessed as **high**.

Technical feasibility

The *technical feasibility* is **high**, because these systems are applicable for limited import frequency of small consignments only. The RRO is currently implemented in the EU according to Council Directive 2008/61/EC. Otherwise this RRO is not applicable.

Uncertainty

The *uncertainty* on these ratings is **low**.

4.1.3.5. Preparation of the consignment

Culling and selection measures during preparation of consignments of citrus plants for planting for citrus fruit production do not eliminate *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* infected units or *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* infections from plants because of the possible presence of latent infections.

Effectiveness

The *effectiveness* is **very low**.

Technical feasibility

The technical feasibility is **high**.

Uncertainty

The *uncertainty* is **low**.

4.1.3.6. Specified treatment of the consignment/reducing pest prevalence in the consignment.

Washing or treatment of plants for planting results in superficial disinfection, but does not eliminate latent infections or cankers. The *effectiveness* is **very low**, with **high** *technical feasibility* and **low** *uncertainty*.

4.1.3.7. Restriction on end use, distribution and periods of entry

Such restrictions are **not applicable** to citrus plants for planting for citrus fruit production: host plants of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* may carry the pest year-round, the end use is planting by definition and the distribution is by definition to areas with host plants.

B. Options preventing or reducing infestation in the crop at the place of origin

4.1.3.8. Treatment of the crop, field or place of production in order to reduce pest prevalence.

Treatments of citrus nurseries against *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* reduces the prevalence of the disease, but no treatment can eliminate *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* from infected plants. Therefore the *effectiveness* of this RRO is assessed as **low**. The *technical feasibility* is **high** and the *uncertainty* is **low**.

4.1.3.9. Resistant or less susceptible varieties.

There are no commercially important citrus varieties with an absolute or very high level of resistance to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii.* Therefore this RRO is **not applicable** to citrus plants for planting for citrus fruit production, commercial trade.

4.1.3.10. Growing plants under exclusion conditions (glasshouse, screen, isolation).

Citrus plants for planting can be grown in enclosed or greenhouse nurseries that effectively isolate from wind and rain and thus protect them from infection with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. Facilities that are aimed only at excluding insects would not be effective for isolation (e.g. Florida Department of Agriculture and Consumer Service, 2011; Gonçalves et al., 2011).

The *effectiveness* is assessed as **high**. *Technical feasibility* is **high**, because this RRO is implemented. The *uncertainty* is **medium**, since no experimental data were found on the effectiveness of such facilities to exclude *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in different weather conditions.

4.1.3.11. Harvesting of plants at a certain stage of maturity or during a specified time of year.

Not applicable since *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* is present year-round.

4.1.3.12. Certification scheme

Certification schemes have been developed for citrus plants for planting (Von Broembsen and Lee, 1988; Passos et al., 2000; Vidalakis et al., 2010: Australian Citrus Propagation Association Inc., undated). When such a scheme includes testing for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* at different stages of production, plants produced according to such a scheme are likely to be free from *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. However, in areas where the pest occurs, the plants may become infected by bacteria entering the nursery from the environment.

Shoot-tip grafting (STG) is a technique used to recover pathogen-free plants which have been cleaned of viruses and bacteria (Navarro, 1992). The procedure is quite long to produce young shoots and in vitro rootstock.

The *effectiveness* is **high** for STG and nurseries in official pest-free areas, but **moderate** in other areas. The *technical feasibility* is **very high** and the *uncertainty* of these ratings is **low**.

C. Options ensuring that the area, place or site of production at the place of origin, remains free from the pest

4.1.3.13. Limiting import of host plant material to material originating in pest-free areas

For discussion on pest-free areas see section 4.1.1.14.

Effectiveness

When the import of citrus plants for planting of hosts of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* is restricted to material originating in pest-free areas, the probability of introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* into the risk assessment area is reduced. The effectiveness depends on the frequency and the confidence level of detection surveys to confirm absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in the pest-free area and the buffer zone, and the intensity of phytosanitary measures to prevent entry of plant material (including fruit) into the pest-free area. The design and frequency of surveys to confirm absence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the area and the buffer zone should take into account the scattered presence of unmanaged host plants in private gardens and uncultivated areas and the possible presence of latently infected plants, in order to accomplish the required confidence level of the surveys.

The *effectiveness* is assessed as **high**.

Technical feasibility

The establishment and maintenance of a pest-free area for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* is technically feasible, but surveys with adequate attention to the distribution of managed and unmanaged host plants in the pest-free area should be performed when designating the pest-free area and its buffer zone.

The *technical feasibility* is assessed as **high**.

Uncertainty

The *uncertainty* of these ratings is **medium**.

4.1.3.14. Limiting import of host plant material to material originating in pest-free production places or pest-free production sites

The *effectiveness* of designation and maintenance of pest-free production places or pest-free production sites with respect to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* within infested areas is assessed as **moderate**, because of the range of natural spread (32 m for wind-blown inoculum under normal, non-extreme weather conditions; see section 3.1.1.2) and the possible presence of latent infections.

The *technical feasibility* and the *uncertainty* are both assessed as **high**.

4.1.3.15. Systems approaches integrating individual RROs.

A possible systems approach for the production of plants for planting is the application of a certification scheme in nurseries in pest-free areas, agreed by the importing countries, including for instance regular testing for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* at different production stages, and preparation and sealing of consignments at the nursery.

The effectiveness of this approach, providing it is adequately monitored by official bodies, is assessed as **high**, with **high** technical feasibility and **low** uncertainty.

Table 14: Summary of the applicable risk reduction options identified and evaluated for the pathway "Citrus plants for planting for citrus fruit production"

Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	Before shipment	Yes	Very high	Very high	Low
	Visual inspection for pest freedom	Before shipment and/or at import	No	Low	Moderate	Medium
	Testing for pest freedom	Before shipment and/or at import	No	Low	Moderate	Medium
	Pre- or post-entry quarantine systems	Before / After shipment	No	High	Very high	Low
	Preparation of consignment	Before shipment	No	Very low	High	Low
	Specified treatment of consignment	Before shipment	No	Very low	High	Low
Options for the crop at the place of origin	Treatment of the crop, field or place of production	Before shipment	Yes	Low	High	Low
	Growing plants under exclusion conditions (glasshouse, screen, isolation)	Before shipment	No	High	High	Medium
	Certification scheme	Before shipment	No	High (in pest-free areas); moderate (in other areas)	Very high	Low
Options ensuring that the area, place or site of production at the place of origin, remains free from the pest	Limiting import of host plant material to material originating in pest-free areas	Before shipment	No	High	High	Medium
	Limiting import of host plant material to material originating in pest-free production places or pest-free production sites	Before shipment	No	Moderate	High	High
Systems approaches	Certification scheme + pest-free area + preparation and sealing of consignment on nursery	Before shipment	No	High	High	Low

4.1.4. Pathway IV (Citrus plants for planting import by passenger traffic)

A. Options for consignments

4.1.4.1. Prohibition

Effectiveness

A prohibition of import of citrus plants for planting for citrus fruit production by passenger traffic would prevent the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU along this pathway. Such a prohibition requires compliance by passengers which can be influenced by the intensity and clarity of communication of this measure to passengers and the intensity of passenger checks. Results of audits performed in Australia for citrus fruit show that interceptions on passengers are made regularly, despite communication and inspection. There are no specific data on interception of citrus plants for planting for citrus fruit production carried by passengers, but the frequency of passengers carrying such material is assumed to be lower than the frequency of passengers with fruit for consumption. The *effectiveness* is assessed as **low**.

Technical feasibility

The *technical feasibility* is **low**, because this measure would have to be performed by customs officers most often without background or training in recognising citrus plants for planting. Training sessions could be offered, but practical efficiency is questionable.

Uncertainty

The *uncertainty* on these ratings is **high**, owing to lack of accurate data on the effectiveness.

4.1.4.2. Prohibition of parts of the host or of specific genotypes of the host

Not applicable.

4.1.4.3. Phytosanitary certificates and other compliance measures

Not applicable.

4.1.4.4. Pest freedom of consignments: inspection or testing

Effectiveness

The *effectiveness* of visual inspection of citrus plants for planting, carried by passengers, for symptoms of citrus canker is **low**, mainly owing to the possible presence of latent infections.

Testing is not applicable, since passengers would not await the result of the test before their further customs procedures.

Technical feasibility

The *technical feasibility* of inspection of citrus fruit carried by passengers as an option to reduce the risk of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is **negligible**. The fraction of passengers carrying such material is likely to be much lower than the estimated 0.1 % of passengers carrying on average one citrus fruit (see section 3.2.3.3), and a very large number of passengers would need to be inspected to detect citrus fruit. Moreover, the inspection would have to be performed by customs officers most often without background or training in recognition of citrus plants for planting nor in plant health inspections. Training sessions could be offered, but practical efficiency is questionable.

Uncertainty

The *uncertainty* on these ratings is **low**.

4.1.4.5. Pre- or post-entry quarantine system.

Not applicable.

4.1.4.6. Preparation of the consignment

Not applicable.

4.1.4.7. Specified treatment of the consignment/reducing pest prevalence in the consignment.

Not applicable.

4.1.4.8. Restriction on end use, distribution and periods of entry

Not applicable.

B. Options preventing or reducing infestation in the crop at the place of origin

Such options are **not applicable** to plants for planting carried by passengers.

C. Options ensuring that the area, place or site of production at the place of origin, remains free from the pest

Such options are **not applicable** to plants for planting carried by passengers.

Table 15: Summary of applicable risk reduction options identified and evaluated for the pathway "Citrus plants for planting, passenger traffic"

Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	During customs checks	No	Low	Low	High
	Visual inspection for pest freedom	During customs checks	No	Low	Negligible	Low

4.1.5. Pathway V (Ornamental rutaceous plants for planting, commercial trade)

A. Options for consignments

4.1.5.1. Prohibition

Prohibition of import of ornamental rutaceous plants for planting by commercial trade would prevent the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the risk assessment area along this pathway. The *effectiveness* is assessed as **very high**.

Technical feasibility

The *technical feasibility* is **high**, because it can be implemented in points of entry procedures and customs operations. This prohibition is currently implemented in Council Directive 2000/29/EC (Annex III of the Directive, point 16), but only for plants of *Citrus*, *Fortunella*, *Poncirus* and their hybrids, other than fruit and seeds.

Uncertainty

The *uncertainty* is assessed as **low**.

4.1.5.2. Prohibition of parts of the host or of specific genotypes of the host

The susceptibility to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* of rutaceous plants other than *Citrus*, *Fortunella*, *Poncirus*, and their hybrids, is uncertain, because it is based on scientific papers that have been published more than 50 years ago. New research to assess their susceptibility would be necessary to evaluate the need for regulation of these species. Therefore, this RRO is **not applicable** to ornamental rutaceous plants for planting, commercial trade.

4.1.5.3. Pest freedom of consignments: inspection or testing

Effectiveness

The *effectiveness* of inspection of ornamental rutaceous plants for planting to reduce the probability of entry is assessed as **low** because of the possibility of latent infections.

The effectiveness of testing is assessed as low, because testing is performed on parts of plants that were sampled from the consignment. Latently infected plants from the consignment may be included in the sample, but if only non-infested parts of these plants are used for testing, these infected plants go unnoticed. Moreover, if *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* infected plants are present in the consignment at low incidence, sample size affects the probability of including these plants in the sample.

Technical feasibility

The *technical feasibility* is assessed as **moderate** because of the difficulty of obtaining representative samples.

Uncertainty

The *uncertainty* on these ratings is **high** because of lack of data on inspection and testing on these plant species.

4.1.5.4. Pre- or post-entry quarantine system.

Pre- or post-entry quarantine systems may be developed for small consignments in commercial trade of ornamental rutaceous plants and plant parts, on similar conditions as discussed for citrus plants for planting (section 4.1.3.5).

Effectiveness

The effectiveness of pre- and post-entry quarantine systems depend on the level of containment established by the quarantine facilities, the quarantine period and the methods and intensity of inspection and testing during the quarantine period. For pre-entry quarantine in a country where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present, the effectiveness would require very high standards for containment of the quarantine facilities. The *effectiveness* is assessed as **high**.

Technical feasibility

Technical feasibility is **high** for limited numbers of small consignments. Otherwise this RRO is not applicable.

Uncertainty

The *uncertainty* on these ratings for ornamental rutaceous plants for planting is **low**, because there would be no difference in quarantine procedures between plants for planting for citrus production and for ornamental rutaceous plants.

4.1.5.5. Preparation of the consignment

Culling and selection measures during preparation of consignments of ornamental rutaceous plants for planting do not eliminate *X. citri* pv. *citri*- and *X. citri* pv. *aurantifolii*-infected units or *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* infections from plants because of the possible presence of latent infections.

Effectiveness

The *effectiveness* is **very low**.

Technical feasibility

The technical feasibility is **high**.

Uncertainty

The *uncertainty* is **low**.

4.1.5.6. Specified treatment of the consignment/reducing pest prevalence in the consignment

Washing or treatment of ornamental rutaceous plants for planting results in superficial disinfection but does not eliminate latent infections or cankers. The *effectiveness* is **very low**, with **high** *feasibility* and **low** *uncertainty*.

4.1.5.7. Restriction on end use, distribution and periods of entry

Such measures are **not applicable** to ornamental rutaceous plants for planting: such plants may carry the bacteria year-round, the end use is planting by definition and the distribution is by definition to areas with host plants.

B. Options preventing or reducing infestation in the crop at the place of origin

4.1.5.8. Treatment of the crop, field or place of production in order to reduce pest prevalence.

Treatment of nurseries growing rutaceous ornamental plants for planting against *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* reduces the prevalence of the disease, but no treatment can eliminate *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* from infected plants. Therefore the *effectiveness* of this RRO is assessed as **low**. The *technical feasibility* is **high** and the *uncertainty* is **low**.

4.1.5.9. Resistant or less susceptible varieties

The susceptibility to *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* of rutaceous plants other than *Citrus*, *Fortunella*, *Poncirus*, and their hybrids, is uncertain, because it is based on scientific papers that have been published more than 50 years ago. New research to assess their susceptibility would be necessary to evaluate the need for regulation of these species. Therefore this RRO **cannot be applied** to ornamental rutaceous plants for planting, commercial trade.

4.1.5.10. Growing plants under exclusion conditions (glasshouse, screen, isolation).

Ornamental rutaceous plants for planting can be grown in enclosed or screened nurseries, with similar conditions and effects as for citrus plants for planting (see section 4.1.3.10).

STG is a technique used to recover pathogen-free plants which have been cleaned of viruses and bacteria (Navarro, 1992). The procedure is quite long to produce young shoots and *in vitro* rootstock.

The *effectiveness* is assessed as **high**. *Technical feasibility* is **high**, but *uncertainty* is **medium**, since no experimental data were found on the effectiveness of such facilities to exclude *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in different weather conditions.

4.1.5.11. Harvesting of plants at a certain stage of maturity or during a specified time of year

Not applicable since *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present year-round.

4.1.5.12. Certification schemes

When certification schemes similar to those for plants for planting for citrus fruit production (see section 4.1.3.12 for references) are implemented for ornamental rutaceous plants for planting, including testing for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* at different stages of production, such plants are likely to be free from *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. However, in areas where the pest occurs the plants may become infected by bacteria entering the nursery from the environment.

The *effectiveness* is **high** for nurseries in official pest-free areas, but **moderate** in other areas. The *technical feasibility* is **very high** and the *uncertainty* of these ratings is **low**.

<u>C. Options ensuring that the area, place or site of production at the place of origin, remains free from the pest</u>

4.1.5.13. Limiting import of host plant material to material originating in pest-free areas

For discussion on pest-free areas see section 4.1.1.14.

<u>Effectiveness</u>

When the import of ornamental rutaceous plants for planting is restricted to material originating in pest-free areas, the probability of introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* into the risk assessment area is reduced. The effectiveness depends on the frequency and the confidence level of detection surveys to confirm absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in the pest-free area and the buffer zone, and the intensity of phytosanitary measures to prevent entry of plant material (including fruit) into the pest-free area. The design and frequency of surveys to confirm absence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the area and the buffer zone should take into account the scattered presence of unmanaged host plants in private gardens and uncultivated areas and the possible presence of latently infected plants, in order to accomplish the required confidence level of the surveys.

The *effectiveness* is assessed as **high**.

Technical feasibility

The establishment and maintenance of a pest-free area for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* is technically feasible, but surveys with adequate attention to the distribution of managed and unmanaged host plants in the pest-free area should be performed when designating the pest-free area and its buffer zone.

The *technical feasibility* is assessed as **high**.

Uncertainty

The *uncertainty* of these ratings is **medium**.

4.1.5.14. Limiting import of host plant material to material originating in pest-free production places or pest-free production sites

The *effectiveness* of designation and maintenance of pest-free production places or pest-free production sites with respect to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* within infested areas is assessed as **moderate**, because of the range of natural spread (32 m for wind-blown inoculum under normal, non-extreme weather conditions; see section 3.1.1.2) and the possible presence of latent infections.

The *technical feasibility* and the *uncertainty* are both assessed as **high**.

4.1.5.15. Systems approaches integrating individual RROs.

A possible systems approach for the production of rutaceous ornamental plants for planting is the application of a certification scheme in nurseries in pest-free areas, agreed by the importing countries, including for instance regular testing for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* at different production stages, and preparation and sealing of consignments at the nursery.

The *effectiveness* of this approach, providing it is adequately monitored by official bodies, is assessed as **high**, with **high** *technical feasibility* and **low** *uncertainty*.

Table 16: Summary of applicable risk reduction options identified and evaluated for the pathway "Ornamental rutaceous plants for planting, commercial trade"

Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	Before shipment	Yes	High	High	Low
	Visual inspection for pest freedom	Before shipment and/or at import	No	Low	Moderate	High
	Testing for pest freedom	Before shipment and/or at import	No	Low	Moderate	High
	Pre- or post-entry quarantine systems	Before/after shipment	No	High	High	Low
	Preparation of consignment	Before shipment	No	Very low	High	Low
	Specified treatment of consignment	Before shipment	No	Very low	High	Low
Options for the crop at the place of origin	Treatment of the crop, field or place of production	Before shipment	Yes	Low	High	Low
	Growing plants under exclusion conditions (glasshouse, screen, isolation)	Before shipment	No	High	High	Medium
	Certification scheme	Before shipment	No	High in pest-free areas Moderate in other areas	Very high	Low
Options ensuring that the area, place or site of production at the place of origin remains free from pest	Limiting import of host plant material to material originating in pest-free areas	Before shipment	No	High	High	Medium
	Limiting import of host plant material to material originating in pest-free production places or pest-free production sites	Before shipment	No	Moderate	High	High
Systems approaches	Certification scheme + pest-free area + preparation and sealing of consignment on nursery	Before shipment	No	High	High	Low

4.1.6. Pathway VI (Ornamental rutaceous plants for planting import by passenger traffic)

4.1.6.1. Prohibition

Effectiveness

A prohibition on the import of ornamental citrus and other rutaceous plants for planting by passenger traffic would prevent the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU along this pathway. Such a prohibition requires compliance by passengers, which can be influenced by the intensity and clarity of communication of this measure to passengers and the intensity of passenger checks. Results of audits performed in Australia for citrus fruit show that interceptions of passengers are made regularly, despite communication and inspection. There are no specific data on interception of ornamental citrus and other rutaceous plants for planting carried by passengers, but the frequency of passengers carrying such material is assumed to be lower than the frequency of passengers with fruit for consumption. The *effectiveness* is assessed as **low**.

Technical feasibility

The *technical feasibility* is **low**, because this measure would have to be performed by customs officers most often without background or training in recognising ornamental rutaceous plants for planting. Training sessions could be offered, but practical efficiency is questionable.

Uncertainty

The *uncertainty* on these ratings is **high**, owing to lack of accurate data on the effectiveness.

4.1.6.2. Prohibition of parts of the host or of specific genotypes of the host

Not applicable.

4.1.6.3. Phytosanitary certificates and other compliance measures

Not applicable.

4.1.6.4. Pest freedom of consignments: inspection or testing

Effectiveness

The effectiveness of visual inspection of ornamental citrus and other rutaceous plants for planting The *effectiveness* of visual inspection of ornamental citrus and other rutaceous plants for planting carried by passengers, for symptoms of citrus canker is **low**, mainly owing to the possible presence of latent infections.

Testing is not applicable, since passengers would not await the result of the test before their further customs procedures.

Technical feasibility

The *technical feasibility* is **negligible**. The fraction of passengers carrying citrus plants for planting is likely to be much lower than the estimated 0.1 % of passengers carrying on average one citrus fruit (see section 3.2.3.3), and a very large number of passengers would need to be inspected to detect citrus fruit. Moreover, the inspection would have to be performed by customs officers most often without background or training in recognition of ornamental rutaceous for planting nor in plant health inspections. Training sessions could be offered, but practical efficiency is questionable.

Uncertainty

The *uncertainty* on these ratings is **low**.

4.1.6.5. Pre- or post-entry quarantine system

Not applicable.

4.1.6.6. Preparation of the consignment

Not applicable.

4.1.6.7. Specified treatment of the consignment/reducing pest prevalence in the consignment

Not applicable.

4.1.6.8. Restriction on end use, distribution and periods of entry

Not applicable.

B. Options preventing or reducing infestation in the crop at the place of origin

Such options are **not applicable** to citrus fruit carried by passengers.

C. Options ensuring that the area, place or site of production at the place of origin, remains free from the pest

Such options are **not applicable** to citrus fruit carried by passengers.

Table 17: Summary of applicable risk reduction options identified and evaluated for the pathway "Ornamental rutaceous plants for planting import by passenger traffic"

Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	During customs checks	No	Low	Low	High
	Visual inspection for pest freedom	During customs checks	No	Low	Negligible	Low

4.1.7. Pathway VII (Citrus and rutaceous leaves and twigs, commercial trade)

A. Options for consignments

4.1.7.1. Prohibition

Effectiveness

Prohibition of the import of citrus and rutaceous leaves and twigs by commercial trade would prevent the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU along this pathway. The *effectiveness* is assessed as **very high**.

Technical feasibility

The *technical feasibility* is **low**, because citrus and rutaceous leaves and twigs can be sent in undeclared packages escaping customs operations and phytosanitary procedures.

Uncertainty:

The *uncertainty* on these ratings is assessed as **low**.

4.1.7.2. Prohibition of parts of the host

Not applicable to citrus and rutaceous leaves, commercial trade.

4.1.7.3. Prohibition of specific genotypes

Citrus species vary greatly in the level of susceptibility for *X. citri* pv. *citri* (Section 3.2.2.1), but there are no commercially important citrus varieties with a high level of resistance to *X. citri* pv. *citri*. Notably *C. hystrix* is highly susceptible to *X. citri* pv. *citri.*

Therefore, this RRO is **not applicable**.

4.1.7.4. Pest freedom of consignments: inspection or testing

Detection of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments is based on inspection, sampling and laboratory testing. Inspection and sampling of the consignment should be performed according to guidelines in the IPPC Standards ISPM No 23 (FAO, 2005) and No 31 (FAO, 2008), respectively. For laboratory testing, specific methods for detection of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have been developed (see section 3.1.1.3). Inspection and testing of consignments may be applied at the time of export and/or at the time of import. At export, inspection and testing may serve as a stand-alone measure, without other official measures for production, harvest and packaging, or as a measure to verify that other measures have been effective. At import, inspection generally serves to verify phytosanitary measures by the exporting country.

Effectiveness

The effectiveness of visual inspection is limited by the possible presence of latent infections or mildly infected leaves escaping detection in the sample, and laboratory testing for detection of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments of citrus and rutaceous leaves and twigs depends on the sampling method and the sample size. No method will provide 100 % effectiveness of detection.

If symptomatic leaves remains undetected, either because they have escaped sampling or they were not detected by visual inspection of the sample, *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* may remain viable for up to 100 days in storage but the number of viable bacteria decrease with time (Bonn et al., 2009).

The *effectiveness* of visual inspection is assessed as **moderate** and that of laboratory testing as high, if PCR-based screening techniques are applied.

Technical feasibility

The *technical feasibility* is assessed as **moderate**, because no data are available on the implementation.

Uncertainty:

The *uncertainty* on the rating of effectiveness is **medium** owing to the influence of the unspecified sampling procedure. The uncertainty for technical feasibility is low.

4.1.7.5. Pre- or post-entry quarantine system

Not applicable to citrus and rutaceous leaves, commercial trade.

4.1.7.6. Preparation of the consignment

Preparation of the consignment includes several stages, including handling and transport of harvested leaves and packing prior to export. Specific conditions may be applied during this process to prevent the presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the consignment.

Effectiveness

Culling and cleaning of leaves may allow the removal of many (but not all) symptomatic leaves, but leaves with latent or asymptomatic infections or with small lesions will not be eliminated by these procedures. The *effectiveness* is assessed as **low**.

Technical feasibility

The *technical feasibility* is assessed as **high**.

Uncertainty

The *uncertainty* on these ratings is **low**.

4.1.7.7. Specified treatment of the consignment/reducing pest prevalence in the consignment.

Some citrus and rutaceous leaves are imported as dried leaves for consumption. They can be submitted to heat treatment at 85 °C for eight hours, as recommended by the Interim Inspector-General of Biosecurity (Australian Government, 2011).

Effectiveness

The *effectiveness* is assessed as **moderate**, based on the fact that there is no available record of evaluation of the proposed treatment procedure. Depending on the size of the consignment, the time to reach the requested temperature and the homogeneity of the treatment may vary. Such a method is also not applicable for fresh leaves which are the ones of most interest.

Technical feasibility

The *technical feasibility* is assessed as **high**, with regards to the ease of implementation.

Uncertainty

The *uncertainty* on these ratings is considered as **high**, considering the lack of information and scientific publication on the treatment and its efficacy.

4.1.7.8. Restriction on end use, distribution and periods of entry

It is not possible to identify periods of the year when citrus and rutaceous leaves and twigs are not infected, nor periods of the year when host plants are not susceptible to infection. Therefore a restriction on the period of entry of citrus and rutaceous leaves and twigs is **not applicable**. Since the end use is consumption and ornamental uses only, a restriction on end use is also **not applicable**. Further to the assessment in section 4.1.1.8, the *effectiveness* of a restriction on distribution would be **high**, with **low** *technical feasibility* and **low** *uncertainty*.

B. Options preventing or reducing infestation in the crop at the place of origin

4.1.7.9. Treatment of the crop, field or place of production in order to reduce pest prevalence

Effectiveness

Treatments of citrus plants against *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* to reduce the prevalence of the disease may be routinely applied by citrus producers in the absence of official phytosanitary requirements, although the combination of chemical treatments, cultural and other methods may vary among producers. Chemical treatments are limited because commodities are intended for direct consumption. The regulation of such measures would result in their standardisation for all imported leaves and thereby reduce the probability of entry. However, these measures will not eliminate *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in production places, and harvesting of infected leaves cannot be prevented. The infestation level of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in harvested leaves remains variable, depending on the intensity of the control programme and the weather conditions during the growing season, notably the occurrence of storms and heavy rainfall and the presence of leaf miner infestation.

The *effectiveness* of the integrated control programme is assessed as **low**.

Technical feasibility

The *technical feasibility* is assessed as **moderate**.

Uncertainty

The *uncertainty* on these ratings is **medium**.

4.1.7.10. Resistant or less susceptible varieties

Citrus species vary greatly in the level of susceptibility for *X. citri* pv. *citri* and/or *X. citri* pv. *aurantifolii* (Table 4). This RRO is **not applicable** to citrus and rutaceous leaves.

4.1.7.11. Growing plants under exclusion conditions (glasshouse, screen, isolation)

This RRO may be applicable to production places producing citrus and rutaceous leaves, if the plants are kept sufficiently small to grow in greenhouses.

The *effectiveness* would be **high**, the *technical feasibility* **moderate** and the *uncertainty* is **medium**.

4.1.7.12. Harvesting of plants at a certain stage of maturity or during a specified time of year.

Not applicable since *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present year-round.

4.1.7.13. Certification schemes

Plants for production of citrus and rutaceous leaves, produced under a certification scheme, will be initially free from *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. However, these plants can become infected when planted in an area where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* occurs. The prevalence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is then dependent on the measures discussed in section 4.1.1.9.

Effectiveness

The *effectiveness* of a certification scheme is **low**.

Technical feasibility

The *technical feasibility* is assessed as **high**.

Uncertainty

The *uncertainty* on these ratings is assessed as **low**.

C. Options ensuring that the area, place or site of production at the place of origin, remains free from the pest

4.1.7.14. Limiting import of host plant material to material originating in pest-free areas

The different aspects of this RRO are discussed in section 4.1.1.14.

Effectiveness

The *effectiveness* of pest-free areas is assessed as **high**, on the condition that procedures for maintaining the pest-free area and its buffer zone are documented and regularly officially evaluated, and the results reported.

Technical feasibility

The establishment and maintenance of a pest-free area for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is technically feasible, but surveys with adequate attention to the distribution of managed and unmanaged host plants in the pest-free area should be performed when designating the pest-free area and its buffer zone. *Technical feasibility* is assessed as **high**.

Uncertainty

The *uncertainty* of the rating for effectiveness is **medium**, because of the possible variation in performance of surveys and other measures to maintain the pest-free area.

4.1.7.15. Limiting import of host plant material to material originating in pest-free production places or pest-free production sites

Effectiveness

The *effectiveness* of this measure is assessed as **high**, but depends on the intensity of monitoring.

Technical feasibility

Technical feasibility is **high**.

Uncertainty

Uncertainty is **high**, owing to the unknown rate of invasion from the infested environment and potential presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* at low prevalence or inconspicuous symptoms at the place or site of production.

4.1.7.16. Systems approaches integrating individual RROs

Systems approaches combining individual RROs are not evaluated for this pathway, because of insufficient information.

Table 18: Summary of the applicable risk reduction options identified and evaluated for the pathway "Citrus and rutaceous leaves and twigs, commercial trade"

Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	Before shipment	Yes [(a)]	Very high	Low	Low
	Visual inspection for pest freedom	Before shipment and/or at import	No	Moderate	Moderate	Medium
	Testing for pest freedom	Before shipment and/or at import	No	High	Moderate	Medium
	Preparation of consignment	Before shipment	No	Low	Low	Low
	Specified treatment of the consignment/reducing pest prevalence in the consignment	Before shipment	No	Moderate	High	High
Options for the crop at the place of origin	Treatment of the crop, field or place of production	Before shipment	No	Low	Moderate	Medium
	Certification scheme	Before shipment	No	Low	High	Low
	Growing plants under exclusion conditions	Before shipment	No	High	Moderate	Medium
Options ensuring that the area, place or site of production at the place of origin, remains free from the pest	Limiting import of host plant material to material originating in pest-free areas	Before shipment	No	High	High	Medium
	Limiting import of host plant material to material originating in pest-free production places or pest-free production sites	Before shipment	No	High	High	High

(a) : EU Directive 2000/29/CE, Annex III, Part A, point 16, for genus *Citrus*, *Poncirus* and *Fortunella*.

4.2. Systematic Identification and Evaluation of options to reduce the probability of establishment and spread

4.2.1. Cultivation and hygienic measures

An important step in the pathway for introduction (entry and establishment) of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU by infected fruit, moved in commercial trade or carried by passengers entering the EU, is the transfer of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* from fruit or fruit waste to growing host plants by splash dispersal over short distances (sections 3.1.1.2 and 3.2.2.4). This event is more likely to occur in public areas where citrus are not grown commercially (streets, parks, gardens) and private gardens than in production sites, assuming that hygienic protocols at places of production will not allow the introduction of citrus fruit from outside into the grove. Especially in citrus-producing parts of the EU, non-cultivated host plants (*Citrus*, *Fortunella*, *Poncirus*, *Murraya*, etc.) are abundant in public areas. Such plants may have branches, receptive for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, close to the ground and within the distance for successful splash dispersion from discarded infected fruit or fruit waste (section 3.2.2.4) If *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* becomes established on such plants it may spread within the area, eventually reaching citrus production sites. The increasing number of abandoned citrus groves where host plants are left unattended may contribute to this spread.

Possible measures to reduce the probability of entry and establishment of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* would be to apply pruning or other tree cultivation measures to host plants of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in public places (parks, streets, public gardens, etc.) such that the distance from the lowest branches to the ground is higher than the maximum distance for splash dispersal; the regular removal of fruit and fruit waste present on the ground; and raising the public awareness for hygienic measures in public and private gardens.

Effectiveness

The effectiveness of cultivation and hygienic measures is assessed as moderate.

Technical feasibility

The technical feasibility is **low**, because of the difficulty to organise and maintain the required programme for large area.

Uncertainty

The uncertainty of these ratings is **high**, because data on the effectiveness are lacking.

4.2.2. Surveillance

A surveillance programme including regular detection surveys in areas with host plants production, public areas and private gardens and abandoned citrus groves, including observations on uncultivated and wild host plants, for early detection of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* outbreaks would contribute to timely eradication if necessary. See section 4.1.1.15 for a discussion on surveys and monitoring.

The effectiveness is determined by the intensity of the surveys and the inclusion of visual inspection and laboratory testing. The *effectiveness* is assessed as **moderate**, the technical *feasibility* is **moderate**, owing to the difficulty of organising surveys in public areas, and the *uncertainty* is **medium**.

4.2.3. Eradication and containment

Following the discovery of an outbreak of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, eradication and containment measures should be implemented immediately.

Eradication programmes have been extensively reviewed (section 4.1.1.15). Eradication is often difficult to achieve (Graham et al., 2004; Gambley et al., 2009) and depends on factors such as environmental conditions and the alertness by surveillance to detect an outbreak as early as possible. The continuous elimination of infected trees and groves may help to keep disease prevalence in an area at a low level and confine the pest to a limited area, but this is not always successful (Gottwald et al., 2002b).

The *effectiveness* of eradication and containment is assessed as **moderate**. The technical *feasibility* is **moderate** and the *uncertainty* is **medium**.

4.2.4. Systems approach

Singular options may be combined in systems approaches and programmes for eradication and containment, and these would have to be specific for different regions within EU.

The *effectiveness* is assessed as **moderate**, with **moderate** technical feasibility and **high** *uncertainty*.

Table 19: Summary of the risk reduction options to reduce the probability of establishment and spread

Type of measure (for details, see EFSA PLH Panel, 2012)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Cultivation and hygienic measures	After entry	No	Moderate	Low	High
Surveillance	After entry	No	Moderate	Moderate	Medium
Eradication	After entry	No	Moderate	Moderate	Medium
Containment	After entry	No	Moderate	Moderate	Medium
Systems approach integrating all above measures	After entry	No	Moderate	Moderate	High

4.3. Evaluation of the current phytosanitary measures to prevent the introduction and spread

The effectiveness and uncertainty of the present phytosanitary measures of the EU against introduction into and spread within the EU of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* (see section 3.1.3) are summarized in Table 20.

The combined regulations for all pathways have shown to result in preventing introduction of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the EU, because there have been no outbreaks of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the EU territory.

Table 20: Effectiveness and uncertainty of the present EU requirements against *Xanthomonas campestris* (all strains pathogenic to *Citrus)*, which are listed in Council Directive 2000/29/EC and Commission Decision 2006/473/EC, in reducing the risk of introduction of this pest into the EU territory

2000/29/EC Annex	**Commodities**	**Countries of origin**	**Requirement**	**Effectiveness and uncertainty assessed by PLH Panel** (NB: technical feasibility is not relevant since these measures are already implemented)
III A (16)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds	Third countries	Prohibition of introduction in all Member States	This requirement is discussed in sections 4.1.3.1., 4.1.5.1. and 4.1.7.1. The effectiveness is assessed as very high, with low uncertainty. The Panel notes that the prohibition by Annex III A (16) does not apply to rutaceous species other than those mentioned, that are known to be a natural or putative host of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* (see section 3.2.6). The plants for planting of these species require a plant health inspection and phytosanitary certificate (Annex V part B section I (1)) but no special requirements are in place. For rutaceous species, that are not mentioned and that are known to be a natural host (i.e. *Microcitrus australis*, *Swinglea glutinosa* and *Naringi crenulata*) the effectiveness of Annex III A (16) is rated as low, with low uncertainty. For rutaceous species, not mentioned and a putative host as based on symptoms after artificial inoculation, the effectiveness is low with high uncertainty.
IV A I (16.1)	Fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids	Third countries	The fruits shall be free from peduncles and leaves and the packaging shall bear an appropriate origin mark	This requirement is discussed in section 4.1.1.2. The effectiveness is assessed as low, with low uncertainty.
IV A I (16.2)	Fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids	Third countries	(a) official statement that the fruits originate in a country recognised as being free from *Xanthomonas campestris* (all strains pathogenic to *Citrus*), in accordance with the procedure referred to in Article 18(2)	**Country freedom** is a type of area freedom, discussed in section 4.1.1.14. The effectiveness is assessed as very high, with low uncertainty.
			OR (b)	**Area freedom** is discussed in section 4.1.1.14.

	official statement that the fruits originate in an area recognised as being free from *Xanthomonas campestris* (all strains pathogenic to *Citrus*),in accordance with the procedure referred to in Article 18(2), and mentioned on the certificates referred to in Articles 7 or 8 of this Directive	The effectiveness is assessed as very high, but depends on the frequency and confidence level of detection surveys and intensity of phytosanitary measures to prevent entry into the pest-free area. The Panel notes that technical feasibility to maintain a pest-free area is affected by its proximity to citrus canker infested areas. The uncertainty is medium.
	OR (c) either, official statement that in accordance with an official control and examination regime, no symptoms of *Xanthomonas campestris* (all strains pathogenic to *Citrus*) have been observed in the field of production and in its immediate vicinity since the beginning of the last cycle of vegetation, and none of the fruits harvested in the field of production has shown symptoms of *Xanthomonas campestris* (all strains pathogenic to *Citrus*), and the fruits have been subjected to treatment such as sodium orthophenylphenate, mentioned on the certificates referred to in Articles 7 or 8 of this Directive, and the fruits have been packed at premises or dispatching centres registered for this purpose	This is a systems approach (discussed in section 4.3),combining components (1) pest freedom of the production site (measured as the absence of symptoms of citrus canker in the field of production and its immediate vicinity); (2) visual inspection to confirm the absence of symptoms of citrus canker on the harvested fruit; (3) treatment of consignments and (4) packing of the harvested fruit at registered premises. Component (1) is discussed in section 4.1.1.15, where effectiveness and uncertainty are rated as high, under the condition that sufficiently large buffer zones are maintained and intensive monitoring (including laboratory testing) for the presence of citrus canker is performed in the production site and in the buffer zones. However, the Panel notes that this requirement of 2000/29/EC has insufficient detail with respect to procedures for the designation of pest-free production sites in areas infested by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* . The distance of natural spread by wind-driven rain in normal (non-extreme) weather conditions has been observed to be at least 32 m and a buffer zone defined as “the immediate vicinity of a field“ is therefore imprecise and possibly too small (section 4.3). Therefore, the effectiveness of pest freedom of production sites, implemented according to this requirement, is assessed as moderate. Component (2), the subsequent “appropriate examinations“ of consignments, requires visual

				inspection but not laboratory testing, since the purpose is to detect symptoms of this organism. Only fruit without symptoms (regardless whether *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present) will meet this requirement. This RRO is discussed in section 4.1.1.4, where the effectiveness of visual inspection is assessed as moderate, with medium uncertainty. The effectiveness of subsequent treatment of consignments (component (3)) and handling at registered packinghouses (component (4)) are each assessed as moderate, with medium uncertainty (sections 4.1.1.6 and 4.1.1.7). The stacked measures will reduce, but not eliminate all infected fruit harvested from infested fields. The Panel assesses the effectiveness of this systems approach as moderate, with medium uncertainty. The lack of minimum procedures for designation of pest-free production sites including requirements for buffer zones are important points of concern for this regulatory requirement
			OR (c) official statement that any certification system, recognised as equivalent to the above provisions in accordance with the procedure referred to in Article 18(2) has been complied with.	Owing to its formulation, this option has the same ratings for effectiveness, technical feasibility and uncertainty as the option in the row above ("(c) either").
V B I (3)	Fruits of Citrus L., Fortunella Swingle, Poncirus Raf., and their hybrids	Non-EU countries	Subject to a plant health inspection in the country of origin or the consignor country, before being permitted to enter the community	The plant health inspection would have to fulfil the special requirements of Annex IV A I. The effectiveness and uncertainty of the inspection are the same as those for the options of Annex IV A I that apply according to the conditions of the place of production of these fruits.

Decision 2006/473/EC	recognising certain third countries and certain areas of third countries as being free from *Xanthomonas campestris* (all strains pathogenic to Citrus), *Cercospora angolensis* Carv. et Mendes and *Guignardia citricarpa* Kiely (all strains pathogenic to Citrus.)

The listing of these countries and areas is based on “the information provided by the European and Mediterranean Plant Protection Organisation and the Centre for Agriculture and Bioscience International” (preamble of Commission Decision 1998/83/EC) and amended by subsequent Commission Decisions 199/104/EC, 2001/440/EC, 2003/129/EC. Commission Decision 1998/83/EC was replaced by Commission Decision 2006/473/EC, which has been amended by Commission Decisions 2010/134/EC and 2013/253/EC

	Commodities + origin	**Countries of origin**	**Requirement**	**Effectiveness and uncertainty assessed by PLH Panel** (NB: technical feasibility is not relevant since these measures are already implemented)
Articlel 1,1.	Fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids	Non-EU Countries	Pest-free countries: For the purposes of point 16.2 of Section I of Part A of Annex IV, the following third countries are recognised as being free from all strains of *Xanthomonas campestris* pathogenic to Citrus: (a) all citrus-growing third countries in Europe, Algeria, Egypt, Israel, Libya, Morocco, Tunisia and Turkey; (b) Africa: South Africa, Gambia, Ghana, Guinea, Kenya, Sudan, South Sudan, Swaziland and Zimbabwe; (c) Central and South America and the Caribbean: the Bahamas, Belize, Chile, Colombia, Costa Rica, Cuba, Ecuador, Honduras, Jamaica, Mexico, Nicaragua, Peru, the Dominican Republic, Saint Lucia, El Salvador, Surinam and Venezuela; (d) Oceania: New Zealand.	The currently listed countries correspond to countries free from *Xanthomonas citri* pv. *citri and X. citri* pv. *aurantifoli*i in Appendix B of this opinion (derived by the Panel from EPPO-PQR database, 5 March 2013, EPPO, online a) The effectiveness of this list is therefore assessed as high, with low uncertainty
Article 1.2	Fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids	Non-EU Countries	Pest-free areas: For the purposes of point 16.2 of Section I of Part A of Annex IV, the following areas are recognised as being free from all strains of *Xanthomonas campestris* pathogenic to Citrus: (a) Australia: New South Wales, the Northern Territory, Queensland, South Australia,	The listing of these areas is based on ‘the information provided by the European and Mediterranean Plant Protection Organisation and the ‘Centre for Agriculture and Bioscience International’ (preamble of Decision 1998/83/EC), and amended on the basis of communications from third countries. The Panel notes that the listing of areas in this

	Victoria and Western Australia; (b) Brazil, except the States of Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, Rio Grande do Sul, Roraima, Santa Catarina and São Paulo; (c) United States: Arizona, California, Guam, Hawaii, Louisiana, Northern Mariana Islands, Puerto Rico, American Samoa, Texas and the United States Virgin Islands; (d) Uruguay, except the Departments of Salto, Rivera and Paysandu — north of River Chapicuy.	Article is more detailed than in Appendix B of this opinion. Louisiana, indicated as pest free-area according to 2006/473/EC, is no longer pest-free (NAPPO, 2013 online) The effectiveness is assessed as high, with low uncertainty.

Concerning entry pathway I (citrus fruit, commercial trade)
Relative to the total volume of imported citrus fruit, very few consignments of citrus fruit were intercepted because of detection of X. citri pv. citri or X. citri pv. aurantifolii during 2003–2012. Apparently exporting countries are largely able to comply with the special requirements for citrus fruit, with respect to X. citri pv. citri and X. citri pv. aurantifolii, of the EU. Most interceptions concerned small consignments from minor exporting countries (Table 3, section 3.2.2.1), suggesting that larger trade chains may be more in a situation of implementing the special requirements of the EU. Several aspects of the regulations are discussed here.

Currently it is requested by EU phytosanitary legislation that fruit from third countries is packed in registered packinghouses, but only if they do not originate from a pest-free country or pest-free area. To further reduce the probability of entry, it could be considered expanding this requirement to all packinghouses in third countries handling citrus fruit to be imported in the EU. In addition, it is currently not required for packinghouses to maintain records on the orchards where fruit was collected, and of the postharvest treatments applied. These requirements would facilitate traceability of fruit destined for export, in particular in cases where fruit from pest-free areas is found infected at export inspection and the pest-free area should be modified accordingly.

Currently there are no special requirements for packinghouses handling citrus fruit originating in pest-free areas, allowing the mixing of fruit coming from infected orchards and pest-free areas. In order to maintain the pest-free quality of fruit from pest-free area, the Panel suggests that additional requirements for packinghouses are formulated, such as effective sanitation between handling of different consignments, a separate area within the packinghouse reserved for fruit from pest-free areas, or the handling of fruit from pest-free areas in separate, dedicated packing stations where no other fruit is accepted.

For fruit originating in areas infested by X. citri pv. citri or X. citri pv. aurantifolii, special requirements in Annex IV, Part A, Section I, point 16.2, of Council Directive 2000/29/EC concern a systems approach, i.e. the combination of pest freedom of the production site (measured as the absence of symptoms of citrus canker in the field of production and its immediate vicinity), the absence of symptoms of citrus canker on the harvested fruit, and treatment and packing of the harvested fruit at registered premises. However, no requirements have been specified for these packinghouses in the Directive. Since these packing stations are likely to be located within the infested area, they may process X. citri pv. citri or X. citri pv. aurantifolii infested fruit or fruit from X. citri pv. citri or X. citri pv. aurantifolii infested fields prior to, or simultaneous with, the fruit destined for the EU that could lead to mixtures of fruit or misidentification of fruit lots. The Panel is of the opinion that the designation of pest-free production sites in areas infested by X. citri pv. citri or X. citri pv. aurantifolii is insufficiently specified. The distance of natural spread by wind-driven rain in normal (non-extreme) weather conditions has been observed to be at least 32 m and a buffer zone defined as "the immediate vicinity of a field" is therefore imprecise and possibly too small.

Concerning entry pathway II (citrus fruit, passenger traffic)
Currently it is a possibility in EU legislation that measures to prevent entry of *X. citri* pv. *citri*- or *X. citri* pv. *aurantifolii*-infested citrus fruit carried by passengers are not applied: the special requirements for plants, plant products and other objects listed in Annex IV, Part A and in Annex V, Part B may not apply for small quantities of plants, plant products, foodstuffs or animal feedingstuffs where they are intended for use by the owner or recipient for non-industrial and non-commercial purposes or for consumption during transport, provided that there is no risk of harmful organisms spreading (Council Directive 2000/29/EC, Article 5, paragraph 4; Article 13b, paragraph 3). According to the risk assessment (section 3.2.3) the movement of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* on fruit carried by passengers is very likely, but the transfer to a suitable host is unlikely, although with high uncertainty. However, the frequency of passengers carrying citrus fruit was estimated as 0.1 % (section 4.1.2.1), and a large sample of passengers would need to be inspected to reduce the rate of entry of citrus fruit by passengers. A combination of improved communication measures to inform

incoming passengers of their obligations with incidental targeted inspection of passengers might be more effective.

Concerning entry pathway III (citrus plants for planting, commercial trade)
During 2003-2012 no consignments containing plants for planting for citrus fruit production were intercepted, suggesting that the prohibition of this material by Annex III of Council Directive 2000/29/EC has been highly effective.

Concerning entry pathway IV (citrus plants for planting, passenger traffic)
Since citrus plants for planting are subject to prohibition of import according to Annex III of Council Directive 2000/29/EC instead of special requirements of Annex IV, Part A, the exceptions of Article 5, point 4, of the Directive do not apply. Such illegal entry of citrus plants for planting poses a high risk for entry of *X. citri* pv. *citri* and. *X. citri* pv. *aurantifolii*. Although there are no reports of interceptions of such material carried by passengers, the Panel raises the need to check passengers and their baggage for planting material.

Concerning entry pathway V (ornamental rutaceous plants for planting, commercial trade).
Rutaceous plants for planting other than *Citrus*, *Fortunella* and *Poncirus* belong to the category of plants for planting in Annex V, Part B, point 1. At entry into the EU they must be accompanied by a phytosanitary certificate and must have been subject to a plant health inspection in the country of origin or the consignor country. At entry into the EU they are subject to phytosanitary import checks.
No notification of interception exist for these plants for the period 2003–2012.

Concerning entry pathway VI (ornamental rutaceous plants for planting, passenger traffic)
According to Council Directive 2000/29/EC, Article 13b, point 3, small quantities of plants, plant products, foodstuffs or animal feedingstuffs, which are not listed in Annex III of the Directive and are intended for use by the owner or recipient for non-industrial and non-commercial purposes or for consumption during transport, may be introduced into the EU without a phytosanitary certificate and are not subject to the phytosanitary import checks. The rutaceous plants other than *Citrus*, *Fortunella* and *Poncirus* would fall in this category with the exception of *Murraya* if it is infested by *Diaphorina citri*.

Concerning entry pathway VII (citrus and rutaceous leaves and twigs, commercial trade)
Currently the import of leaves of *Citrus*, *Poncirus* and *Fortunella* (but not of other rutaceous plants such as *Murraya*) is prohibited according to Annex III of Council Directive 2000/29/EC. The notifications of interception of citrus leaves during 2003-2012 indicate that this prohibition does not effectively control this pathway.

Concerning establishment and spread of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in the EU
An important step in the pathway for introduction (entry and establishment) of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* into the EU by infected fruit, moved in commercial trade or carried by passengers entering the EU, is the transfer of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* from fruit or fruit waste to growing host plants. No measures are currently in place to reduce the probability of transfer to a suitable host for this pathway. Experimental data on transfer are scarce but the event cannot be excluded (section 3.2.2.4). The probability of this transfer of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is assumed to be higher for host plants growing in public areas (streets, parks, gardens) and private gardens than in citrus production places (section 4.2). The implementation of detection surveys by national plant protection organisations, apart from citrus-growing fields, would help keep Member States free from *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, permitting early detection.

4.4. Conclusions on the analysis of risk reduction options and on the current phytosanitary measures

Currently *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are not known to occur in the territory of the EU. Once established, spread of the bacteria is difficult to control, hence risk reduction options to reduce the probability of entry are the main means to maintain the absence of this pest. The enormous investment to prevent outbreaks and for eradication in response to outbreaks of citrus canker made by various countries (Gottwald et al., 2002a; Alam and Rolfe, 2006; Gambley et al., 2009) highlights the importance of maintaining the absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in citrus-producing areas and of the risk reduction options to maintain this absence.

The effectiveness of current EU phytosanitary measures to reduce the risk of introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* ranges from moderate to high. However, the requirements for buffer zones of pest free production sites in areas infested by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are insufficiently detailed.

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of plants for planting for citrus production and of ornamental rutaceous plants (species listed in section 3.1.1.4) is rated as likely. Prohibition of import of host plants for planting is the most reliable option to reduce the risk of entry, with the exception of small consignments of plants for planting for breeding and selection purposes under strict post-entry quarantine conditions (as described in Directive 2008/61/CE).

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of citrus fruit by commercial trade is rated as unlikely, but there is a high uncertainty about its transfer to suitable hosts in the EU territory. To reduce the risk associated with the high uncertainty, the large import volumes and the moderate to major consequences of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, options have been identified to reduce the probability of entry via this pathway. The current measures to prevent entry to the EU are evaluated as effective. As some fruit lots are intercepted at EU borders from time to time, one can consider that exporting countries may have difficulty with always complying with EU regulations. Additional options are suggested to further reduce the risk of entry.

The entry of fruit or other material infected with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, carried by passengers, poses a risk for entry and establishment, but effective RROs have not been identified. Communication to increase public awareness and responsibility is recommended.

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of citrus and rutaceous leaves and twigs through commercial trade is rated as unlikely, but there is a high uncertainty about the transfer of the bacteria to suitable hosts in the EU territory. Currently the import of leaves of *Citrus*, *Poncirus* and *Fortunella* is prohibited by Council Directive 2000/29/EC, but, despite this regulation, there is a large number of interceptions of citrus leaves imported via undeclared packages and passenger baggage.

CONCLUSIONS

With regard to the assessment of the risk to plant health for the EU territory:

Under the scenario of absence of the current specific EU plant health legislation and the assumption that citrus-exporting countries apply measures to reduce yield and quality losses, the conclusions of the pest risk assessment are as follows:

<u>Entry</u>

For fruit:

- The association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruit imported within the EU from countries where citrus canker is reported. The association with the passenger pathway is rated likely to very likely based on the lack of control measures through regulation and packinghouse processes for domestic markets as well as a lower awareness of the disease by passengers.
- The ability of bacteria to survive during transport, verified by the isolation of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, is rated very likely.

- The probability of the pest surviving existing management procedure is very likely, since cultural practices and chemical treatments (pre- and post-harvest) currently applied at the place of origin cannot eliminate the pathogen and no specific measures are currently in place in the risk assessment area.
- The probability of transfer to a suitable host is rated unlikely, based on the literature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur (i) because of occurrence of climatic conditions suitable for the transfer, (ii) the reports of infections from inoculum available at soil level owig to the short distance between tree canopy and soil in the risk assessment area and (iii) because of th presence of waste near to orchards.

Because transfer is critical and a limiting factor, the probability of entry is rated as unlikely for fruit.

For leaves and twigs, the probability of entry is rated unlikely because:

- The association with the pathway at origin is likely because leaves and cut twigs are imported from where the disease is endemic but the volume of citrus leaves is very low in comparison with citrus fruit imported within the EU from countries where citrus canker is reported;
- The ability to survive during transport is very likely.
- The probability of the pest surviving existing management procedure is very likely, since no management practices are currently undertaken in the risk assessment area.
- The probability of transfer to a suitable host is rated unlikely.

For plants for planting for citrus fruit production and for ornamental rutaceous plants that are natural hosts for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, through both the commercial trade and passengers pathways, the probability of entry is rated as likely because:

- The association with the pathway at origin is rated as likely for plants for planting for citrus production, through both the commercial trade and passengers pathways, because plants for planting have been recorded in the past as a source for outbreaks and based on the expected level importation of plants for planting from countries where citrus canker is reported.
- The association with the pathway at origin is rated as moderately likely for plants for planting for other rutaceous plants, through both the commercial trade and passengers pathways, owing to the lack of recent information on rutaceous ornamental host plants' susceptibility and a real difficulty in evaluating the level of trade under a hypothetically unregulated pathway.
- As for the fruit pathways, the ability to survive during transport is very likely.
- The probability of the pest surviving any existing management procedure is very likely since no specific measure is currently (prohibition excepted) in place in the risk assessment area as it is free of citrus canker. This probability would be even higher in the case of plants or plant parts imported through the passenger pathway.
- The probability of transfer to a suitable host is rated as very likely, based on the intended use of the plant material for planting (rootstocks) or grafting (scions, budwood) as well as on the fact that citrus (for fruit or ornamentals) and other rutaceous hosts are extensively grown in the risk assessment area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of amateur gardeners who are likely to import through passenger traffic.

The uncertainties of probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are rated as high and are due to:

- The role of infected citrus fruit/peel and leaves present in the vicinity of susceptible plants as a source of primary inoculum allowing the transfer to a suitable host remains poorly documented. The two papers published on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of many more experimental data.
- Partial data on the presence and distribution of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country of origin.
- There is globally a lack of knowledge on sources of primary inoculum associated with outbreaks in areas where *X. citri* pv. *citri* was not endemic.
- The rate of infection of citrus fruit imported from countries where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* is present and the concentration of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in consignments are difficult to assess because they are highly dependent on variable environmental conditions at the place of production and they are also dependent on the technologies implemented by exporting countries in the field and in packinghouses. The numerous interceptions in the EU of consignments containing diseased fruit suggest a lack of total reliability of the integrated measures that are taken in a systems approach for eliminating the risk of exporting contaminated and/or diseased fruit.
- The extent of importation of citrus material via passenger traffic is not well documented.
- The susceptibility of ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus* to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the latent infection and/or endophytic and/or epiphytic presence of *X. citri* pv. *citri* in ornamental rutaceous species other than *Citrus*, *Fortunella* and *Poncirus*.

<u>Establishment</u>

The probability of establishment is rated as moderately likely to likely because host plants are widely present in some areas of the risk assessment area where environmental conditions are frequently suitable. The host is susceptible during most of the year to infection through wounds and for shorter periods through natural openings (two to three growth flushes except for some lemon and lime cultivars), and some severe weather events potentially promoting establishment occur on a regular basis in the risk assessment area. Cultural practices and control measures against fungal diseases currently used in the risk assessment area may reduce the severity of the disease but they cannot prevent the establishment of the pathogen. The pathogen would not require pathological adaptation to become established when it encountered a susceptible host.

Uncertainty on the probability of establishment is rated medium because information on the occurrence of suitable host in the risk assessment area is well documented. However, pieces of information are missing on the type of irrigation systems employed across orchards in the EU and the plant host susceptibility under environmental conditions that occur where citrus are grown in the risk assessment area. Furthermore, uncertainties remain on the efficacy of cultural practices and control measures in use in European groves and nurseries.

<u>Spread</u>

Once established in areas where citrus plants are grown, spread would be likely. Natural dispersal at low to medium scales would primarily be driven by splashing, aerosols and wind-driven rain. Some weather events such as thunderstorms, which occur infrequently but on a regular basis in Southern Europe, have the ability to spread *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* at larger distances (i.e. approximately at up to a kilometer scale). Human activities would favour spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* whatever the considered scale. This would primarily be through movement of contaminated or exposed plant material including fruit and through machinery, clothes, and tools polluted by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* during grove or nursery maintenance operations.

Human-driven unintentional spread could also be due to the massive presence of citrus trees in streets, private and public gardens that can serve as a pathway for dissemination of the pest.
Uncertainty on the probability of spread is rated as low. Citrus canker has the ability to spread at small to medium spatial scales in relation to weather events similar to that reported in the pest risk area (e.g. Argentina). Practices and citrus varieties used in the RA area are similar to those used in countries where the disease occurs. Human-assisted spread would undoubtedly contribute to the spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii.*

Endangered areas

Citrus plants are widely available as commercial crops in parts of the risk assessment area (Figure 5 in section 3.1.4.2). Citrus plants are commonly grown in Southern Europe, in eight countries: Spain (314 908 ha), Italy (112 417 ha), Greece (44 252 ha), Portugal (16 145 ha), Cyprus (3 985 ha), France (1 705 ha), Croatia (1 500 ha) and Malta (193 ha). Citrus nurseries dedicated to fruit production and ornamentals are located in the same areas as citrus groves (Spain 10 665 000 trees/year; Italy 5 771 000 trees/year; Portugal 844 000 trees/year; Greece 826 000 trees/year and France 819 000 trees/year). Moreover, citrus are commonly available in these countries in city streets and public and private gardens. Citrus production regions in the EU correspond to hardiness zones 8 to 10. Based on the current worldwide distribution of citrus canker, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* have the ability to establish in hardiness zones 8 to 12. So, all citrus-growing areas within the EU are considered as the endangered area.

Consequences

Based on the above, the impact of the disease, even if control measures are used, could be moderate to major should *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* enter and establish in the risk assessment area. The disease would cause losses of yield and require costly control measures. It would have negative social consequences in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies would reduce their access to some markets. The occurrence of the disease would lead to increased chemical application in groves and to the use of copper compounds that would create environmental concerns such as copper accumulation in the soil and selection of resistance genes that could spread in the plant associated microflora and beyond.

Once CBC enters the risk assessment area, uncertainties on the assessment of consequences would be rated as medium because, even though eradication would probably be a valuable option, it is uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions occurring in the risk assessment area.

With regard to risk reduction options:

Currently *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are not known to occur in the territory of the EU. Once established, spread of the bacteria is difficult to control, hence risk reduction options to reduce the probability of entry are the main means to maintain the absence of this pest. The enormous investment to prevent outbreaks and for eradication in response to outbreaks of citrus canker made by various countries (Gottwald et al., 2002a; Alam and Rolfe, 2006; Gambley et al., 2009) highlights the importance of maintaining the absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in citrus-producing areas and of the risk reduction options to maintain this absence.

The effectiveness of current EU phytosanitary measures to reduce the risk of introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* ranges from moderate to high. However, the requirements for buffer zones of pest free production sites in areas infested by *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are insufficiently detailed.

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of plants for planting for citrus production and of ornamental rutaceous plants (species listed in section 3.1.1.4) is rated as likely. Prohibition of import of host plants for planting is the most reliable option to reduce the risk of entry, with the exception of small consignments of plants for planting for breeding and selection purposes under strict post-entry quarantine conditions (as described in Directive 2008/61/CE).

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of citrus fruit by commercial trade is rated as unlikely, but there is a high uncertainty about its transfer to suitable hosts in the EU territory. To reduce the risk associated with the high uncertainty, the large import volumes and the moderate to major consequences of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*, options have been identified to reduce the probability of entry via this pathway. The current measures to prevent entry to the EU are evaluated as effective. As some fruit lots are intercepted at EU borders from time to time, one can consider that exporting countries may have difficulty with always complying with EU regulations. Additional options are suggested to further reduce the risk of entry.

The entry of fruit or other material infected with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, carried by passengers, poses a risk for entry and establishment, but effective RROs have not been identified. Communication to increase public awareness and responsibility is recommended.

The probability of entry of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* via import of citrus and rutaceous leaves and twigs through commercial trade is rated as unlikely, but there is a high uncertainty about the transfer of the bacteria to suitable hosts in the EU territory. Currently the import of leaves of *Citrus*, *Poncirus* and *Fortunella* is prohibited by Council Directive 2000/29/EC, but, despite this regulation, there is a large number of interceptions of citrus leaves imported via undeclared packages and passenger baggage.

DOCUMENTATION PROVIDED TO EFSA

1. Request (background and term of reference) to provide a Scientific Opinion on the risk to plant health of *Xanthomonas campestris* (all strains pathogenic to *Citrus*) for the EU. SANCO.E2 GC/ap (2012) 1371212. October 2012. Submitted by European Commission, DG SANCO, Directorate-General Health and Consumers.

2. USDA (United States Department of Agriculture), 2012. APHIS Response to “Scientific Opinion on the request from USA regarding export of Florida citrus to the EU”, version April 2012, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, USA. (Document provided to EFSA as attachment to the Request to provide this Scientific Opinion.)

3. Organisation of hearing with US researchers in the context of the EFSA Scientific Opinion on the risk to plant health of *Xanthomonas campestris* (all strains pathogenic to *Citrus*) for the EU territory. SANCO.E2 GC/ap (2012) 1638051. November 2012. Submitted by European Commission, DG SANCO, Directorate-General Health and Consumers.

4. Request to organise public consultations before final adoption of the Scientific Opinions on *Xanthomonas campestris* (all strains pathogenic to *Citrus*) and *Guignardia citricarpa* (all strains pathogenic to *Citrus*). SANCO. E2/GC/ap (2013) 408930. March 2013. Submitted by European Commission, DG SANCO, Directorate-General Health and Consumers.

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APPENDICES

Appendix A. Rating descriptors

In order to follow the principle of transparency as described under paragraph 3.1 of the guidance document on the harmonised framework for risk assessment (EFSA Panel on Plant Health (PLH), 2010)—"… Transparency requires that the scoring system to be used is described in advance. This includes the number of ratings, the description of each rating … the Panel recognises the need for further development …"—the Plant Health Panel has developed specifically for this opinion rating descriptors to provide clear justification when a rating is given.

1. Ratings used in the conclusion of the pest risk assessment

In this opinion of EFSA's Plant Health Panel on the risk assessment of X. campestris (all strains pathogenic to citrus) for the EU territory and the evaluation of the effectiveness of the RROs, a rating system of five levels with their corresponding descriptors has been used to formulate separately the conclusions on entry, establishment, spread and impact as described in the following tables.

1.1. Rating of probability of entry

Rating for entry	Descriptors
Very unlikely	The likelihood of entry would be very low because the pest: • is not, or is only very rarely, associated with the pathway at the origin; and/or • may not survive during transport or storage; and/or • cannot survive the current pest management procedures existing in the risk assessment area; and/or • may not transfer to a suitable host in the risk assessment area.
Unlikely	The likelihood of entry would be low because the pest: • is rarely associated with the pathway at the origin; and/or • survives at a very low rate during transport or storage; and/or • is strongly limited by the current pest management procedures existing in the risk assessment area; and/or • has considerable limitations for transfer to a suitable host in the risk assessment area.
Moderately likely	The likelihood of entry would be moderate because the pest: • is frequently associated with the pathway at the origin; and/or • survives at a low rate during transport or storage; and/or • is affected by the current pest management procedures existing in the risk assessment area; and/or • has some limitations for transfer to a suitable host in the risk assessment area.

Likely	The likelihood of entry would be high because the pest: • is regularly associated with the pathway at the origin; and/or • mostly survives during transport or storage; and/or • is partially affected by the current pest management procedures existing in the risk assessment area; and/or • has very few limitations for transfer to a suitable host in the risk assessment area.
Very likely	The likelihood of entry would be very high because the pest: • is usually associated with the pathway at the origin; and/or • survives during transport or storage; and/or • is not affected by the current pest management procedures existing in the risk assessment area; and/or • has no limitations for transfer to a suitable host in the risk assessment area.

1.2. Rating of probability of establishment

Rating for establishment	**Descriptors**
Very unlikely	The likelihood of establishment would be very low because, although the host plants are present in the risk assessment area, the environmental conditions are unsuitable and/or the host is susceptible for a very short time during the year; other considerable obstacles to establishment occur.
Unlikely	The likelihood of establishment would be low because, although the host plants are present in the risk assessment area, the environmental conditions are mostly unsuitable and/or the host is susceptible for a very short time during the year; other obstacles to establishment occur.
Moderately likely	The likelihood of establishment would be moderate because, although the host plants are present in the risk assessment area, the environmental conditions are frequently unsuitable and/or the host is susceptible for short time; other obstacles to establishment may occur.
Likely	The likelihood of establishment would be high because the host plants are present in the risk assessment area, they are susceptible for a long time during the year, and the environmental conditions are frequently suitable; no other obstacles to establishment occur.
Very likely	The likelihood of establishment would be very high because the host plants are present in the risk assessment area, they are susceptible for a long time during the year, and the environmental conditions are suitable for most of the host growing season; no other obstacles to establishment occur. Alternatively, the pest has already been established in the risk assessment area.

1.3. Rating of probability of spread

<table>
<tr><th>Rating for spread</th><th>Descriptors</th></tr>
<tr><td>Very unlikely</td><td>The likelihood of spread would be very low because:
• the pest has only one specific way to spread (e.g. a specific vector) which is not present in the risk assessment area;
and/or
• highly effective barriers to spread exist;
and/or
• the host is not or is only occasionally present in the area of possible spread;
and/or
• the environmental conditions for infestation are unsuitable in the area of possible spread.</td></tr>
<tr><td>Unlikely</td><td>The likelihood of spread would be low because:
• the pest has one or only a few specific ways to spread (e.g. specific vectors) and its occurrence in the risk assessment area is occasional;
and/or
• effective barriers to spread exist;
and/or
• the host is not frequently present in the area of possible spread;
and/or
• the environmental conditions for infestation are mostly unsuitable in the area of possible spread.</td></tr>
<tr><td>Moderately likely</td><td>The likelihood of spread would be moderate because:
• the pest has few specific ways to spread (e.g. specific vectors) and its occurrence in the risk assessment area is limited;
and/or
• effective barriers to spread exist;
and/or
• the host is moderately present in the area of possible spread;
and/or
• the environmental conditions for infestation are frequently unsuitable in the area of possible spread.</td></tr>
<tr><td>Likely</td><td>The likelihood of spread would be high because:
• the pest has some unspecific ways to spread, which occur in the risk assessment area;
and/or
• no effective barriers to spread exist;
and/or
• the host is usually present in the area of possible spread;
and/or
• the environmental conditions for infestation are frequently suitable in the area of possible spread.</td></tr>
<tr><td>Very likely</td><td>The likelihood of spread would be very high because:
• the pest has multiple unspecific ways to spread, all of which occur in the risk assessment area;
and/or
• no effective barriers to spread exist;</td></tr>
</table>

	and/or • the host is widely present in the area of possible spread; and/or • the environmental conditions for infestation are mostly suitable in the area of possible spread.

1.4. Rating of magnitude of the potential consequences

Rating for potential consequences	**Descriptors**
Minimal	Differences in crop production are within normal day-to-day variation; no additional control measures are required.
Minor	Crop production is rarely reduced or at a limited level; additional control measures are rarely necessary.
Moderate	Crop production is occasionally reduced to a limited extent; additional control measures are occasionally necessary.
Major	Crop production is frequently reduced to a significant extent; additional control measures are frequently necessary.
Massive	Crop production is always or almost always reduced to a very significant extent (severe crop losses that compromise the harvest); additional control measures are always necessary.

2. Ratings used for the evaluation of the risk reduction options

The Panel developed the following ratings with their corresponding descriptors for evaluating the effectiveness of the RRO to reduce the level of risk.

2.1 Rating of the effectiveness of risk reduction options

Rating of the effectiveness of RRO	**Descriptors**
Negligible	The RRO has no practical effect in reducing the probability of entry or establishment or spread, or the potential consequences
Low	The RRO reduces, to a limited extent, the probability of entry or establishment or spread, or the potential consequences
Moderate	The RRO reduces, to a substantial extent, the probability of entry or establishment or spread, or the potential consequences
High	The RRO reduces the probability of entry or establishment or spread, or the potential consequences, to a major extent
Very high	The RRO essentially eliminates the probability of entry or establishment or spread, or any potential consequences

2.2. Rating of the technical feasibility of risk reduction options

Rating of technical feasibility of RRO	Descriptors
Negligible	The RRO is not in use in the risk assessment area, and the many technical difficulties involved (e.g. changing or abandoning the current practices, implement new practices and or measures) make their implementation in practice impossible
Low	The RRO is not in use in the risk assessment area, but the many technical difficulties involved (e.g. changing or abandoning the current practices, implementing new practices and/or measures) make its implementation in practice very difficult or nearly impossible
Moderate	The RRO is not in use in the risk assessment area, but it can be implemented (e.g. changing or abandoning the current practices, implementing new practices and/or measures) with some technical difficulties
High	The RRO is not in use in the risk assessment area, but it can be implemented in practice (e.g. changing or abandoning the current practices, implementing new practices and/or measures) with limited technical difficulties
Very high	The RRO is already in use in the risk assessment area or can be easily implemented with no technical difficulties

3. Ratings used for describing the level of uncertainty

For the risk assessment chapter - entry, establishment, spread and impact - as well as for the evaluation of the effectiveness of the risk reduction options, the level of uncertainty has been rated separately in coherence with the descriptors that have been defined specifically by the Panel in this opinion.

Rating for uncertainty	Descriptors
Low	No or little information or no or few data missing, incomplete, inconsistent or conflicting. No subjective judgement is introduced. No unpublished data are used.
Medium	Some information is missing or some data are missing, incomplete, inconsistent or conflicting. Subjective judgement is introduced with supporting evidence. Unpublished data are sometimes used.
High	Most information is missing or most data are missing, incomplete, inconsistent or conflicting. Subjective judgement may be introduced without supporting evidence. Unpublished data are frequently used.

Appendix B. World distribution of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii*

Table B.1: World distribution of *Xanthomonas citri* pv. *citri* and *X. citri* pv. *aurantifolii* as extracted from the EPPO-PQR database on 5 March 2013 (EPPO, online a)

Country	State	Situation
Continent: Africa		
Algeria		Absent, confirmed by survey
Comoros		Present, widespread
Congo, Democratic Republic of the		Present, no details
Cote d'Ivoire		Present, no details
Egypt		Absent, confirmed by survey
Ethiopia		Present, no details
Gabon		Present, no details
Gambia		Absent, confirmed by survey
Ghana		Absent, confirmed by survey
Guinea		Absent, confirmed by survey
Kenya		Absent, confirmed by survey
Libya		Absent, confirmed by survey
Madagascar		Present, no details
Mali		Present, restricted distribution
Mauritius		Present, no details
Morocco		Absent, confirmed by survey
Mozambique		Absent, pest no longer present
Réunion		Present, no details
Seychelles		Present, no details
Somalia		Present, few occurrences
South Africa		Absent, confirmed by survey
Sudan		Absent, confirmed by survey
Swaziland		Absent, confirmed by survey
Tanzania		Present, restricted distribution
Tunisia		Absent, confirmed by survey
Zimbabwe		Absent, confirmed by survey
Continent: America		
Argentina		Present, restricted distribution
Bahamas		Absent, confirmed by survey
Belize		Absent, confirmed by survey
Bolivia		Present, no details
Brazil		Present, restricted distribution
Brazil	Matto Grosso	Absent, unreliable record
Brazil	Matto Grosso do Sul	Present, no details
Brazil	Minas Gerais	Present, no details
Brazil	Paraná	Present, no details
Brazil	Rio Grande do Sul	Present, no details
Brazil	Santa Catarina	Present, no details
Brazil	São Paulo	Present, no details
Chile		Absent, confirmed by survey
Colombia		Absent, confirmed by survey

Country	State	Situation
Costa Rica		Absent, confirmed by survey
Cuba		Absent, confirmed by survey
Dominica		Absent, unreliable record
Dominican Republic		Absent, confirmed by survey
Ecuador		Absent, confirmed by survey
El Salvador		Absent, confirmed by survey
Guadeloupe		Absent, confirmed by survey
Haiti		Absent, unreliable record
Honduras		Absent, confirmed by survey
Jamaica		Absent, confirmed by survey
Martinique		Absent, confirmed by survey
Mexico		Absent, confirmed by survey
Netherlands Antilles		Absent, unreliable record
Nicaragua		Absent, confirmed by survey
Paraguay		Present, widespread
Peru		Absent, confirmed by survey
Puerto Rico		Absent, confirmed by survey
Saint Lucia		Absent, confirmed by survey
Suriname		Absent, confirmed by survey
Trinidad and Tobago		Absent, unreliable record
United States of America		Present, restricted distribution
United States of America	Alabama	Absent, pest eradicated
United States of America	Florida	Present, restricted distribution
United States of America	Georgia	Absent, pest eradicated
United States of America	Louisiana	Absent, pest eradicated
United States of America	South Carolina	Absent, pest eradicated
United States of America	Texas	Absent, pest eradicated
Uruguay		Present, restricted distribution
Venezuela		Absent, confirmed by survey
Virgin Islands (British)		Present, no details
Virgin Islands (US)		Absent, confirmed by survey
Continent: Asia		
Afghanistan		Present, no details
Bangladesh		Present, restricted distribution
Cambodia		Present, no details
China		Present, widespread
China	Fujian	Present, no details
China	Guangdong	Present, no details
China	Guangxi	Present, no details
China	Guizhou	Present, no details
China	Hubei	Present, no details
China	Hunan	Present, no details
China	Jiangsu	Present, no details
China	Jiangxi	Present, no details
China	Sichuan	Present, no details
China	Xianggang (Hong Kong)	Present, few occurrences

Country	State	Situation
China	Yunnan	Present, no details
China	Zhejiang	Present, no details
Christmas Island		Present, no details
Cocos Islands		Present, no details
India		Present, no details
India	Andaman and Nicobar Islands	Present, no details
India	Andhra Pradesh	Present, no details
India	Assam	Present, no details
India	Gujarat	Present, no details
India	Haryana	Present, widespread
India	Karnataka	Present, no details
India	Lakshadweep	Absent, unreliable record
India	Maharashtra	Present, no details
India	Punjab	Present, no details
India	Sikkim	Present, no details
India	Tamil Nadu	Present, no details
India	Uttar Pradesh	Absent, invalid record
India	West Bengal	Present, no details
Indonesia		Present, no details
Indonesia	Irian Jaya	Present, no details
Indonesia	Java	Present, no details
Iran		Present, restricted distribution
Iraq		Absent, unreliable record
Israel		Absent, confirmed by survey
Japan		Present, widespread
Japan	Honshu	Present, no details
Japan	Kyushu	Present, no details
Japan	Ryukyu archipelago	Absent, unreliable record
Japan	Shikoku	Present, no details
Korea, Democratic People's Republic		Present, no details
Korea, Republic		Present, no details
Laos		Present, no details
Malaysia		Present, widespread
Malaysia	Sabah	Present, no details
Malaysia	West	Present, no details
Maldives		Present, no details
Myanmar		Present, no details
Nepal		Present, no details
Oman		Present, no details
Pakistan		Present, no details
Philippines		Present, no details
Saudi Arabia		Present, restricted distribution
Singapore		Present, no details
Sri Lanka		Present, no details
Taiwan		Present, widespread
Thailand		Present, no details

Country	State	Situation
United Arab Emirates		Present, no details
Vietnam		Present, widespread
Yemen		Present, restricted distribution
Continent: Europe		
Albania		Absent, confirmed by survey
Croatia		Absent, confirmed by survey
Cyprus		Absent, confirmed by survey
Georgia		Absent, invalid record
Malta		Absent, confirmed by survey
Netherlands		Absent, confirmed by survey
Turkey		Absent, confirmed by survey
Continent: Oceania		
American Samoa		Absent, confirmed by survey
Australia		Absent, pest eradicated
Australia	Northern Territory	Absent, pest eradicated
Australia	Queensland	Absent, pest eradicated
Fiji		Present, no details
Guam		Absent, confirmed by survey
Micronesia		Present, no details
New Zealand		Absent, pest eradicated
Northern Mariana Islands		Absent, confirmed by survey
Palau		Present, no details
Papua New Guinea		Present, no details
Solomon Islands		Present, few occurrences

Appendix C. Citrus fruit imports into EU Member States in 2008–2012

Table C.1: Number of consignments inspected for citrus canker by Member States according to the information provided by the Member State

Citrus fruit imports into Member state	Number of consignments				
	2008	**2009**	**2010**	**2011**	**2012**
Austria	17	14	14	9	6
Belgium	7 816	4 760	4 678	3 085	2 469
Bulgaria	9 181	13 083	13 231	11 903	8 992
Cyprus	77	104	83	74	Not provided
Czech Republic	4	1	4	16	1
Denmark	394	389	428	281	221
Estonia	37	88	39	23	27
Finland	803	633	789	1 002	955
France	Not provided	Not provided	Not provided	Not provided	Not provided
Germany	1 532	986 [(a)]	1 403 [(a)]	1 325	1 292
Greece	294	888	403	664	453
Hungary	137	84	233	109	107
Ireland	1 965	1 694	1 637	1 399	1 774
Italy	1 153	1 108	1 058	1 170	1 166
Latvia	Not provided	Not provided	Not provided	Not provided	Not provided
Lithuania	481	786	769	768	963
Luxembourg	Not provided	Not provided	Not provided	Not provided	Not provided
Malta	Not provided	Not provided	Not provided	Not provided	Not provided
Netherlands	Not provided	Not provided	Not provided	Not provided	Not provided
Poland	181	173	134	115	108
Portugal	823	572	827	833	905
Romania	578	336	235	222	326
Slovakia	0	0	0	0	0
Slovenia	945	815	844	521	709
Spain	Not provided	Not provided	Not provided	Not provided	Not provided
Sweden	5	Not provided	Not provided	Not provided	1 511
UK	12 614	12 708	12 849	11 711	12 719

(a): Data incomplete

Appendix D. Citrus fruit movement within the EU

Sweet oranges

The network based on the intra-EU (thus without Switzerland and Norway) trade data for oranges in 2011 is shown in the following graph. The weight of the links is proportional to trade volume. The network has $N = 27$ nodes and $L = 310$ links (310 incoming and 310 outgoing), and thus a connectance ($C = L/N^2$) of 0.44. This means that 44 % of the potential links are realised. The total amount of oranges traded in 2011 is about 2 million tons.

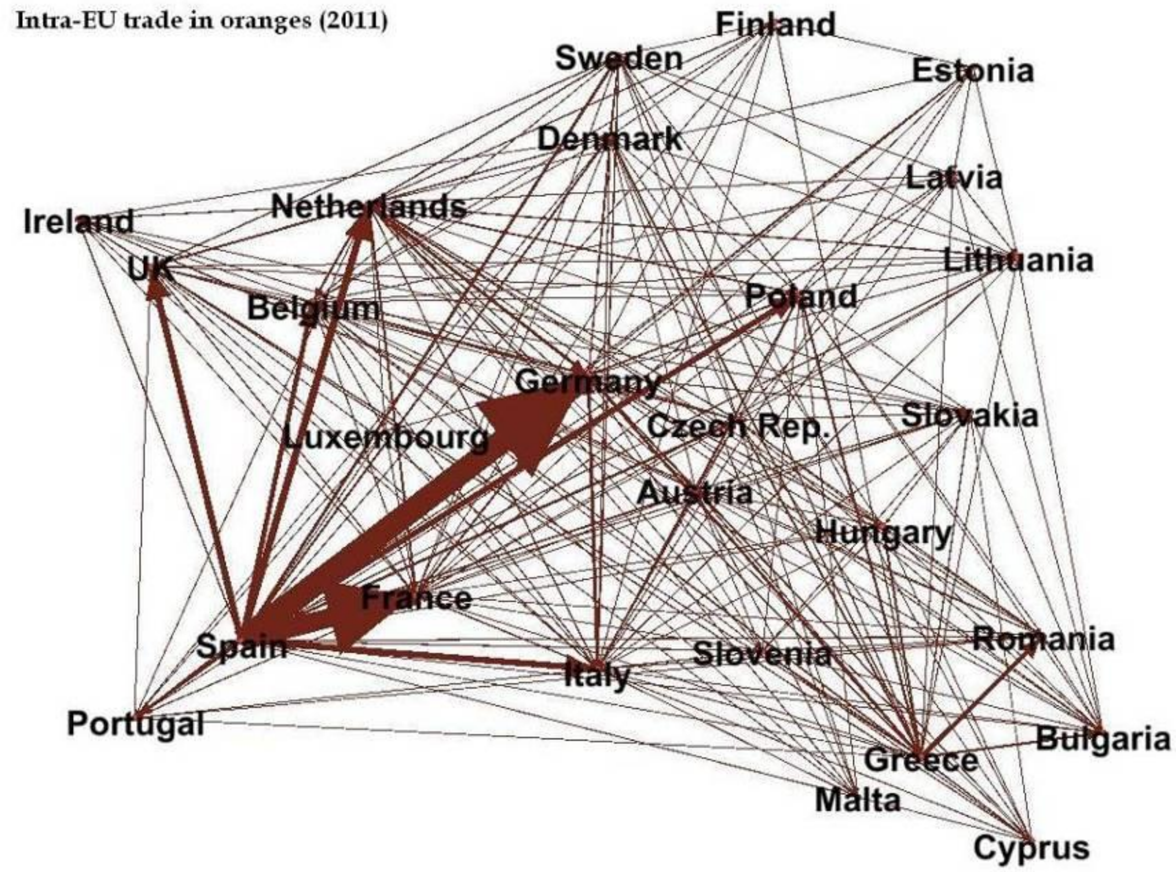


Figure D.1: Network visualization of the intra-EU trade in sweet oranges in 2011 (the weight of the links is proportional to trade volume)

There are seven countries that export oranges to at least 20 other countries (Spain and the Netherlands (26), Italy (25), Greece (23), Germany (22), France (21) and Belgium (20)).

This is not the case for imports: the maximum number of countries from which oranges are imported is 17 (this happens for Denmark, Germany, Italy and Poland).

Mandarins

The network of the intra-EU trade in mandarins (2011) is shown in the following graph. There are fewer trade links than for oranges (282 instead of 310) and hence a slightly lower connectance level (0.39 instead of 0.44). Also the amount of traded mandarins is lower than for oranges (~ 1.6 vs. 2 million tons).

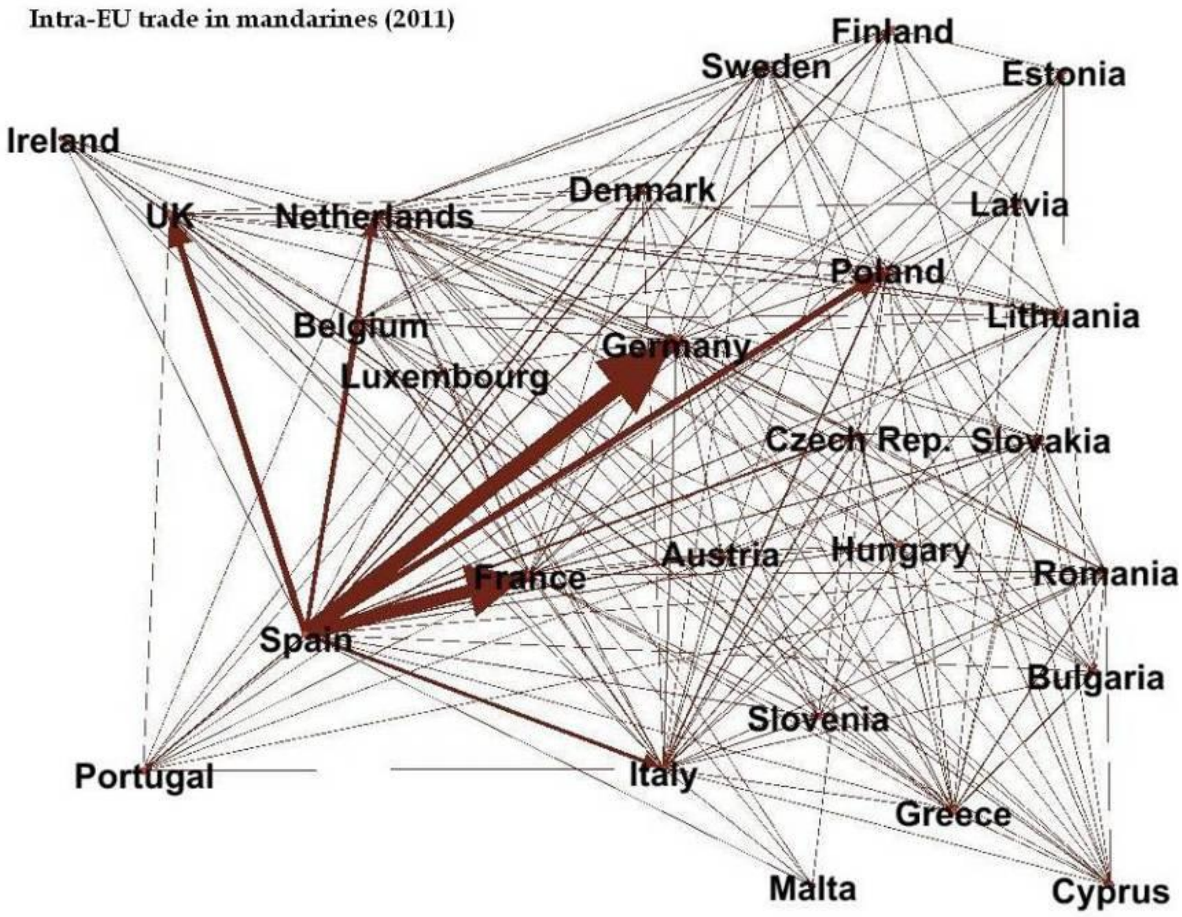


Figure D.2: Network visualization of the intra-EU trade in mandarins in 2011 (the weight of the links is proportional to trade volume)

There are six countries exporting mandarins to at least 20 EU countries: the Netherlands (to 26 countries), Spain (25), Italy (25), Germany (22), France (21) and Greece (20).

No EU country imports mandarins from 20 EU countries, with Italy importing them from 17 countries and Spain and Poland from 16.

Lemons

The intra-EU trade in lemons (2011) is shown in the following graph. The network is slightly less connected than for mandarins (261 instead of 282 links), for a connectance level of 0.36. Also the amount of traded lemons is lower than for mandarins (~ 0.5 vs. 1.6 million tons). However, also for lemons, Spain is the major exporter, whereas France and Germany are the main importers (with the addition of Italy, Poland and the UK).

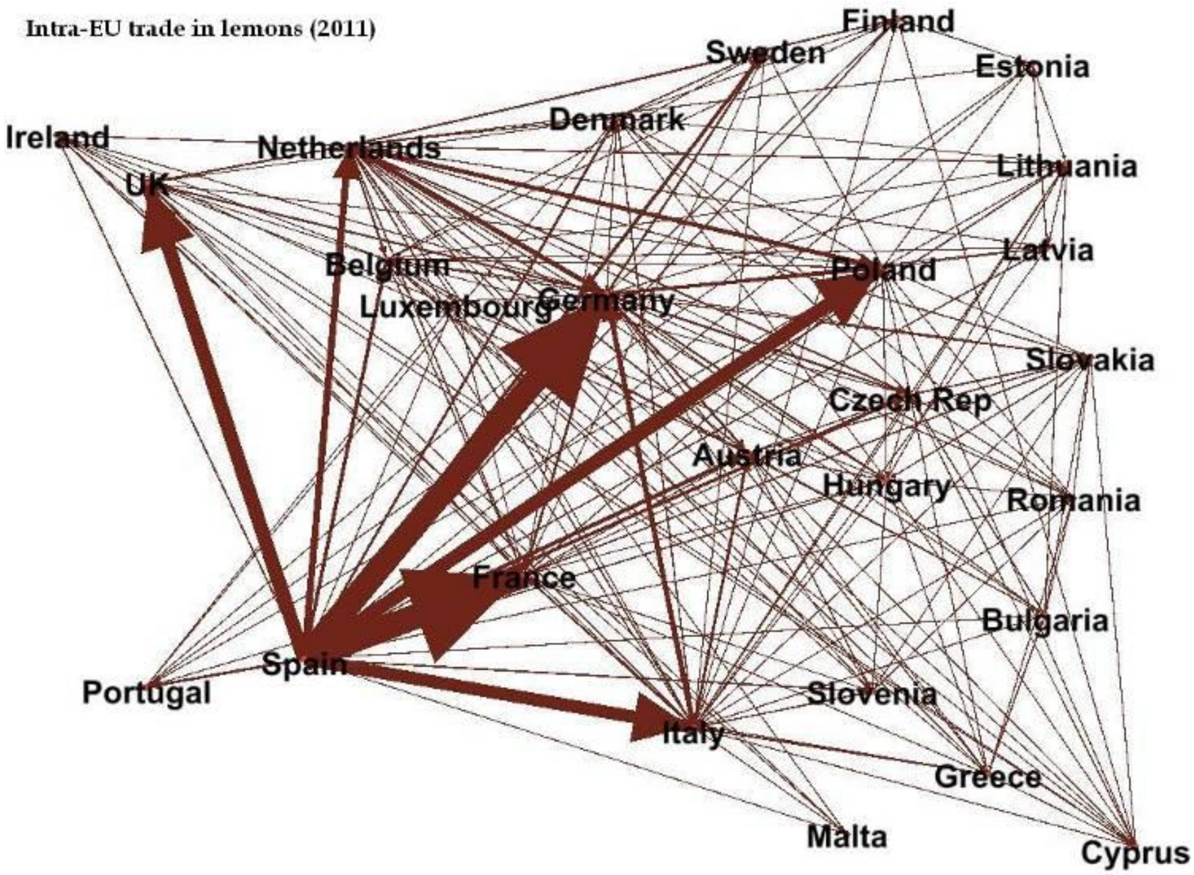


Figure D.3: Network visualization of the intra-EU trade in lemons in 2011 (the weight of the links is proportional to trade volume)

Only four EU countries export lemons to at least 20 EU countries: Spain (25), the Netherlands (25), Italy (24), and Germany (22). Import sources are less diverse, with Poland importing lemons from 18 countries, and Denmark, Estonia, Portugal and Slovenia from 14.

For more information on citrus fruit movement within the EU see the EFSA opinion" Scientific Opinion on the risk of *Phyllosticta citricarpa* (*Guignardia citricarpa*) for the EU territory with identification and evaluation of risk reduction options" (EFSA PLH Panel, 2014).

Appendix E. Packing houses and citrus juice industries in Spain

Table E.1: Packing houses and citrus juice industries in Spain (Pichardo, personal communication, 2014)

Autonomous community	Province	Number of registered citrus packinghouses	Number of registered citrus packinghouses with a permit to import citrus from non-EU countries	Number of citrus juice industries
Andalucía	Almería	33	Not available	1
	Cádiz	10	Not available	0
	Córdoba	18	Not available	0
	Granada	7	Not available	0
	Huelva	27	Not available	3
	Jaen	6	Not available	0
	Málaga	20	Not available	0
	Sevilla	41	Not available	3
	Total Andalucía	**162**	**Not available**	**7**
Cataluña	Barcelona	1	0	0
	Gerona	0	0	0
	Lérida	0	0	8
	Tarragona	19	19	0
	Total Cataluña	**20**	**19**	**8**
Región de Murcia	Murcia	183	25	27
	Total Región de Murcia	**183**	**25**	**27**
Comunidad Valenciana	Valencia	255	45	15
	Castellón	135	26	1
	Alicante	50	7	5
	Total Comunidad Valenciana	**440**	**78**	**21**
Total national		**805**	**122 [(a)]**	**63**

(a): No data from Andalucía.

Appendix F. Monthly percentage of hours with suitable weather conditions

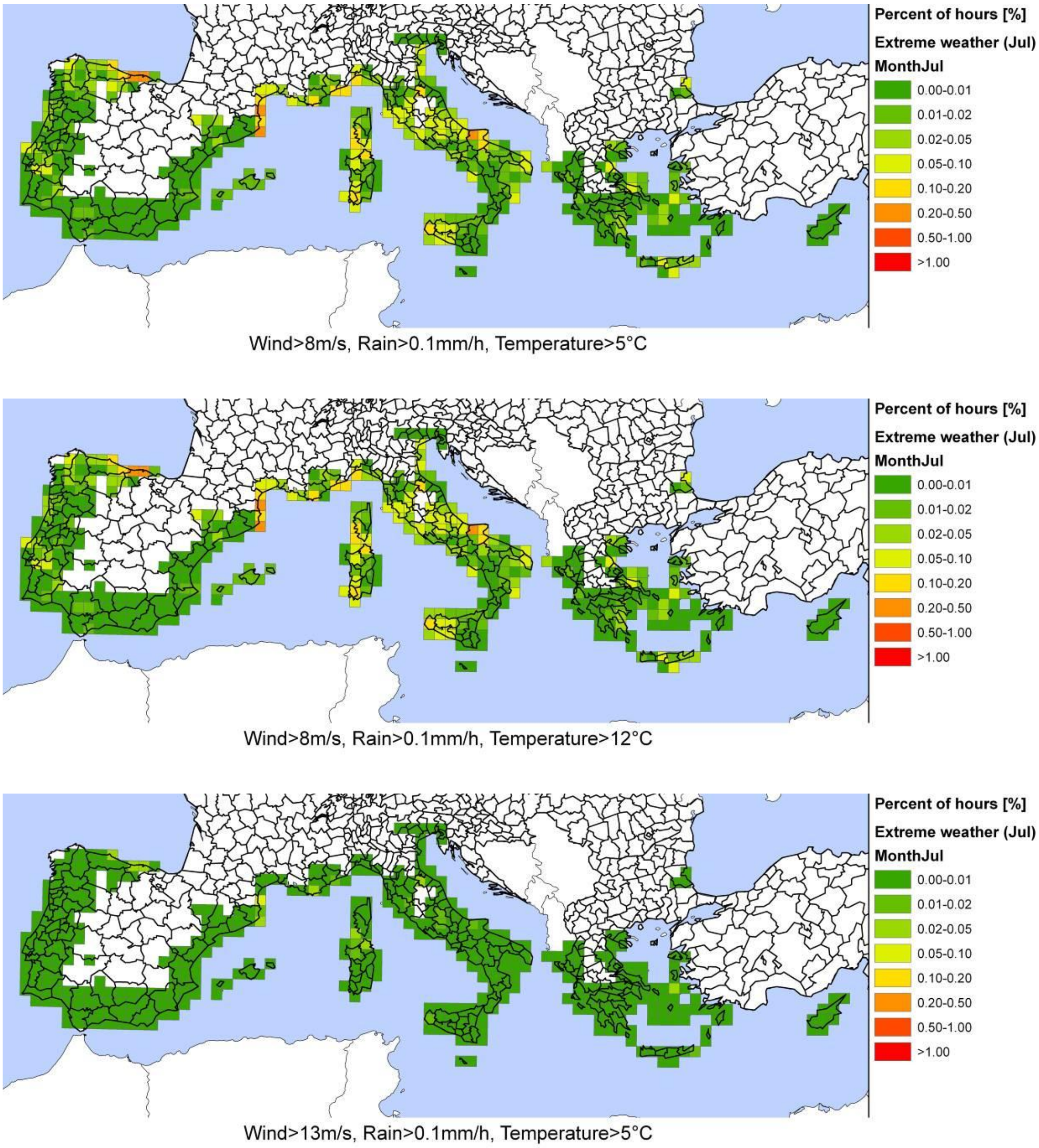


Figure F.1: Monthly percentage of hours with different extreme weather conditions in July in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

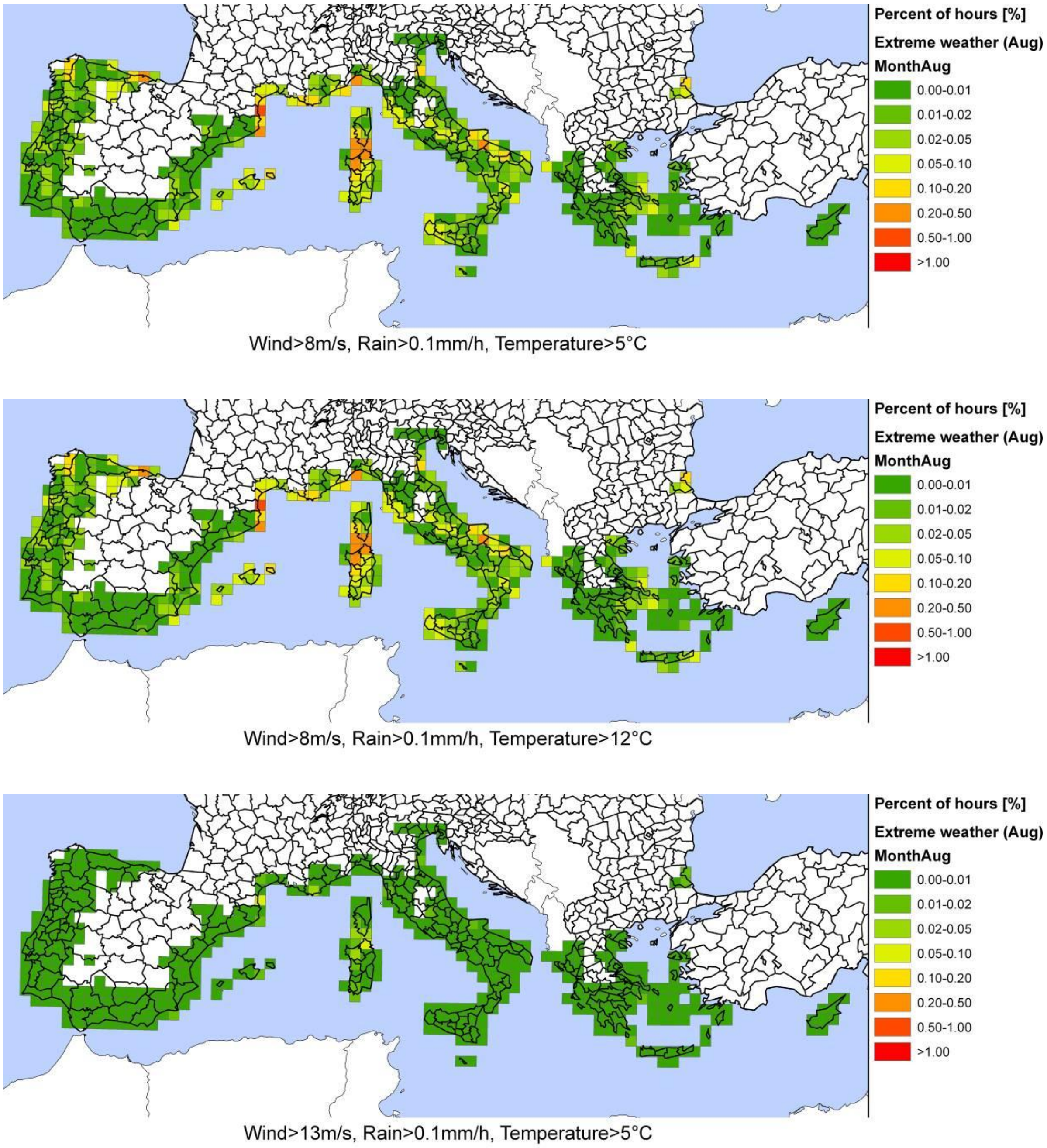


Figure F.2: Monthly percentage of hours with different extreme weather conditions in August in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

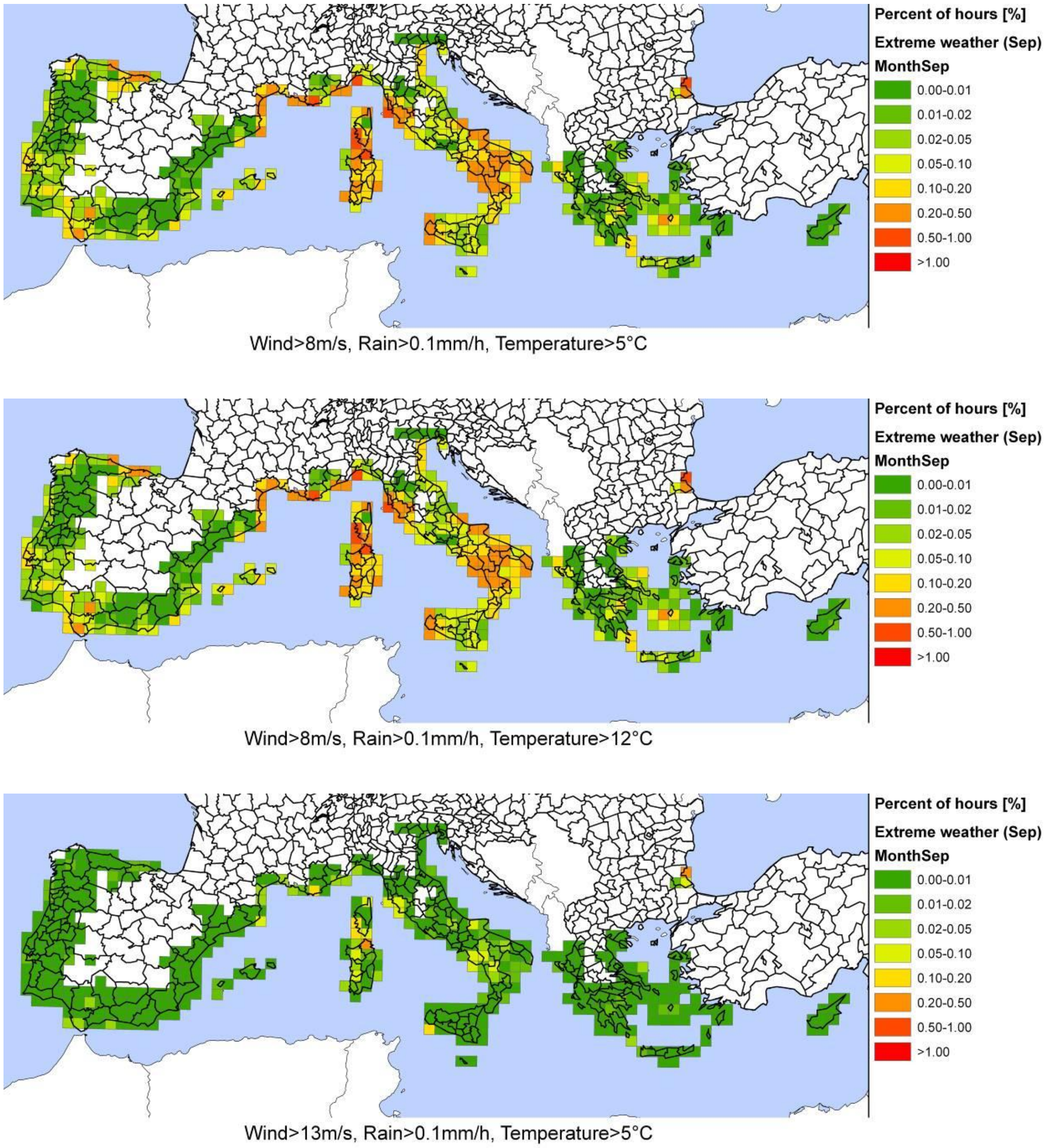


Figure F.3: Monthly percentage of hours with different extreme weather conditions in September in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

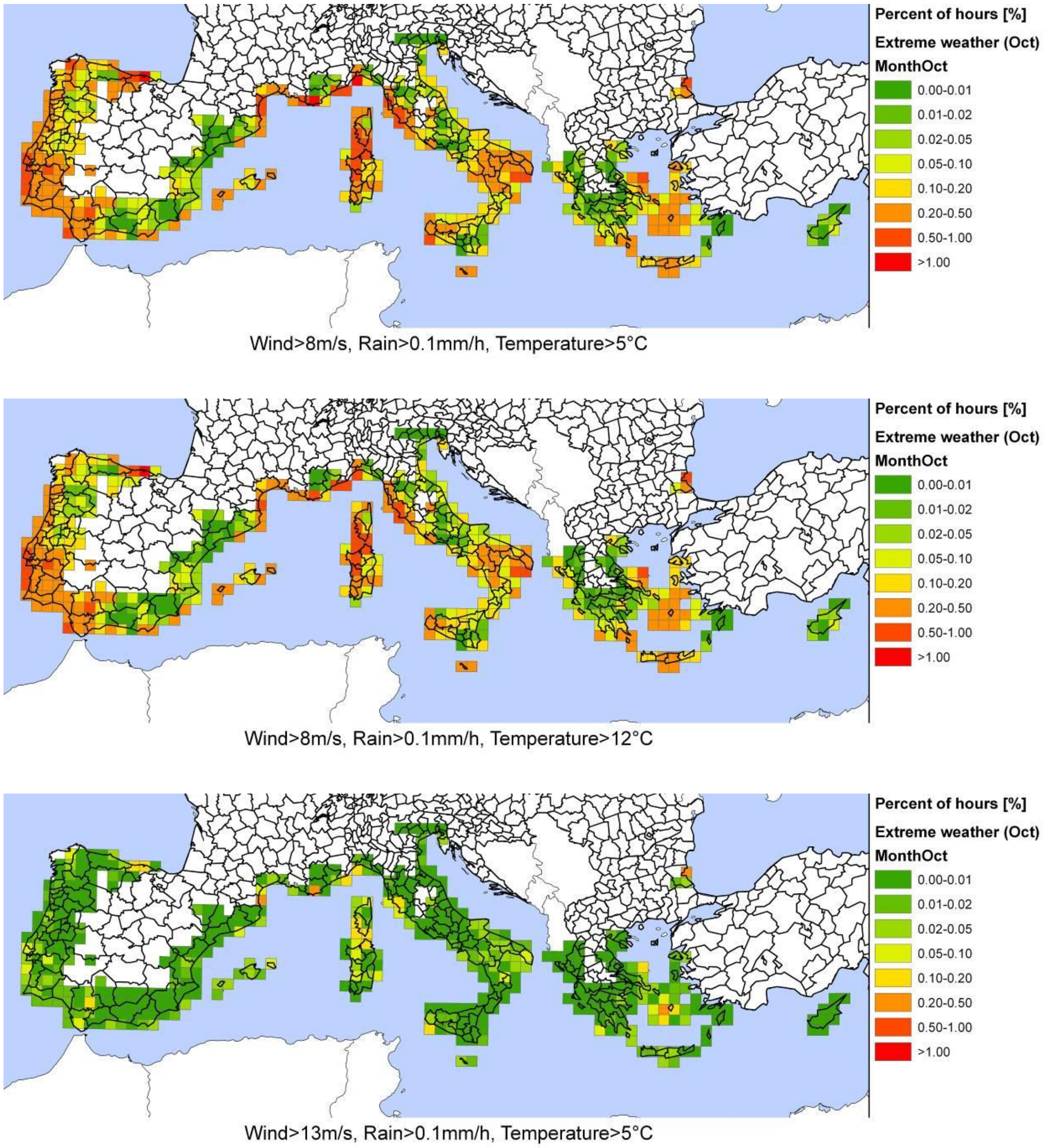


Figure F.4: Monthly percentage of hours with different extreme weather conditions in October in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

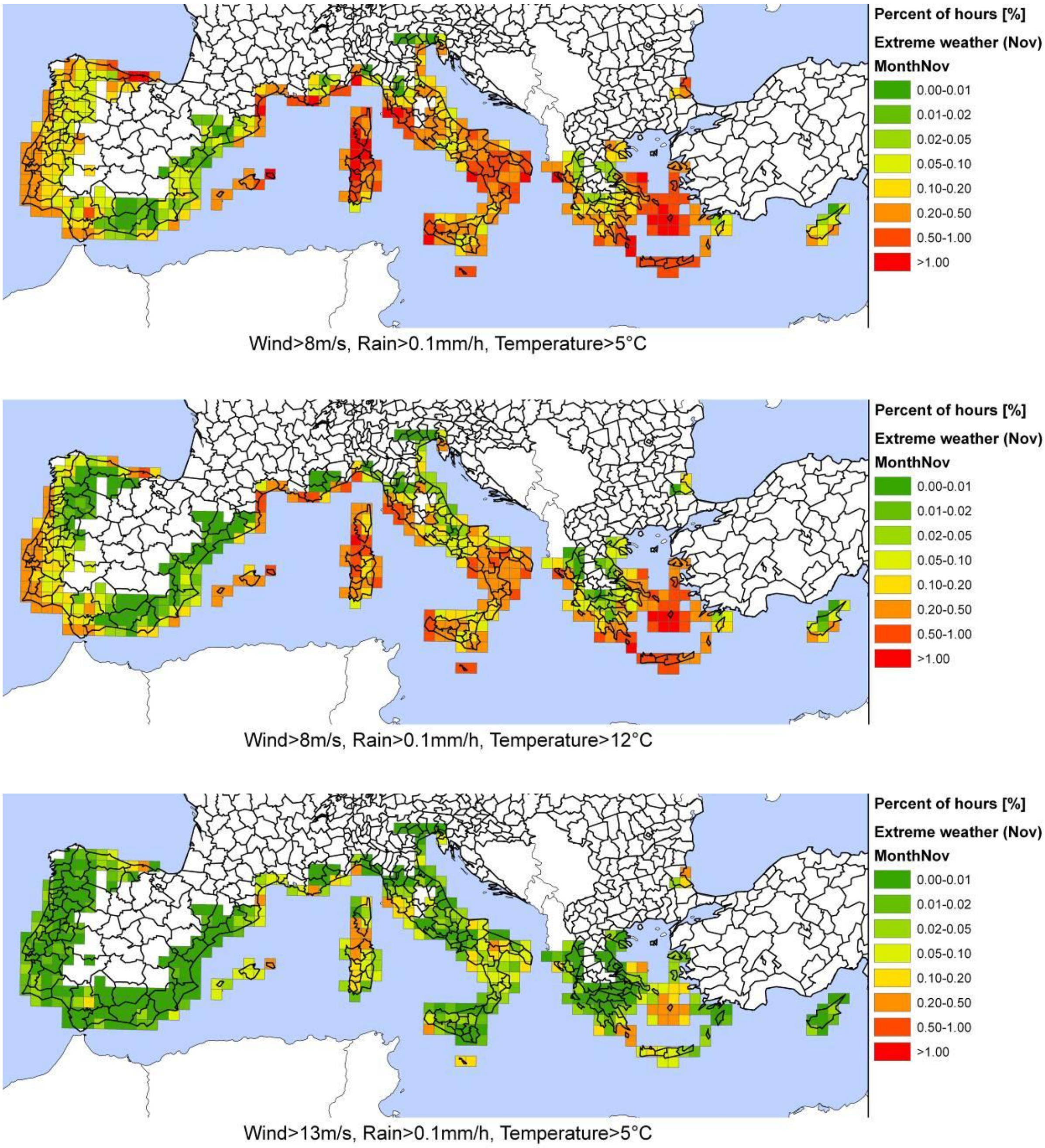


Figure F.5: Monthly percentage of hours with different extreme weather conditions in November in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50×50 km (JRC, online; Leip et al., 2008)

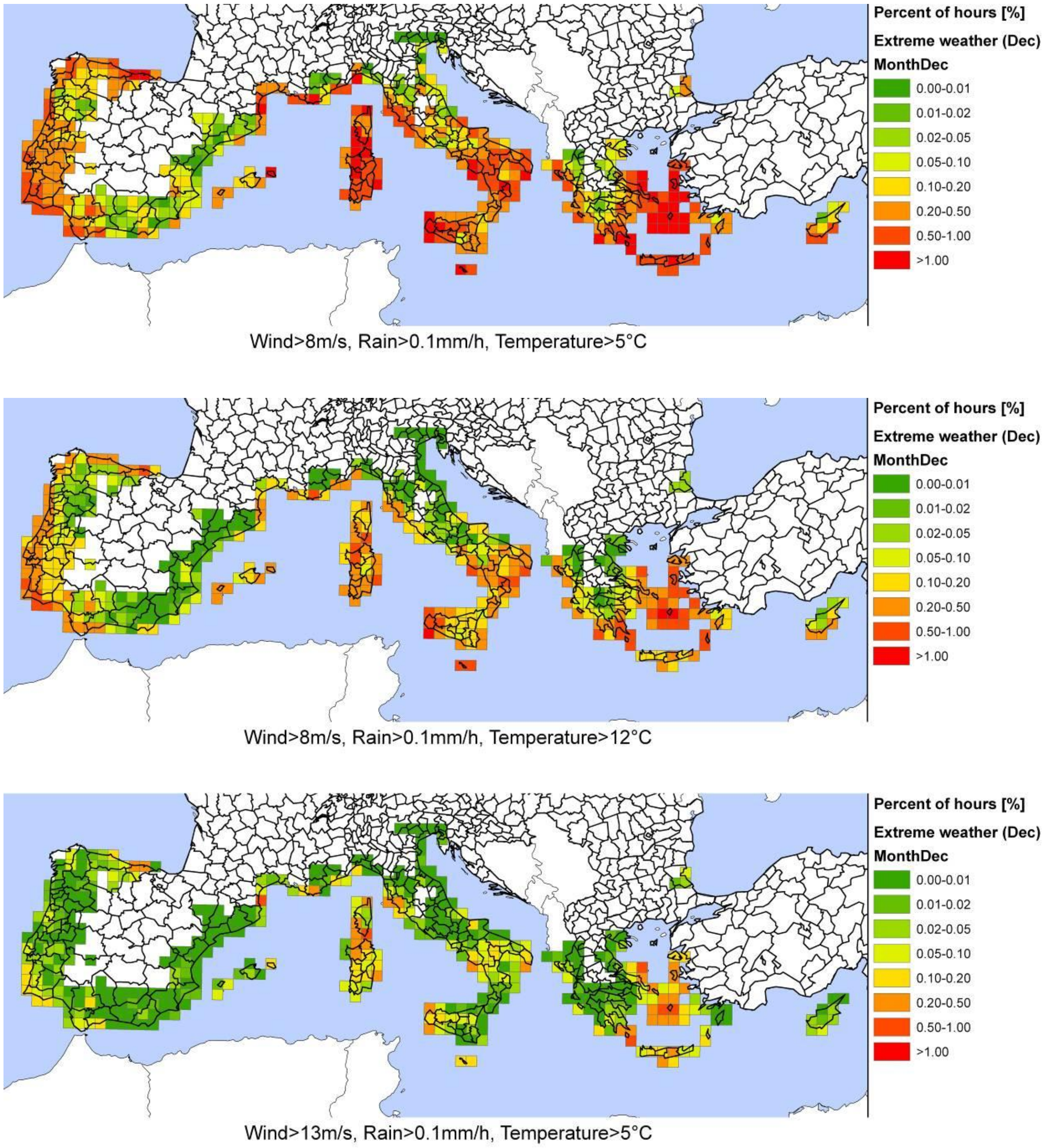
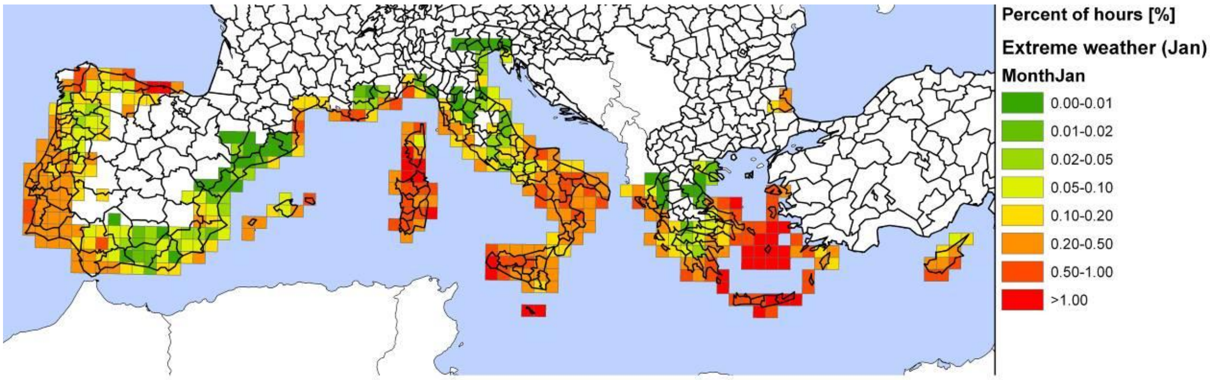
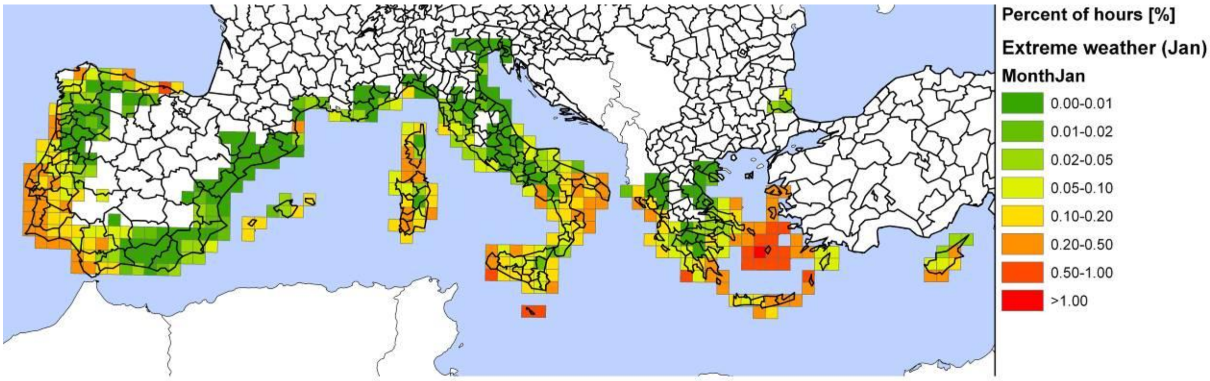


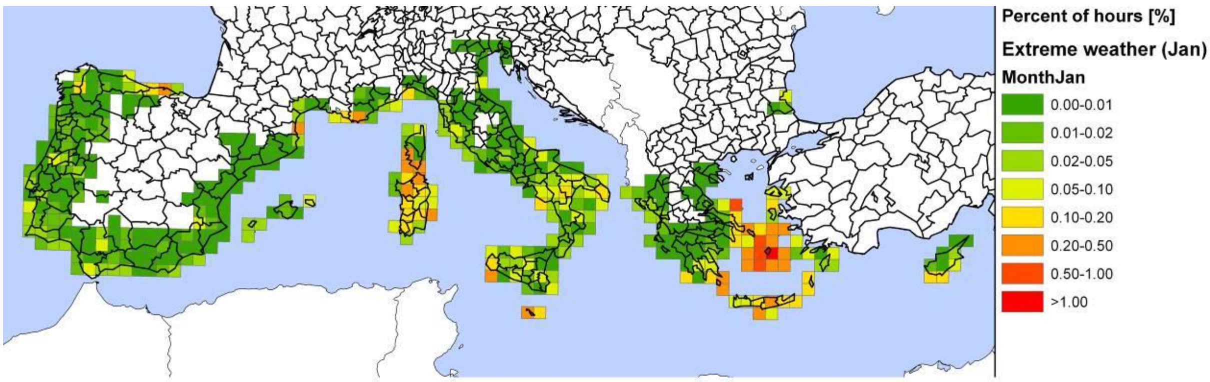
Figure F.6: Monthly percentage of hours with different extreme weather conditions in December in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50×50 km (JRC, online; Leip et al., 2008)



Wind>8m/s, Rain>0.1mm/h, Temperature>5°C



Wind>8m/s, Rain>0.1mm/h, Temperature>12°C



Wind>13m/s, Rain>0.1mm/h, Temperature>5°C

Figure F.7: Monthly percentage of hours with different extreme weather conditions in January in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

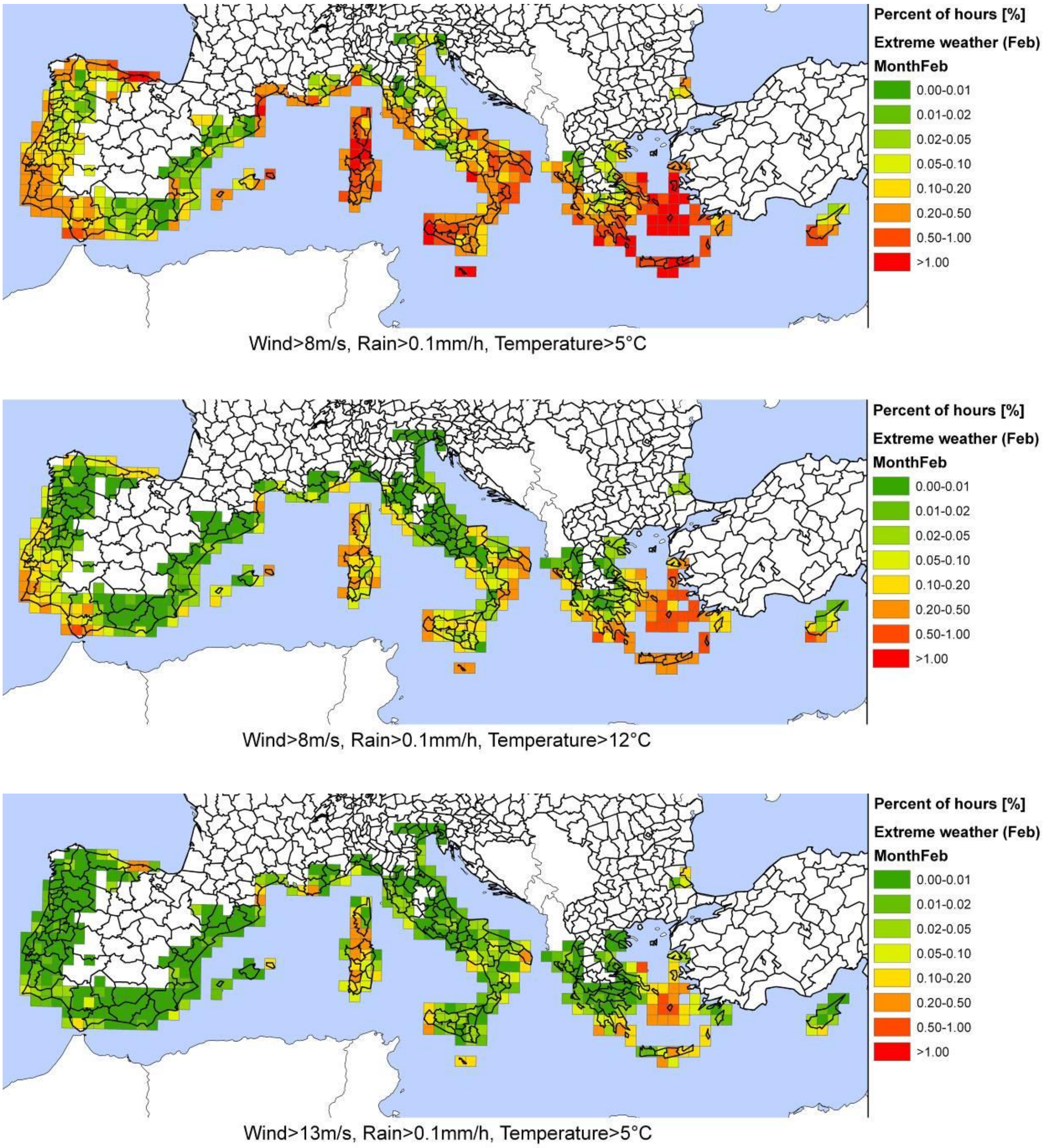


Figure F.8: Monthly percentage of hours with different extreme weather conditions in February in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

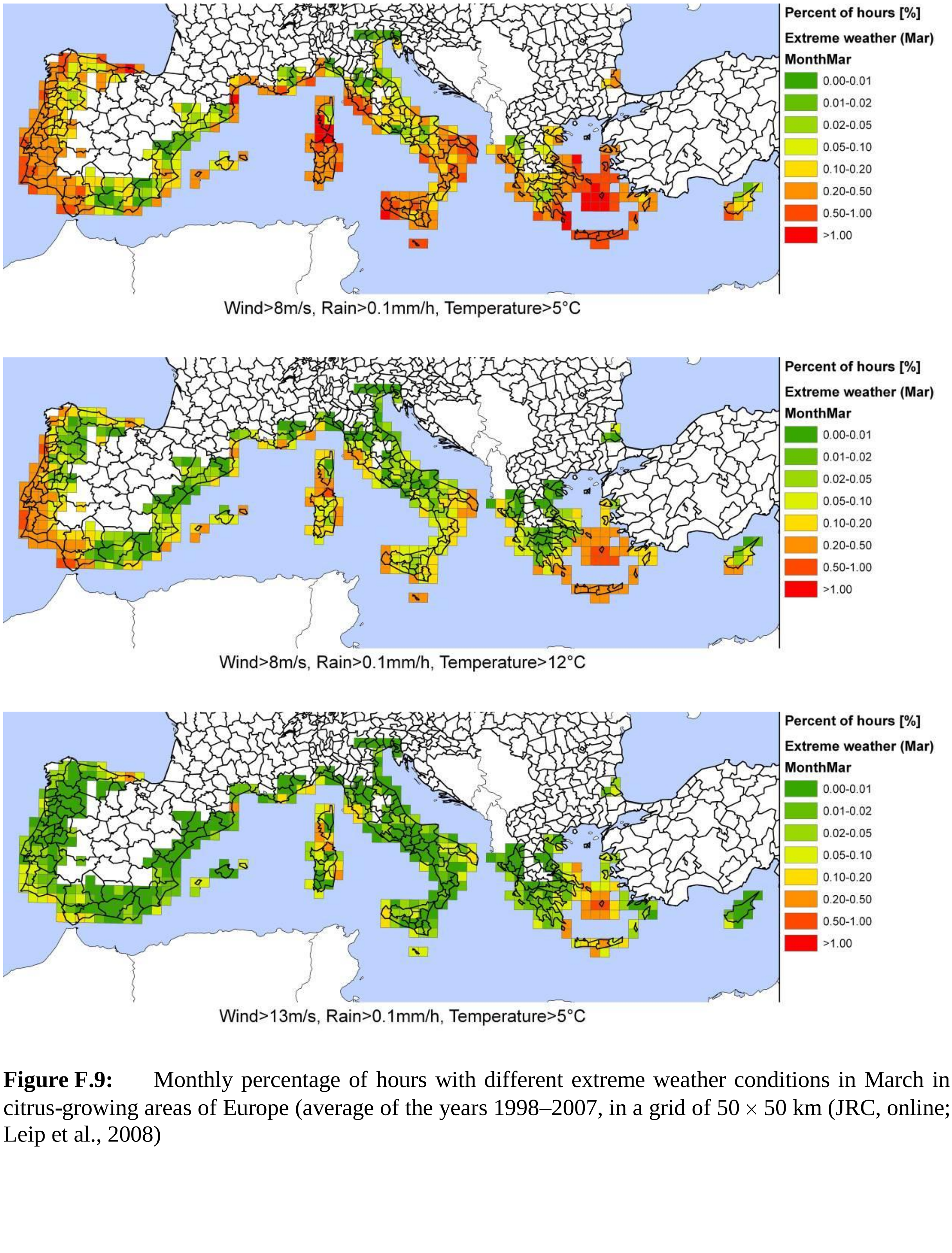


Figure F.9: Monthly percentage of hours with different extreme weather conditions in March in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

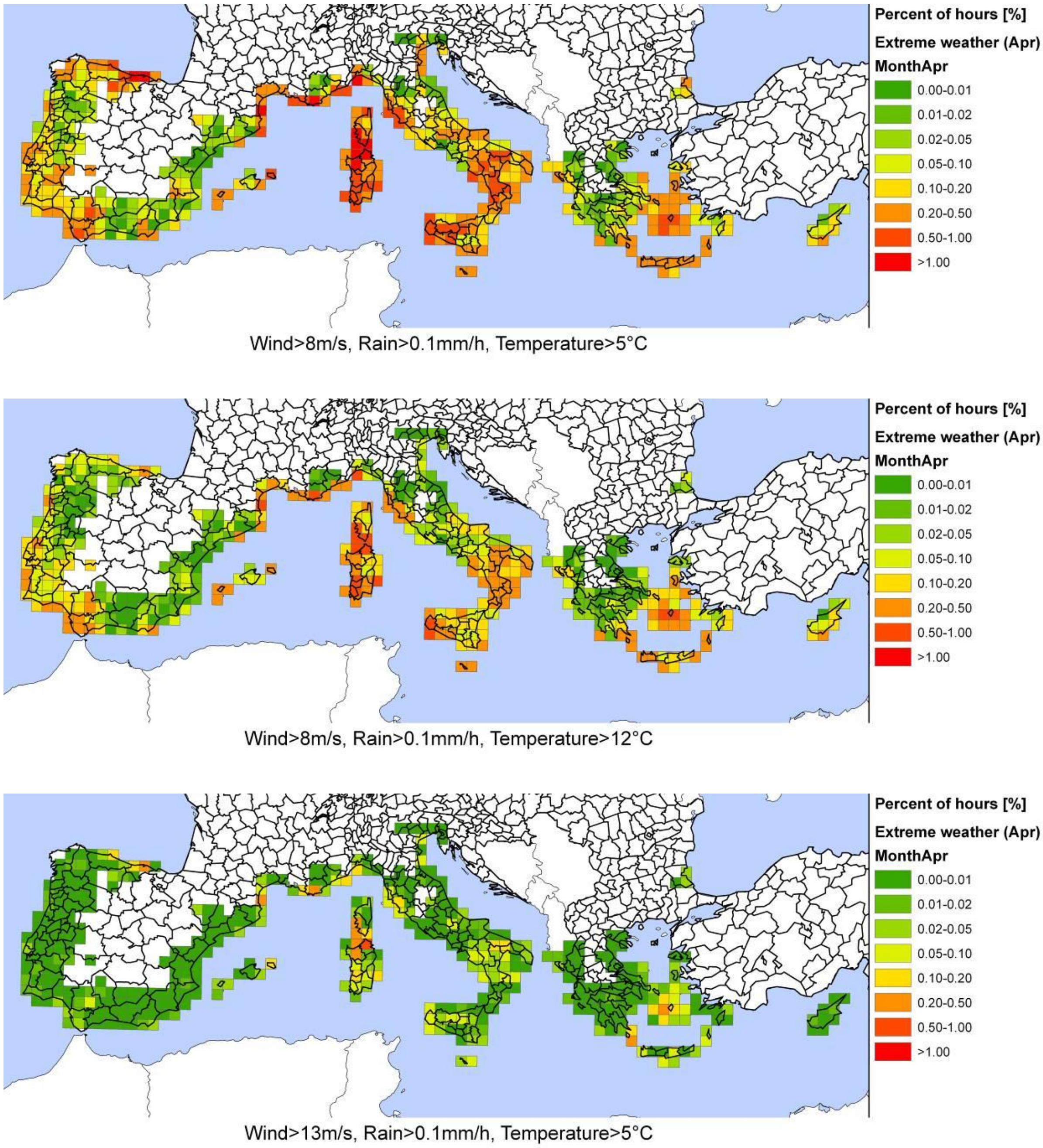


Figure F.10: Monthly percentage of hours with different extreme weather conditions in April in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

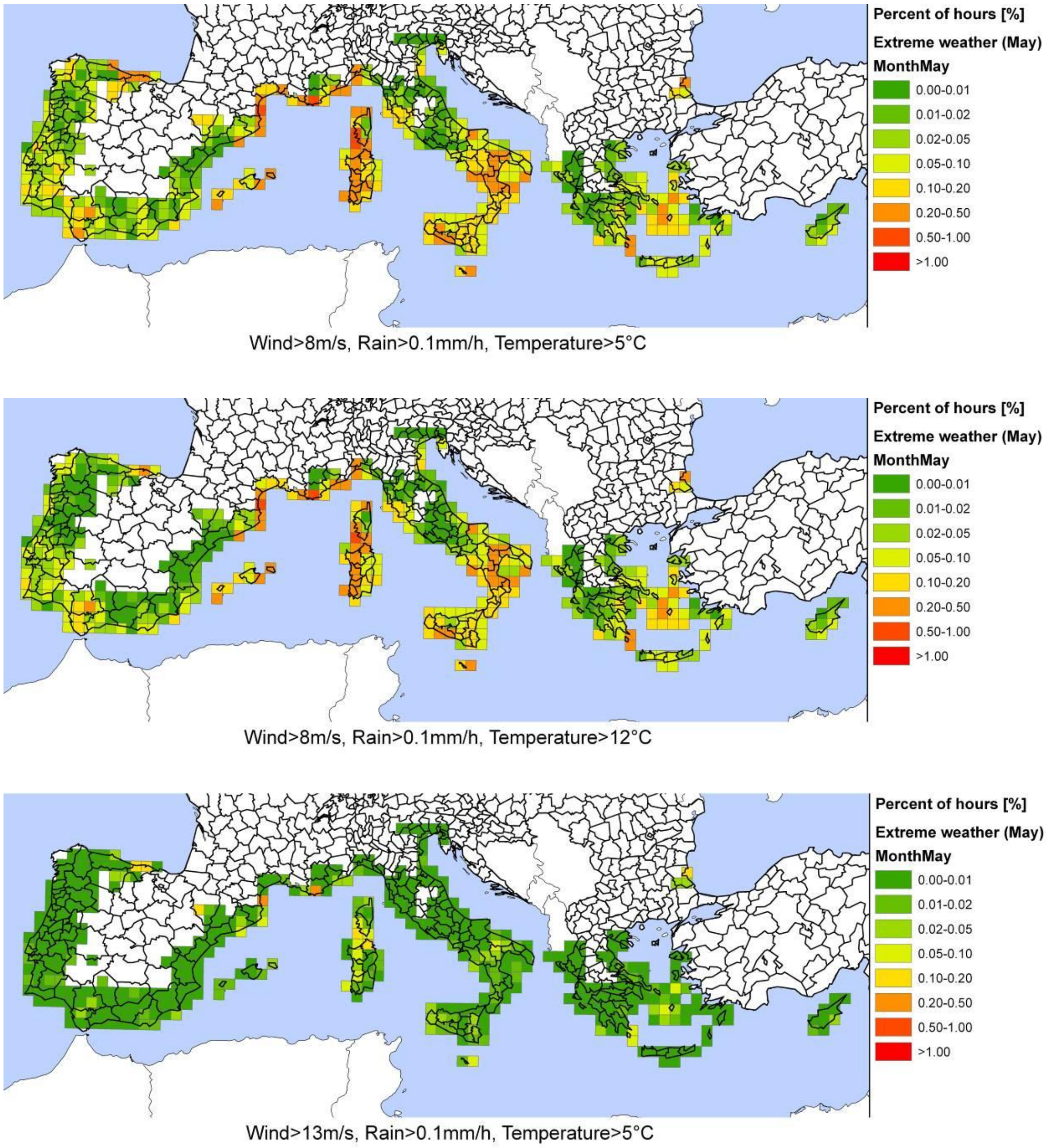
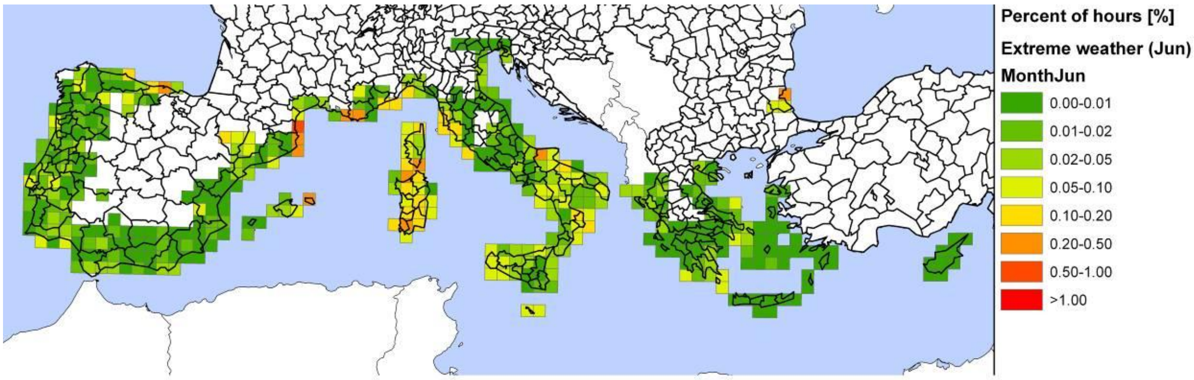
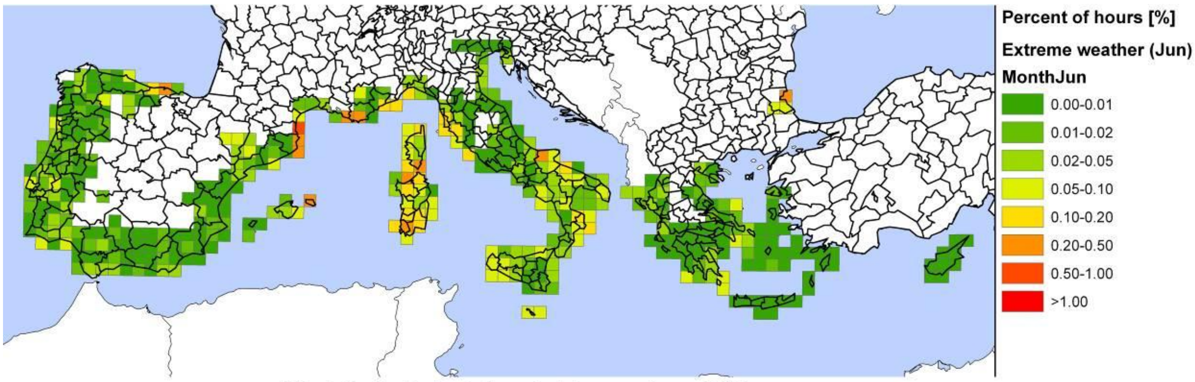


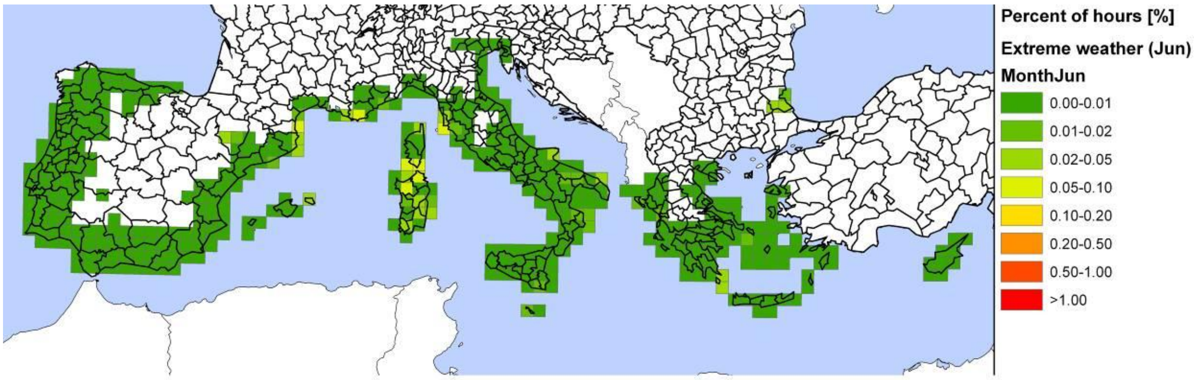
Figure F.11: Monthly percentage of hours with different extreme weather conditions in May in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)



Wind>8m/s, Rain>0.1mm/h, Temperature>5°C



Wind>8m/s, Rain>0.1mm/h, Temperature>12°C



Wind>13m/s, Rain>0.1mm/h, Temperature>5°C

Figure F.12: Monthly percentage of hours with different extreme weather conditions in June in citrus-growing areas of Europe (average of the years 1998–2007, in a grid of 50 × 50 km (JRC, online; Leip et al., 2008)

Appendix G. Personal communications

Luis Navarro, 2013

In March 2013 the Panel contacted Luis Navarro (Professor of Research at IVIA, Protección Vegetal y Biotecnología at IVIA, Instituto Valenciano de Investigaciones Agrarias, Carretera de Moncada-Náquera Km 4.5, 46113 Moncada, Valencia (Spain)) in order to obtain information regarding the number of importations of citrus plant material to the quarantine facility in Spain over the last 10 years. The information provided is reflected in Table 7.

Luis Navarro has been contacted to ask if she is content with the way her contribution has been shown in the table.

Philippe Legrand, 2013

In March 2013 the Panel contacted Philippe Legrand (Executive Chief of the French Plant Quarantine Unit, Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (ANSES), Laboratoire de la santé des végétaux, Unité de Quarantaine, 6 rue Aimé Rudel, Marmilhat, F-63370 LEMPDES, France) in order to obtain information regarding the number of importations of citrus plant material to the quarantine facility in France over the last 10 years. The information provided is reflected in Table 7.

Philippe Legrand has been contacted to ask if he is content with the way his contribution has been shown in the table.

Christian Vernière, 2013

In April 2013 the Panel contacted Christian Vernire (Research Plant Pathologist in the Laboratoire de Pathologie et Génétique Moléculaire, CIRAD Réunion, 7 chemin de l'IRAT, 97410 St. Pierre, Île Réunion, France) in order to obtain information regarding the evaluation of the citrus canker situation in Mali, based on his visit to Mali in 2008.

The information provided is as follows: "Following my visit in Mali in 2008 with an objective of evaluating the citrus canker situation, different points came out:

- The incidence of the disease at the regional level was quite important, five provinces being concerned by the disease. We could suspect that the plant material was mainly the primary factor of disease propagation as nurserymen and growers did not know the disease.
- The incidence of citrus canker was sometimes high in some orchards. According to the growers, these situations resulted from an increase since the first observation of the symptoms. This supports a secondary dispersal during the rainy season, may be in association with human activities, which increases the incidence and severity of the disease within the orchards. There was no overhead irrigation and during the dry season, irrigation was done by watering directly the trees or filling small channels going through the orchards with water from the close river.
- Citrus canker is maintained from a rainy season to another rainy season. Bacteria survive within the lesions on leaves or twigs as frequently observed. This is compatible with the life duration of the leaves and inoculum is re-activated when the first rain comes back.

These points conducted to an epidemic situation that should be managed at both levels, regional and local."

Christian Vernière has been contacted to ask if he is content with the way his contribution has been presented in this opinion.

Bruno Hostachy, 2013

In May 2013 the Panel contacted Bruno Hostachy (Head of Tropical Pests and Diseases, Laboratoire de la santé des végétaux, Station de la Réunion, Pôle de Protection des Plantes, CIRAD Réunion, Ligne Paradis, 7 chemin de l'IRAT, 97410 St. Pierre, Île Réunion, France) in order to obtain information regarding the importation of plant material to France since 2000. The information was provided in two tables dealing with *Murraya* species and *Citrus* species separately (see Tables G.1. and G.2).

Bruno Hostachy has been contacted to ask if he is content with the way his contribution has been presented in this opinion.

Table G.1: *Murraya* species

Année	Nom produit en saisie	Classe produit libellé	Pays expéditeur libellé	Nombre de PV04	Poste de contrôle libellé	Quantité importé en milliers
2000	*Murraya paniculata*	Bonsaï	Chine	1	Marseille port (PEC)	0.05
2000	*Murraya* sp.	Bonsaï	Chine	1	Clermont Ferrand	0.004
2000	*Murraya* sp.	Bonsaï	Chine	2	Le Havre port (PEC)	0.15
2000	*Murraya* sp.	Bonsaï	Chine	2	Marseille port (PEC)	0.252
2001	*Murraya* sp.	Bonsaï	Chine	2	Clermont Ferrand	0.031
2001	*Murraya* sp.	Bonsaï	Chine	1	Le Havre port (PEC)	0.013
2001	*Murraya* sp.	Bonsaï	Chine	3	Marseille port (PEC)	0.007
2002	*Murraya* sp.	Bonsaï	Chine	3	Le Havre port (PEC)	1.07
2002	*Murraya* sp.	Bonsaï	Chine	1	Marseille port (PEC)	0.077
2003	*Murraya* sp.	Bonsaï	Chine	2	Le Havre port (PEC)	0.3
2003	*Murraya* sp.	Plant de végétal raciné destiné à la plantation	Burundi	1	Roissy (PEC)	0.01
2004	*Murraya*	Bonsaï	Chine	1	Le Havre port (PEC)	0.02
2004	*Murraya* sp.	Plant de végétal raciné destiné à la plantation	Burundi	1	Roissy (PEC)	0.01
2006	*Murraya*	Bonsaï	Chine	2	Clermont Ferrand	0.255
2008	*Murraya koenigii*	Feuilles, légumes-feuille, branchages frais	Republique Dominicaine	2	Roissy (PEC)	0
2009	*Murraya koenigii*	Feuilles, légumes-feuille, branchages frais	Inde	7	Roissy (PEC)	0
2009	*Murraya koenigii*	Feuilles, légumes-feuille, branchages frais	Republique Dominicaine	1	Roissy (PEC)	0
2009	*Murraya paniculata*	Plant de végétal raciné destiné à la plantation	Thailande	1	Roissy (PEC)	0.05
2010	*Murraya koenigii*	Feuilles, légumes-feuille, branchages	Inde	2	Roissy (PEC)	0

Année	Nom produit en saisie	Classe produit libellé	Pays expéditeur libellé	Nombre de PV04	Poste de contrôle libellé	Quantité importé en milliers
		frais				
2010	*Murraya koenigii*	Feuilles, légumes-feuille, branchages frais	Republique Dominicaine	1	Roissy (PEC)	0
2010	*Murraya* sp.	Feuilles, légumes-feuille, branchages frais	Inde	1	Roissy (PEC)	0

Table G.2: *Citrus* species

Année	Nom produit en saisie	Classe produit libellé	Pays expéditeur libellé	Nombre de PV04	Poste de contrôle libellé	Quantité importé en tonnes
2000	*Citrus hystrix*	Feuilles, légumes-feuille, branchages frais	Thailande	1	Roissy (PEC)	0.01
2000	*Citrus limon*	Feuilles, légumes-feuille, branchages frais	Mali	1	Roissy (PEC)	0.001
2000	Agrume	Plant de végétal raciné destiné à la plantation	Italie	1	Angers CRD	0
2000	*Citrus grandis*	Plant de végétal raciné destiné à la plantation	Martinique	1	Roissy (PEC)	0
2000	*Citrus hystrix*	Plant de végétal raciné destiné à la plantation	Martinique	1	Roissy (PEC)	0
2000	*Citrus limon*	Plant de végétal raciné destiné à la plantation	Martinique	1	Roissy (PEC)	0
2000	*Citrus paradisi*	Plant de végétal raciné destiné à la plantation	Martinique	1	Roissy (PEC)	0
2000	*Citrus sinensis*	Plant de végétal raciné destiné à la plantation	Suisse	1	Rungis (PEC)	0
2001	*Citrus sinensis*	Feuilles, légumes-feuille, branchages frais	Liban	1	Roissy (PEC)	0.002
2001	Agrume	Plant de végétal raciné destiné à la plantation	Guadeloupe	1	Aéroport Nice Côte d'Azur (PEC	0
2001	*Citrus sinensis*	Plant de végétal raciné destiné à la plantation	Maroc	1	Avignon CRD	0
2001	*Citrus sinensis*	Plant de végétal raciné destiné à la plantation	Tunisie	1	Aéroport Nice Côte d'Azur (PEC	0
2001	*Poncirus trifoliata*	Plant de végétal raciné destiné à la plantation	Coree (Republique de)	1	Roissy (PEC)	0
2002	*Citrus sinensis*	Ecorce isolée	Togo	1	Aéroport Nice Côte d'Azur (PEC	0.024
2002	*Citrus paradisi*	Fleurs coupées fraîches	Pologne	1	Limoges CRD	0

Année	**Nom produit en saisie**	**Classe produit libellé**	**Pays expéditeur libellé**	**Nombre de PV04**	**Poste de contrôle libellé**	**Quantité importé en tonnes**
2002	*Citrus*	Plant de végétal raciné destiné à la plantation	Mali	1	Roissy (PEC)	0
2002	*Citrus limon*	Plantes finies, semi-finies (plante en pot, arbre etc.	Italie	1	Aéroport Nice Côte d'Azur (PEC	0
2002	*Citrus limon*	Plantes finies, semi-finies (plante en pot, arbre etc.)	Yougoslavie	2	Orly (PEC)	0
2003	*Citrus paradisi*	Bois scié	Etats-Unis	1	Le Havre port (PEC)	20.004
2003	*Citrus sinensis*	Fleurs coupées fraîches	Tunisie	1	Orly (PEC)	0
2004	*Citrus*	Feuilles, légumes-feuille, branchages frais	Viet Nam	1	Roissy (PEC)	0.001
2004	*Citrus sinensis*	Inflorescence seules	Tunisie	1	Orly (PEC)	0.001
2004	*Fortunella* sp.	Plantes finies, semi-finies (plante en pot, arbre etc.)	Syrie	1	Rungis (PEC)	0
2004	Cédratier	Végétal non raciné destiné à la plantation (bouture, greffon)	Maroc	1	Strasbourg Entzheim	0
2005	*Citrus aurantifolia*	Fleurs coupées fraîches	Mexique	1	Roissy (PEC)	0
2005	*Citrus*	Plant de végétal raciné destiné à la plantation	Tunisie	1	Orly (PEC)	0
2005	*Citrus aurantifolia*	Plantes finies, semi-finies (plante en pot, arbre etc.)	Egypte	1	Marseille port (PEC)	0
2005	*Citrus sinensis*	Plantes finies, semi-finies (plante en pot, arbre etc.)	Egypte	1	Marseille port (PEC)	0
2006	*Fortunella margarita*	Feuilles, légumes-feuille, branchages frais	Israel	1	Roissy (PEC)	0.4
2006	*Citrus sinensis*	Tubercule primeur destiné à la consommation	Algerie	1	Perpignan (PEC)	2.209
2007	*Citrus paradisi*	Emballage	Israel	2	Marseille port (PEC)	1
2007	*Citrus sinensis*	Emballage	Tunisie	1	Marseille port (PEC)	0.04
2007	*Citrus* sp.	Plant de végétal raciné destiné à la plantation	burkina	1	Roissy (PEC)	0
2008	*Citrus limon*	Autres	Chili	1	Toulouse-Blagnac (PEC)	0
2008	*Citrus paradisi*	Bois scié	Etats-Unis	1	Le Havre port (PEC)	18.823
2008	*Citrus latifolia*	Emballage	Mexique	1	Rungis (PEC)	0.265
2008	*Citrus* sp.	Feuilles fleurs, rameaux, branchages	Iran	1	Le Havre port (PEC)	4.939

Année	Nom produit en saisie	Classe produit libellé	Pays expéditeur libellé	Nombre de PV04	Poste de contrôle libellé	Quantité importé en tonnes
		secs				
2008	*Citrus clementina*	Feuilles, légumes-feuille, branchages frais	Maroc	4	Perpignan (PEC)	93.6
2009	*Citrus grandis*	Bois scié	Chine	1	Rungis (PEC)	15.73
2009	*Fortunella* sp.	Feuilles, légumes-feuille, branchages frais	Israel	1	Rungis (PEC)	0.64
2010	*Citrus reticulata* p.p.	Emballage	Maroc	1	Fos-Port-Saint-Louis (PEC)	0.04
2010	*Citrus aurantifolia*	Feuilles, légumes-feuille, branchages frais	Thailande	1	Roissy (PEC)	0.001

Maria Holeva, 2013

In June 2013 the Panel contacted Maria Holeva (Senior Research Scientist, Laboratory of Bacteriology, Department of Phytopathology, Benaki Phytopathological Institute, 8 Stefanou Delta str., Kifissia, GR-14561, Greece) in order to obtain information regarding the number of trees/plants in citrus nurseries in Greece. The information provided is fully used in section 3.3.1.

Maria Holeva has been contacted to ask if she is content with the way her contribution has been presented in this opinion.

María Pastor Pichardo, 2014

In December 2013 the Panel contacted María Pastor Pichardo (SG Sanidad e Higiene Vegetal y Forestal, Dirección General de Sanidad de la Producción Agraria, Ministerio de Agricultura, Alimentación y Medio Ambiente, C/ Almagro nº 33, 28010 Madrid, Spain) in order to obtain information regarding the number of registered citrus packinghouses per province/NUTS 3 area; the number of registered citrus packing houses with a permit to import citrus from non-EU countries per province/NUTS 3 area; and the number of citrus juice industries per province/NUTS 3 area in Spain. The information provided is fully used in Appendix E.

María Pastor Pichardo has been contacted to ask if he is content with the way his contribution has been presented in this opinion.

Acknowledgements

The Panel wishes to acknowledge Luis Navarro, Philippe Legrand, Christian Vernière, Bruno Hostachy, Maria Holeva and María Pastor Pichardo for their contributions.