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 including identification, evaluation of risk management options and assessment of the effectiveness of present EU requirements against *Xanthomonas* strains pathogenic to citrus. The strains of *X. campestris* pathogenic to citrus have been reclassified as four distinct pathovars. Only two pathovars (*X. citri* pv. *citri*, *X. citri* pv. *aurantifolii*) are responsible for 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 is rated unlikely for fruit and leaves, likely for fruit plants for planting and moderately likely for ornamental plants for planting. The probability of establishment is rated as moderately likely to likely because host plants are widely present where environmental conditions are frequently suitable. Once established, spread would be likely because of human activities and suitable weather conditions. The impact of the disease, even if control measures are applied, could be moderate to major. The disease would cause yield losses, negative social incidence in areas where citrus is the main crop, costly control measures and create environmental problems. The combined EU regulations have 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. © European Food Safety Authority, 20YY

KEY WORDS

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

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SUMMARY

Following a request from 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 *Xanthomonas campestris* (all strains pathogenic to *Citrus),* which are listed in Annex 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 of on a US request regarding the export of Florida citrus fruit to the EU (EFSA Journal 2011;9(2):2461). However the comments are not addressed in this opinion as they will be discussed in a separate document.

The strains of *X. campestris* pathogenic to *Citrus* have been reclassified as four 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. The *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 has the potential for causing consequences in the risk assessment area once it establishes as hosts are present and the environmental conditions are favorable. 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.

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 Panel on Plant Health (PLH), 2010) and of the “Guidance on evaluation of risk reduction options” (EFSA Panel on Plant Health (PLH), 2012). The Panel conducted the risk assessment considering the scenario of absence of the current requirements against *Xanthomonas campestris* (all strains pathogenic to *Citrus),* which are listed in Annex 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 still apply measures voluntarily, or in response to requirements by non EU importing countries.

[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. Official Journal of the European Communities L 169/1, 10.7.2000, pp. 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. Official Journal of the European Communities 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). Official Journal of the European Communities 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. Official Journal of the European Union L 31, 31.1.2013, p. 75-76.

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 still apply measures voluntarily or as required by non EU importing countries, the conclusions of the pest risk assessment are as follows:

<u>Entry</u>

Under a scenario of absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* official EU regulation, the probability of entry has been rated as unlikely for the fruit pathways and as likely for the plants for planting pathways.

For fruits, the probability of entry is rated unlikely because:

- the association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruits imported within the EU from countries where citrus canker is reported, with documented reports of interceptions. 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 to 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 no specific measure is currently in place in the RA area;
- the probability of transfer to a suitable host is rated unlikely, based on the litterature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur because of presence of waste near to orchards and sometime short distance between tree canopy and soil in the RA area and because of occurrence of climatic conditions suitable for the transfer.

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

- the association with the pathway at origin is likely because leaves and cut branches 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 procedure 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 as it is for infected fruit.

For plants for planting, through both the commercial trade and passengers pathways, the probability is rated as likely for plants for planting for citrus production and moderately likely for plants for planting for ornamental Citrus and other rutaceous, 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, due to the fact that 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 ornamental Citrus and other rutaceous, through both the commercial trade and passengers pathways, due to the lack of recent information on the rutaceous ornamental host plants susceptibility and a real difficulty in evaluating the level of trade under a non regulated pathway:
- as for the fruit pathways, the ability to survive during transport is very likely;

- the probability of the pest to survive any existing management procedure is very likely since no specific measure is currently in place in the RA area. Such probability would even be 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 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 RA area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of gardening amateur likely to import through the 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 is not clearly stated. The two published papers on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of much more experimental data;
- partial data on effective presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country at 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 fruits 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 fruits 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 fruits;
- the extent of importation of citrus material via passenger traffic is not well documented;
- the susceptibility of *Murraya* and other ornamental rutaceous species to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the possibility of latent infection and/or endophytic and/or epiphytic presence of *X. citri* pv. *citri* in *Murraya* plants.

<u>Establishment</u>

The probability of establishment is rated as moderately likely to likely because host plants are widely present in the risk assessment area and environmental conditions are frequently suitable. The host is susceptible along 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) 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 would partially act as a barrier to establishment. Once the pathogen would enter in the risk assessment area, no host jump requiring pathological adaptation would be needed for establishment, as it would likely encounter susceptible host species.

Uncertainty on the probability of establishment is rated medium because information on the occurrence of suitable host in the PRA area is well documented. However, pieces of information are missing on the type of irrigation systems employed across the EU orchards and the plant host susceptibility under environmental conditions that occur in citrus groves in certain location of the PRA 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, 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 summer storms, which can be quite frequent 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 been reported to spread in countries where climatic conditions are similar to those occurring in the pest risk area (China, Japan, and Argentina). Practices and citrus varieties used in the RA area are similar to those used in countries where the disease occurs.

<u>Endangered areas</u>

Citrus are widely available as commercial crops in Southern Europe located in 8 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), and Malta (193 ha). Citrus nursery dedicated to fruit production and ornamentals are located in the same area 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, 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 area in the EU are considered as the endangered area.

<u>Consequences</u>

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 RA area. The disease would cause losses of yield and costly control measures. It would have negative social incidence in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies should close part of their market places. The occurrence of the disease would lead to increase chemical application in groves and to use copper coumpounds that should create environmental concerns such as copper accumulation in soil, selection of resistance gene that could spread in the plant associated microflora and beyond.

Once citrus bacterial canker would enter the RA area, uncertainties on the assessment of consequences would rated as medium because, even though eradication would likely be a valuable option, it uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions prevailing the RA area that are favourable to citrus bacterial canker.

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. The enormous investments for preventing outbreaks and for eradication in response to outbreaks of citrus canker made by various countries (Gottwald et al, 2002a; Gambley et al, 2009; Alam and Rolfe, 2006) indicate the high importance of 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. Once established, the 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 current set of EU regulations for all pathways have shown to be highly effective in preventing introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in the EU, because there have been no outbreaks of citrus canker in the EU territory.

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 methods under strict post-entry quarantine conditions. The potential of a systems approach combining production of plants for planting in nurseries in officially controlled pest free areas according to a certification scheme, including 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, might be further explored.

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 the the 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 on this pathway. The current measures to prevent entry of the EU are evaluated as effective, although exporting countries do not always comply. Additional options are suggested to further reduce the risk of entry.

The possible 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 by 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 high number of interceptions of citrus leaves imported via non-declared packages and passenger baggage.

TABLE OF CONTENTS

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 will be discussed in a separate document.

1.2. Scope

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

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[8].

2. Methodology and data

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 Panel on Plant Health (PLH), 2010). The evaluation of risk reduction options has been conducted in line with the principles described in the above mentioned guidance (EFSA Panel on Plant Health (PLH), 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 Panel on Plant Health (PLH), 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 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 Panel has developed rating descriptors to provide clear justification when a rating is given, which are presented in Appendix A of this opinion.

When expert judgement and/or personal communication are used, 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.

8 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. Official Journal of the European Communities L 169, 10.7.2000, p. 1–112

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 *Xanthomonas campestris* (all strains pathogenic to *Citrus)*, which are listed in Annex II, III, IV and V of Council Directive 2000/29/EC, as well as in Commission Decision 2004/416/EC[9], Commission Decision 2006/473/EC[10] and Commission Implementing Decision 2013/67/EU[11]. However it is assumed that citrus exporting countries still apply measures voluntarily, or in response to requirements by non EU importing countries.

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 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 appeared in the meanwhile. Literature searches were performed consulting several sources such as ISI web of Knowledge database including Web of Science, 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 thesis and technical reports from national authorities were included.

When expert judgement and/or personal communication were used, justification and evidence are provided to support the statements. Personal communications have been considered only when in

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

[10] 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). Official Journal of the European Communities L 187, 8.7.2006, p. 35–36.

[11] 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. Official Journal of the European Union L 31, 31.1.2013, p. 75-76.

written form and supported by evidence and when other sources of information were not publicly available.

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, 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, 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 events, the European Severe Weather Database was 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 hour with suitable weather conditions weather data from agrometeirological station and interpolated climate data from JRC, as described in the previous EFSA opinion on citrus black spot (EFSA, 2008) were used.

3. Pest risk assessment

3.1. Pest categorisation

3.1.1. Identity of pest

3.1.1.1. Taxonomic position and biological properties

The 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 effort 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 economical significance (Table 1).

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

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

[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.

- **Xanthomonads causing citrus bacterial canker (CBC) symptoms**

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) (Ah-You et al., 2009; Schaad et al., 2006; Vauterin et al., 1995). 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) (Bui Thi Ngoc et al., 2009; Bui Thi Ngoc et al., 2010; Sun et al., 2004; Vernière et al., 1998).

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*) (Ah-You et al., 2009; Schaad et al., 2006; Vauterin et al., 1995). 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] Natural infections have been reported for the following rutaceous genera : *Fortunella*, *Microcitrus*, *Poncirus* and *Swinglea*. Additional genera were shown to be susceptible only after artificial inoculations (*Aeglopsis*, *Atalantia*, *Casimiroa*, *Clausena*, *Citropsis*, *Eremocitrus*, *Evodia*, *Feroniella*, *Lansium*, *Melicope*, *Murraya*, *Paramignya* and *Zanthoxylum*).
[d] Reported for strains originating from Iran (Escalon et al., 2013).

- **Xanthomonads causing watersoaked spots symptoms**

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* x *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) (Rademaker et al., 2005; Schaad et al, 2006; Vauterin et al., 1995). *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* x *Poncirus trifoliata*) caused by the aggressive strain type (F1-like) - credit Dr. James Graham, University of Florida. **B:** closeup 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 the 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 alfalfae* 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*) (Bui Thi Ngoc et al., 2010; Patel et al, 1953). 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 summarized in Table 1. Visual inspections would allow distinguishing between bacterial spot-like and citrus canker-like symptoms on leaves and fruit (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 center of spots on aging 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 for untrained inspectors with citrus scab (*Elsinoe fawcetti*), *Phaeoramularia* leaf and fruit spot disease (*Phaeoramularia angolensis*) or greasy spot (*Mycosphaerella citri*) (Figure 3) (Civerolo, 1984; Rossetti, 1981; 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 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) (Almeida et al., 2010; Bui Thi Ngoc et al., 2010; Young et al., 2008). The use of phenotypic tests is no longer recommended.

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 & Christian Vernière, CIRAD.

Figure 3. Fruit lesions that could get confused with that of citrus canker by untrained inspectors. A: Citrus scab 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 Dr. A. Seif, ICIPE Kenya.

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 restrict to *X. citri* strains causing citrus bacterial canker (CBC) disease. These canker strains are the only ones significantly impacting the citrus industry (Goto, 1992; Spreen et al., 2003; Anonymous, 2007; Jetter et al., 2000).

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

Other scientific names
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

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 color 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 no more erumpent or only pustule-like taking the shape of a pimple or a blister without any rupture of epidermis (Civerolo, 1984; Fulton and Bowman, 1929; Koizumi, 1972). 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 is 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 (Civerolo, 1984; Koizumi, 1976). 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^{-1} (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 developed canker lesions 17–21 days after inoculation whatever the host genotype. There is 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 (Pruvost et al., 2002; Timmer et al., 1991). 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 of Philippine islands (Peltier and Frederich, 1926). Recent observations of Asiatic citrus canker in Mali (Traoré et al, 2008) confirmed that dry environments with a relatively short rain season and no overhead irrigation can lead to severe outbreaks and persistence of high levels of inoculum over years (Vernière, personal communication, 2013). The bacterium multiplies in the intercellular spaces, 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 fruits generally increases with tissue age (Stall et al, 1982; Vernière et al., 2003). Leaves are most susceptible to stomatal infections when half to two third-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 1000 times lower to initiate infections as compared to infections of unwounded leaves through natural openings (Christiano et al., 2007).

The most critical period for fruit infection following pressurized 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 larger 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 (<20mm 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).

- **Survival in association with host tissue**

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 occur (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 (Pruvost et al 2002; Stall et al 1980). Survival in diseased leaves that are incorporated into soil occurs for a few months at low population sizes (Gottwald et al., 2002a).

- **Survival outside host tissue**

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 reversible viable but not culturable (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; Goto et al., 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 population between 10^5-10^8 cfu/ml (Goto, 1962; Pruvost et al., 2002; Stall et al., 1980; Timmer et al., 1996). 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 absence of plant tissue or debris has not been conclusively established and is likely transient and at low population sizes (Goto, 1970; Goto et al., 1975; Graham and Gottwald, 1989; Graham et al., 1987). 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 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 localized spread on grove-established and nursery plants, respectively (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 the possibility of infection of citrus (and disease development) through localized splash dispersal of *X. citri* pv. *citri* originated from asymptomatic sources (contaminated soil, rice straw, weed) (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 spread bacteria usually over short distances, i.e. within trees or to neighbouring trees when wind speed reaches or exceeds 8 m s^{-1} (Gottwald et al., 1992; Gottwald et al., 1988; Serizawa and Inoue, 1975; Serizawa et al., 1969; Stall et al., 1980). 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 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 meters 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 (Gottwald and Graham, 1992; Gottwald et al, 2001; Stall et al., 1980). 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 > 10-15 ms^{-1} (Bock et al., 2010a). This was associated with visible leaf injury occurring at wind speed $\geq$ 13 ms^{-1} and the relationship between wind speed and leaf injury could be described by a logistic model (Bock et al., 2010a).

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., 2007; Gottwald et al., 1997; Hall et al, 2010). This insect is widely present in citrus producing regions of the EU27 EPPO-PQR database (EPPO, online). 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 EU27 based on the EPPO Reporting Service (EPPO, online). 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 only occur within 72 hours due limited survival on inert surfaces (Graham et al., 2004). Wooden harvesting boxes that contained diseased fruit and leaves have been implicated in long-distance spread (Das, 2003). 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) (Almeida et al., 2010; Bui Thi Ngoc et al, 2010; Young et al., 2008), 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 (Bui Thi Ngoc et al., 2008; Bui Thi Ngoc et al, 2010; Cubero and Graham, 2002). 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* (Alvarez et al., 1991; Civerolo and Fan, 1982). 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, ELISA tests 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 to 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 taxonomical data and all PCR primers lacked completely 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., 2012]. 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., 2012). 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 programs.

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 utilization of two labeled 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. The following other rutaceous genera have been reported as hosts based on lesion development following artificial inoculations: *Acronychia* (*A. acidula*), *Aeglopsis* (*A. chevalieri*), *Atalantia* (*A. ceylonica*, *A. citrioides* and *A. disticha*), *Casimiroa* (*C. edulis*), *Clausena* (*C. lansium*), *Citropsis* (*C. schweinfurthii*), *Eremocitrus* (*E. glauca*), *Euodia* sp., *Feroniella* (*F. lucida*), *Lunasia* (*L. amara*), *Melicope* (*M. denhamii* and *M. triphylla*), *Microcitrus* (*M. australasica*, *M. australis* and *M. garrowayi*), *Micromelum* (*M. minutum*), *Murraya* (*M. exotica*, *M. ovatifoliolata*), *Paramignya* (*P. longipedunculata* and *P. monophylla*), *Swinglea* (*S. glutinosa*), and *Zanthoxylum* (*Z. clava-herculis*) (Lee, 1918; Peltier and Frederich, 1920, 1924; Koizumi, 1978; Reddy, 1997; Hailstones et al., 2005). A few other species have been reported as hosts but with contradicting data in the literature (*Aegle marmelos*, *Feronia limonia*, *Microcitrus australis*, *Murraya exotica*, *Toddalia asiatica* and

Zanthoxylum fagara) (Jehle, 1917; Lee, 1918; Peltier and Frederich, 1920, 1924; Koizumi, 1978; Reddy, 1997; Hailstones et al., 2005). In addition, natural infections with lesion development were reported for *Microcitrus australis* and *Swinglea glutinosa* (Koizumi, 1978; Lee, 1918). A few other species have been reported as hosts but with contradicting data in the literature (*Aegle marmelos*, *Feronia limonia*, *Microcitrus australis*, *Murraya exotica*, *Toddalia asiatica* and *Zanthoxylum fagara*) (Jehle, 1917; Lee, 1918; Peltier and Frederich, 1920, 1924; Koizumi, 1978; Reddy, 1997; 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). A summary of host susceptibility of the different pathotypes responsible for citrus canker disease is provided in Table. 2.

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 (*Citrus 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* x *C. paradisi*), Natsudaidai (*C. natsudaidai*), some pummelo 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 fruits 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 processed market (Spreen et al., 2003). In addition, windbreaks have to be established and maintained. In California, four copper additional treatments would be expected if the pathogen would 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…) for countries or areas where a satisfactory control of the disease cannot be achieved. The annual cost for living with Asiatic canker in Florida (approximately 0.3 million ha 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 program settled in Florida and known as the 1900 ft exposure zone Florida law (Gottwald et al, 2001; Centner and Ferreira, 2012). The legal consequences of this program, 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 program. This interpretation of the Florida Constitution's Just Compensation Clause makes it more difficult to administer a successful eradication program (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 economical benefits of averting a national outbreak of citrus canker would be A$ 410 million in relation with the estimated cost of an Australian citrus ban for 5 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 $6,401/acre for Hamlin sweet oranges and $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 is 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) is given below in Figure 4 and Annex B. 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 RA area.

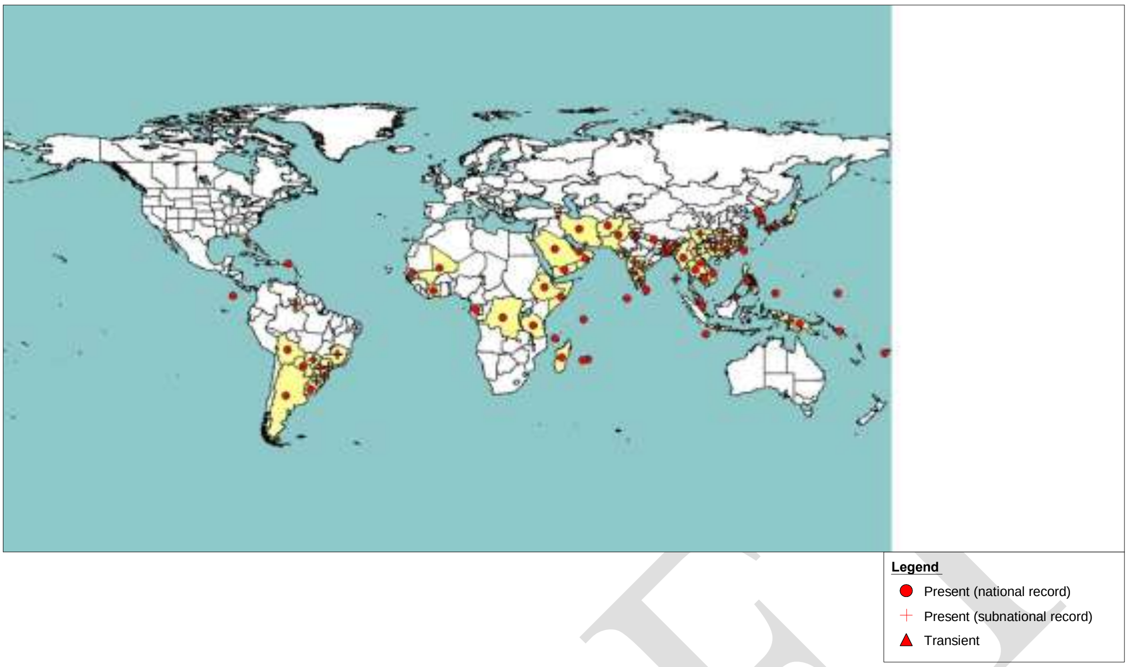


Figure 4: World distribution of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* as extracted from the EPPO-PQR database on February 20th, 2013 (EPPO, online)

3.1.3. Regulatory status

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 fruits 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 fruits 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 fruits originate in a country recognised as being free from *Xanthomonas campestris* (all strains pathogenic to *Citrus*).

or

the fruits originate in an area recognised as being free from *Xanthomonas 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 *Xanthomonas 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 fruits harvested in the field of production has shown symptoms of citrus bacterial canker, 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,

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 V Part A,

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

and

- fruits 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,

- fruits 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 fruits, leaves and branches 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 *Xanthomonas campestris* (all strains pathogenic to *Citrus*).

Commission Decision 2004/416/EC

From 2004 – 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[12].

Commission Directive 2008/61/EC[13]

12 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. Official Journal of the European communities L 31, 31.1.2013, p. 75–76.

13 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. Official Journal of the European communities L 158, 18.6.2008, p. 41–55.

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 *Xanthomonas campestris* (all strains pathogenic to *Citrus*) host plants carrying the pathogen and/or cultures of *Xanthomonas 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 for the premises where the material is to be used.

To summarize, the pathway 'plants for planting' is regulated by prohibition of import and the pathway 'fruit' is regulated by special requirements that the fruits 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 chapter 3.2.2.)

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

X. citri pv. *citri* or *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 27 estimated to 494 913 ha and located in 7 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, public and private gardens. A relatively low number of rutaceaous genera other than citrus known to possibly host citrus canker are present in the RA area. These are *Casimiroa*, *Microcitrus*, and *Zanthoxylum*, the two latter ones being present in mainland EU (De Rogatis et al, 1990; Recupero et al., 2001; Ducci and Malentacchi, 1993), while *Casimiroa* was only reported 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).

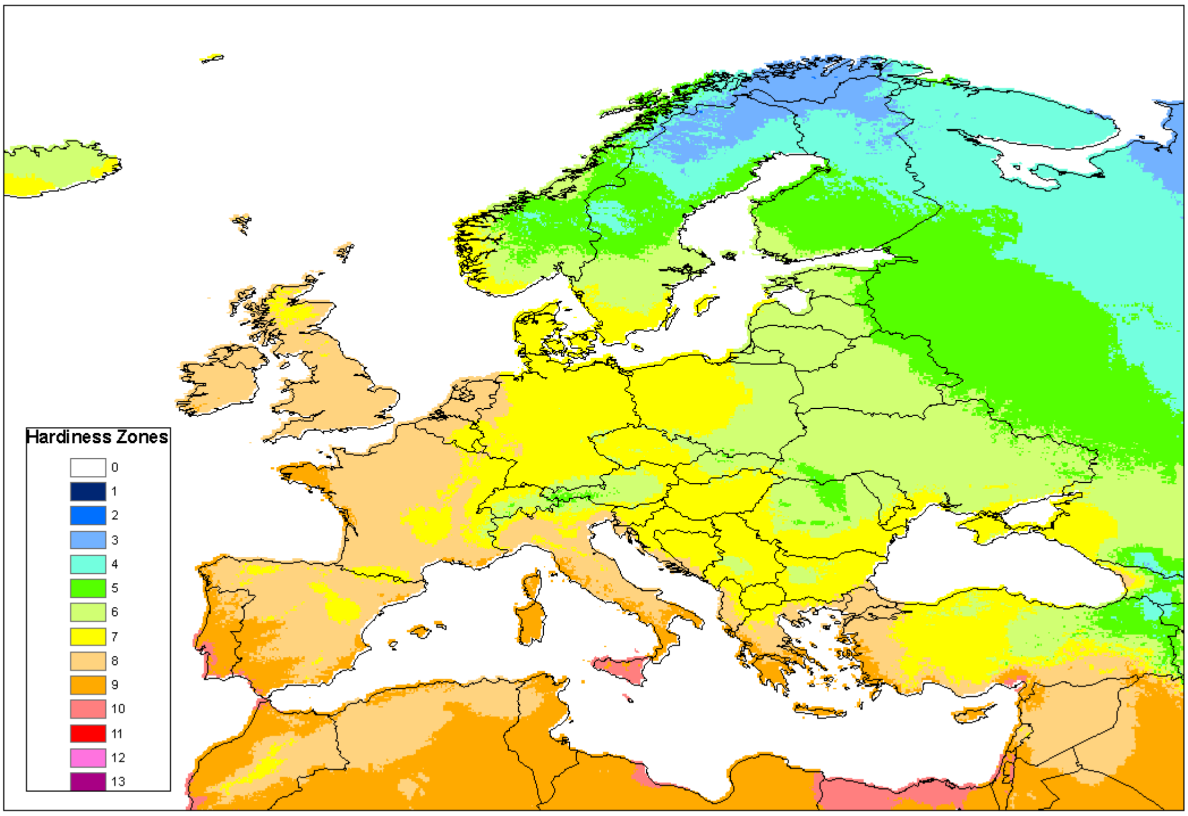


Figure 5: European Hardiness Zones updated by Magarey et al (2008) (PRATIQUE, 2011)

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 enable a good vigour of 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 (Gottwald et al., 2002a; Pruvost et al, 1999), is still of 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* (Pabitra *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 favors 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 RA 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) 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

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 has the potential for causing consequences in the risk assessment area once it establishes as hosts are present and the environmental conditions are favorable. 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.

3.2. Probability of entry

Citrus represents one of the most important fruit crops in Europe as in the world (see Table 9). *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are not known to be present in the RA area where they are presently considered as quarantine organism. Importation of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf. and their hybrids in the European Union is regulated, according to the Council Directive 2000/29/EC. For this section, we will provide an analysis of the pathway without taking into consideration any existing EU regulation. However, it is assumed that citrus exporting countries still apply measures as required by non EU importing countries.

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:

- Fruits (commercial trade and import by passenger traffic)

The import of fresh fruit is considered as a major pathway because it is the most frequent route for importing citrus material within the RA area. Fresh citrus fruit includes oranges, mandarins, clementines, tangerines, grapefruits, pummelos, 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 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 have 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 and rootstocks, would be imported in the risk assesment 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, other rutaceous plants which are regarded as potential hosts of *X. citri* pv. *citri* (Lee, 1918; Peltier and Frederich, 1920; Peltier and Frederich, 1924; Koizumi, 1978; Reddy, 1997) should also be taken into account.

The pathway "plant for planting for the commercial citrus fruit production" and "Ornamental citrus and other rutaceous plants" are clearly separated since 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 potpourri combination 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. In Indian and Sri Lankan cooking, leaves of the rutaceous plant *Murraya koenigii* (known as "curry tree") are also commonly used as seasoning. Besides cooking and ornemantal purposes, leaves from rutaceous plants have also been reported to be used in medicine, in rituals or cosmetic products. The importation of citrus leaves seems to be possible through internet web sites delivering such items e.g. in UK.

3.2.1.2. Major pathways

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

- Citrus fruit commercial trade
- Citrus fruit and leaves import by passenger traffic
- Citrus plants for planting for citrus fruit production through commercial trade
- Citrus plants for planting for citrus fruit production through import by passenger traffic
- Ornamental rutaceous plants for planting commercial trade
- Ornamental rutaceous plants for planting import by passenger traffic
- Citrus leaves commercial trade

3.2.2. Entry pathway I: Citrus fruits commercial trade

Importation of fruit is considered as major pathway because of the high volume of citrus commodities imported into RA 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 assessment documents made by the European Food Safety Authority (EFSA Panel on Plant Health (PLH), 2006, 2011), the United States Department of Agriculture (USDA, 2006, 2007a, 2007c, 2008, 2009a, 2009b, 2009d, 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). 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 fruits were considered as fruit alone as well as fruits with attached petioles 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 Ethiopia, Mali, Senegal or Somalia (see Appendix B Table B.1) (Leduc et al., 2011, Khodakaramina and Swings, 2011; Al-Saleh and Ibrahim, 2010; Balestra et al., 2008; Traore et al., 2008). Approximately 2.000 ktons of citrus fruits are imported each year in the RA area precisely, in 2011, 1925 ktons, among which one third is coming from countries where the disease is reported. Such countries are, by importance of citrus fruit importation level, Argentina, Uruguay, Brazil, United States (Florida), China, Pakistan and Vietnam all with 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 Philippines (Table 5).

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

Citrus fruits 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, on line). In Spain, secondary inspections done by local authorities in markets, supermarkets or packinghouses have also identified additional diseased consignments (EUROPHYT, on line). It is worth noting that approximately 90 % of the reported interceptions (EUROPHYT reported interceptions, Table 3) have been done by 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), (iii) MS specific pathway of citrus fruit; most of infected fruit detected in UK was originating from Bangladesh India and Pakistan.

Table 3: *X. citri* pv. *citri* interceptions reported in EUROPHYT on fruit consignments over the last 10 years (data extracted from EUROPHYT 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[1]	2
2003	Spain	Argentina	5

[1] *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* not officialy reported to be present in Mexico but symptoms of citrus canker were observed in consignements from Mexico.

Most of the origins from which interceptions have been made are minor exporting countries. Among these, the most significant citrus exporter to the EU27 is Pakistan (small citrus 3 ktons, half of which is sent to UK). In contrast, huge volumes that should be more extensively surveyed originate primarily from Argentina (lemon 268 ktons, orange 96 ktons, grapefruit 24 ktons, small citrus 33 ktons), Uruguay (lemon 10 ktons, orange 58 ktons, small citrus 29 ktons) and China (pummelo/grapefruit 68 ktons) (EUROSTAT, online). No interception has been reported yet from Brazil although huge volumes are imported. This can likely be explained by the fact that imported citrus primarily originate from Sao Paulo state, which undergoes an eradication strategy for *X. citri* pv. *citri*. Although no interception of infected fruit was reported in shipments from the United States, APHIS stated that less than 1% of 72 millions boxes of packed fruit were contaminated by *X. citri* pv. *citri* (APHIS, 2012).

Bactericide treatments such as chlorine or sodium orthophenylphenate (SOPP), recommended for the 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 of fruit in the packing house contributes to decrease the rate of symptomatic fruits, but it cannot prevent the exportation of apparently healthy but nevertherless contaminated fruit lots.

Citrus fruits are susceptible to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* infections and develop lesions 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 sction 3.1.). The younger the fruit the more susceptible it is to infection. Goto (1962, 1992) reports that artificial inoculation is successful in absence of extreme wheather conditions when bacterial concentrations reach or exceed ca. 10^5 cells per ml. However, successful infections can be generated with much lower inoculum concentrations, especially when extreme weather events like storms or hurricanes enforce *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in stomata or wounds (Bock et al., 2010). Therefore extreme weather conditions will increase citrus canker incidence and severity (Bock et al., 2010; Parker et al., 2008). 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 fruits and is low when lesions get older (Stall et al., 1980; Civerolo, 1984, Gotwall 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 symptoms most often do not develop on mature unwounded fruit (USDA, 2007a), it does not mean that the bacterium is absent from such mature fruit. It has been reported that *X. citri* pv. *citri* may also survive on apparently healthy citrus fruits (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 infected, bacterial populations were able to survive for several weeks at low population densities (Gottwald et al., 2009).

Recently, the colonization and adherence of *X. citri* pv. *citri* prior to development of canker disease as biofilms on plant surfaces has been suggested (Rigano et al., 2007; Cubero et al. 2011). Moreover, a reversible viable but not culturable (VBNC) state has been suggested for *X. citri* pv. *citri* in response to copper ions (Del Campo et al., 2009; Golmohammadi et al., 2012). 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 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 worlwide (see section 3.1.2.). Some places of production may be free of CBC in countries where CBC is reported.

- Cultivar resistance: citrus cultivars show markedly different levels of susceptibility to citrus bacterial canker (Table 4 below). For instance, grapefruit (*Citrus paradisi*) is highly susceptible while mandarin (*C. reticulata*) is moderately resistant (Das, 2003).

- The existence of 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 destinated 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 (Behlau et al., 2011 a, b; Canteros et al., 2010).

- Cleaning, sorting and treatment of fruits: sorting of fruits may allow the removal and destruction of many (but not all) symptomatic fruits. Such treatments may be performed in packinghouse lines before export, for example the prewash of fruits with water and detergent (SOPP) and treatment with chlorine, and would have a partial negative effect on surface populations of *X. citri* pv. *citri* (Gottwald et al., 2009). 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. Cleaning, sorting and treatment of fruits could be done in the exporting country on a voluntary basis. However, packinghouse operation fail to remove all *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*; incidence of detecting citrus canker symptoms in packed fruit was less than 1% each season for fruit coming from grove free of CBC or not, in Florida (APHIS, 2012). 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 probability to survive the packing packing process.

Table 4: Relative susceptibility/resistance to *X. 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. sinenesis*) -- 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, Pummelo (*C. grandis*); **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 Pointed leaf Hystrix (*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) partial data on effective presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* strains in the country at origin, ii) the variation in cultivar resistance, iii) the differences in the pest management measures set up according to the countries exporting citrus fruits 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 to 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 (Stall et al., 1980; Civerolo, 1984). The epiphytic populations of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* hat might survive the packing process would probably not be affected by transportation conditions. 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 conditions of the trees at harvest. The cooler temperature provides better decay control while the warmer protects against chilling injury (Wardowski, 1981). It is thus very likely that *X. citri* pv. *citri* survives the transport. 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). Investigations on symptomatic or healthy fruits showed that post-harvest treatments at packinghouses are not completely efficient to clean the fruits (Gottwald et al., 2009). *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 to existing pest management procedures

No or a few management practices are currently undertaken in the RA area against other pests that prevent the entry of *X. citri* pv. *citri*. Copper-based treatments are applied to control Alternaria Brown Spot in areas of Spain where it is present and Mal Secco in Italy (Vicent et al., 2009; Migheli et al., 2009). When applied, these copper programs would not prevent the introduction of citrus canker in areas where it is currently absent. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are therefore very likely to be associated with citrus fruit, with a low level of uncertainty.

3.2.2.4. Probability of transfer to a suitable host

Most of the EU27 import fresh citrus fruit (see Table 5 and Appendix C). Some of these citrus fruits originate from countries where citrus canker is widespread: more than 280 ktons from Argentina, 90 ktons from Uruguay, 83 ktons from Brazil and 47 ktons from China in 2011 (EUROSTAT, on line). Citrus producing countries of the EU27 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 fruits imported into the EU from third countries are re-distributed in the internal market by many MS (i.e. Netherlands, Belgium, Germany, France, UK…), see Appendix D. In 2008, the Netherlands imported from third countries around 390 ktons of sweet orange (one sixth of which originated from countries where *X. citri* pv. *citri* has established) and 150 ktons of grapefruit (one third of which originated from countries where *X. citri* pv. *citri* has established) and distributed approximately 180 ktons of sweet orange and 120 ktons 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 RA area during the months of the year most appropriate for establishment. The seasonal import of Citrus fruits into EU Citrus producing countries (Spain, Portugal, Italy, Greece, Malta, Cyprus and France) is reported in Table 6. Furthermore citrus packinghouses are generally located within citrus growing areas. For example, in Spain, according to the list of collective stock-houses and shippping centers in the zones of citrus production 78 establishments are located in the Comunidad Valenciana, 167 in the province of Murcia, 44 in Andalucia and 1 in Catalunya (EFSA, 2008). For more details see the Appendix E.

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 fruits to citrus trees remains uncertain due to a lack of research in this area. Only two recent papers reported on the transmission from infected fruit to healthy tree (Shiotani et al., 2009; Gottwald 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). They are consistent with previous data collected in Japan. Goto et al. (1978) observed some canker leaf lesions on *Citrus 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. Moreover, results by Gottwald et al. (2009) are difficult to transpose to situations where the lower branches of adult citrus trees grown commercially can be very close to the soil surface with a putative presence of contaminated fruit or fruit peel. 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 impossible to transpose to susceptible cultivars. Therefore, considering the current knowledge (see section 3.1.1.2), the transfer of *X. citri* pv. *citri* from infected fruits to citrus hosts could occur although with a low likelihood. Nevertheless, there is no authenticated record of this having happened under natural conditions (Das, 2003). Interestingly, it is useful to stress that there is a general lack of knowledge on the origin of inoculum associated with new outbreaks in countries where the pathogen is not established. 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, but the source of inoculum is unknown, although likely 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 failed to be 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 fated for waste. The main intended use of the commodity is consumption. However, some of the fruits that are imported from third countries are used for juice production. Stockhouses for trade and processing plants in Spain, Italy and Greece are located in citrus producing areas (Baker et al., 2008) (see also Figure 6 and Appendix E). Data from season 2003-2004 indicated that approximately 2.500 ktons of citrus (62 % of sweet orange) were transformed in the UE primarily for juice production.

Moreover, some alternative uses of citrus fruit are industrial (pectin extraction, cosmetics…). By now, no waste treatment is considered by the EU-based industries, as according to the 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 RA area.

Figure 6: a), b) Processing of citrus pulp residues and whole citrus fruit in close proximity of citrus orchards; c) uncontrolled citrus waste discharged in the vicinity of neglected citrus trees; and d) sweet orange orchard with low hanging branches and fruit (Valencia, Spain)

Depending on species/cultivars, citrus fruit production period in the EU is primarily over approximately half a year. At least in Spain, plants process fruits 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, ii) the lack of extensive information on transfer under natural condition and considering:

- the amount of citrus fruits imported within the Citrus European growing area during periods where Citrus are the most 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 (iiii) wind speed of 16 m/sec (7 Beaufort) quite common 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/sec (4 Beaufort) and these speeds occur very often in the southern Mediterranean Member states;
- the limited but real possibility of transfer from cull piles of fruit to surrounding trap plants unless environmental conditions highly conducive to spread were applied (Gottwald et al., 2009);

- failure to trace back the origin of outbreaks in countries where citrus canker 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 (Baker et al., 2008). It cannot be excluded 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 fruits (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 (in 100 kg)

Place of origin	Oranges (080510)	Mandarins (080520)	Grapefruit (080540)	Lemons (08055010)	Limes (08055090)	Citrus other (08059000)	Citrus total (0805)
SOUTH AFRICA	3386686	577919	940061	452173	279	2764	5359882
ARGENTINA	807196	321305	82759	1591131	129	317	2802837
TURKEY	103807	512132	674189	1163387	380	44	2453939
MOROCCO	980175	865513	4966	16616	47	58	1867375
EGYPT	1022778	11654	692	2593	1312	1	1039030
URUGUAY	576096	241601		82804			900501
ISRAEL	110532	297200	406521	2136	1900	37757	856046
BRAZIL	268717	1024	694	1588	565927		837950
UNITED STATES	7848	48134	579966	544	220	17	636729
PERU	98924	419253	2497	16	3274	172	524136
CHINA (PEOPLE'S REPUBLIC OF)	3	1651	476075			297	478026
MEXICO	51358		131805	627	279229	218	463237
SWAZILAND (NGWANE)	118791	3015	149857				271663
TUNISIA	203103	13		257			203373
ZIMBABWE	116450		22279				138729
CHILE	47157	15603	175	32112	60	57	95164
CROATIA	27	69598	80				69705
JAMAICA	51425	2675					54100
DOMINICAN REPUBLIC	14515	14	45	12455	6976		34005
PAKISTAN	772	33162		4	8	10	33956
VIET-NAM	1		25543		92	5	25641
MOZAMBIQUE	5710		10164				15874
HONDURAS	11443		609	68	2560		14680
CUBA	13754						13754
COLOMBIA	4002				8320		12322
BELIZE	9211						9211
BOLIVIA				8140			8140
AUSTRALIA	2425	2200		1	2	22	4650

Place of origin	Oranges (080510)	Mandarins (080520)	Grapefruit (080540)	Lemons (08055010)	Limes (08055090)	Citrus other (08059000)	Citrus total (0805)
NORWAY	1242	3174					4416
VENEZUELA					3981		3981
GHANA	3120						3120
DOMINICA	637		1603	5	10		2255
THAILAND	50	10	1871		4	19	1954
KOREA, REPUBLIC OF (SOUTH KOREA)		1366					1366
IRAN, ISLAMIC REPUBLIC OF	168			127	715	166	1176
GUATEMALA					1050		1050
RUSSIAN FEDERATION (RUSSIA)	236	670	92	14	35	1	1048
SWITZERLAND	320	605	9	14		4	952
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

Place of origin	Oranges (080510)	Mandarins (080520)	Grapefruit (080540)	Lemons (08055010)	Limes (08055090)	Citrus other (08059000)	Citrus total (0805)
INDIA	2			54	8		64
JAPAN		53				2	55
SRI LANKA (ex CEYLAN)					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 2011till February 2012 as extracted from EUROSTAT (on .lione) on 12 April 2013 (quantity given in tons)

		Total import from third countries (outside EU)				Total import from other EU countries including redistributed fruits			
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)		31	47	2	103	59	91	32
CYPRUS	Mandarins (080520)	48			17	1	0	31	51
CYPRUS	Grapefruit (080540)		42	0	0	16	47	10	
CYPRUS	Lemons (08055010)	259	1237	49		10	166	38	
CYPRUS	Limes (08055090)			4		9	33	4	3
CYPRUS	Citrus other (08059000)					2	1	2	
CYPRUS	Citrus total (0805)	307	1309	100	19	140	306	178	87
FRANCE	Oranges (080510)	20620	8495	11458	14779	119482	44648	57692	137224
FRANCE	Mandarins (080520)	7122	842	3352	30235	34981	2295	79323	194064
FRANCE	Grapefruit (080540)	2865	3568	8268	7523	17094	9133	13593	15836
FRANCE	Lemons (08055010)	387	2306	1945	313	28546	23836	23415	31813

		Total import from third countries (outside EU)				**Total import from other EU countries including redistributed fruits**			
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)**
FRANCE	Limes (08055090)	618	391	828	1269	2187	2149	1750	1536
FRANCE	Citrus other (08059000)	12	26	73	97	367	384	359	368
FRANCE	Citrus total (0805)	31625	15628	25924	54217	202657	82444	176133	380841
GREECE	Oranges (080510)	360	742	2075		1357	276	678	4228
GREECE	Mandarins (080520)	61		16	120	1598	565	1306	787
GREECE	Grapefruit (080540)	45	1361	700	277	380	662	149	197
GREECE	Lemons (08055010)	1509	13301	7571	2097	1932	2793	467	307
GREECE	Limes (08055090)					211	227	63	201
GREECE	Citrus other (08059000)					25	179	37	27
GREECE	Citrus total (0805)	1975	15404	10362	2494	5504	4702	2700	5748
ITALY	Oranges (080510)	1702	16628	21752	997	49027	23901	15091	25038
ITALY	Mandarins (080520)	661	463	2402	1029	19197	1856	30651	33318
ITALY	Grapefruit (080540)	5032	9290	3264	2472	2645	2644	2150	1715
ITALY	Lemons (08055010)	370	33189	12672	192	14360	12597	11740	15304
ITALY	Limes (08055090)	405	710	329	158	1050	1428	876	743
ITALY	Citrus other (08059000)	31	14	6		1168	182	238	259
ITALY	0805citrus 0805citrus	81734	602830	404198	48487	863960	424433	605326	761435
MALTA	Oranges (080510)	8488	2025	4352	6273	10529	4828	5080	4324
MALTA	Mandarins (080520)	262			396	4175	420	1825	2347
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)	8776	2119	4352	6705	15845	6598	8249	7233
SPAIN	Oranges (080510)	1575	302475	479660		16096	115019	206168	88057
SPAIN	Mandarins (080520)	1043	13977	2947	415	5525	8525	14123	61244
SPAIN	Grapefruit (080540)	1708	25299	697	2129	2067	17353	11461	6287

		Total import from third countries (outside EU)				**Total import from other EU countries including redistributed fruits**			
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)**
SPAIN	Lemons (08055010)		272105	71559		618	20376	18825	16392
SPAIN	Limes (08055090)	6864	8196	2768	7673	2813	4024	6288	5636
SPAIN	Citrus other (08059000)			5	29	128	626	194	517
SPAIN	Citrus total (0805)	11190	622052	557636	10246	27247	165923	257059	178133
PORTUGAL	Oranges (080510)		154794	205339		152060	94930	59808	56364
PORTUGAL	Mandarins (080520)	786	15835	521		21031	12874	55714	70728
PORTUGAL	Grapefruit (080540)	1110	17996	3120		795	1049	702	2292
PORTUGAL	Lemons (08055010)		16951	15102	0	7412	26983	18241	5935
PORTUGAL	Limes (08055090)	2562	3659	793	2146	2790	4948	3217	3265
PORTUGAL	Citrus other (08059000)					8048	1130	774	29
PORTUGAL	Citrus total (0805)	4458	209235	224875	2146	192136	141914	138456	138613

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

The pathway of entry of citrus bacterial canker causing bacteria with imported citrus fruit has been previously analysed in risk assessment documents made by the European Food Safety Authority (EFSA Panel on Plant Health (PLH), 2006, 2011), the United States Department of Agriculture (USDA, 2006, 2007a, 2007c, 2008, 2009a, 2009b, 2009d, 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 have 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 fruits were considered as fruit alone as well as fruits with attached petioles and leaves.
Public awareness about importation of fruit or plant parts is considered to be limited, hence offering the opportunity for entry possibilities 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 with pathway I (Citrus fruit commercial trade) (see 3.2.2), the Panel considers that fruits imported through the passenger traffic are less likely to have been submitted to pest management (especially post treatments at the packinghouses), or sorting procedures at the country of origin. The worlwide presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* and the susceptibility of citrus fruits have already been described (see 3.2.2). The likelihood of association with the pathway at origin, when compared to commercial fruit trade, is also higher because some countries where the disease is present are often visited for tourists who buy fruit and/or leaves on local open markets (eg Thailand, Vietnam, India, Sri Lanka).

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 are likely to be done at temperature between 18°C 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 the transport, with a low level of uncertainty.

3.2.3.3. Probability of survival to existing pest management procedures

Besides the fact that no treatment fully eliminate 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 fruits imported through the passenger traffic would not have been submitted to pest management procedures like fruit disinfection and sorting in the packing house. There is no measure currently established within the RA area for CBC management. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to be associated with citrus fruit and/or leaves coming from local market without any phytosanitary measures during packing with a low uncertainty.

3.2.3.4. Probability of transfer to a suitable host

It is very likely that citrus fruit imported from third countries by air passengers would arrive in the RA 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, due to the high air traffic passengers entering within the EU, especially from countries where citrus canker is

present, and the lack of control measures to avoid contaminated fruit and leaves importation;
- there is lack of awareness of traffic passengers about the disease;
- the ability of the bacteria to survive during transport is very likely;
- the probability of pest surviving existing pest management procedure is very likely, since no measure is currently established within the RA area;
- the probability of transfer to a suitable host is considered as unlikely based on the available literature, but with a high uncertainty;

the Panel considers that one cannot rule out the possibility of transfer to suitable host, although such an event remains unlikely. The Panel also stress the high level of uncertainty for this pathway, due to the lack of data available one hand, and to the variation of conditions prone for plant infection within the RA 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 bacterium primarily survives in canker lesions, which are quite common on shoots of susceptible cultivars (Gottwald et al., 2002a). It has been found in association with leaves or budwood material. 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 many years in lesions on woody branches (Goto, 1992; Gootwald et al., 1992). Twig lesions on young shoots are also known to perpetuate the inoculum and prolong survival in areas where the disease is endemic (Graham et al., 2004).

It is somehow 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 propagative material. Currently, importation of citrus plants or plant parts from third countries is only possible through certified quarantine stations: the main origin of the imported planting material in EU is Australia, Morocco, South Africa, and USA with a total of 68 importations since 2003 (Table 7), with minor importations from Argentina, Chile, Brazil, Israel, Japan, Turkey, Vietnam. Reports of interceptions from imported propagative material (Importation of *Citrus*, *Fortunella* and *Poncirus* sp.) are rare, though the control level of illegal entries of plant material is considered as very low (Table 8).

Table 7: Number of importation 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 mandarines)	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

Table 8: Citrus canker interceptions on citrus leaves reported in EUROPHYT on consignments over the last 10 years (data extracted from EUROPHYT (on line) on 14 March 2013)

Year	**Reporting country**	**Country of origin**	**Number of consignements**
2010	Netherlands	Thailand	1
2009	Netherlands	Thailand	5
2008	UK	Vietnam	1

Nonetheless, in agreement with MacLeod et al. (2012) and taking into consideration the wide areas 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 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* (Das, 2003);
- 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 propagative material in a non-regulated pathway is less likely to have been submitted to sorting procedures, pest management strategies or quarantine process in the area of origin. High concentrations of inoculum would be correlated to the presence of canker lesions in the consignment.

Therefore, considering that
- the disease occurs worlwide, including in areas where plant for planting material is produced and already imported within the RA area;
- 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 likely bear juvenile organs, possibly allowing for latent infections,
- the expected volumes of plant for planting material of *Citrus*, *Fortunella*, *Poncirus* and their hybrids importation in the European Union under a non-regulated pathway 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 (level of contamination of the country, separation of areas for production and nurseries, isolation of mother plants…) are important for contamination of planting material.

3.2.4.2. Probability of survival during transport or storage

Propagation material, grafted plants and foliage 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* (Goto, 1962). It is thus very likely that *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* survive the transport. Latent population of bacteria could be maintained at these conditions and will keep multiplying later on at suitable conditions then producing symptoms (see section 3.1.1.2.). Furthermore, *X. citri* pv. *citri* exponential multiplication primarily preceeds lesion development (Graham et al., 1992) and of *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 low level uncertainty.

3.2.4.3. Probability of survival to 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. 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 sodium orthophenylphenate (SOPP). However, the level of efficiency of such treatments has not been precisely reported for asymptomatic material but it is likely partial, and is recognized as weakly effective for symptomatic material (Gottwald et al., 2009).

No pest management procedures are currently taken within the RA area. Therefore, *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are very likely to survive pest management procedure 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 direct use could result in transfer to 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 exposing the inoculum to several climatic events which allow bacterial growth and dispersal (see section 3.3.2). *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are very likely to transfer to a suitable host from plant for planting material, including plant parts like budwood material *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 produces from this mother material could be distributed on a wider scale.

The primary source of outbreaks inoculum 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 hypothesized that the former one has been 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 likely 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 garden. 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* or *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 to survival existing pest management procedures and the probability of transfer to a suitable host are very likely, the entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* through citrus plant for planting import commercial trade, under a non regulated pathway, 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 presently.

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 inoculum and prolong survival 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 by now. Based on Australian passenger control data, the assumption is made that the quantity of imported plant material through the passenger traffic is likely to be low to very low. Nevertheless, it is relatively easy to travel with budwood material: thousands of contaminated citrus budwood have been 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 a consignment 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* (Das, 2003);
- te 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 propagative material in a non regulated pathway is less likely to have been submitted to sorting procedures, pest management strategies or quarantine process in the area of origin. High concentrations of inoculum would be correlated to the presence of canker lesions in the consignment.

Therefore, considering that:

- the disease occurs worlwide, including in areas where plant for planting material is produced and already imported within the RA area;
- plant 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…) may be used by passengers for planting;
- whole plants would likely 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 a non-regulated pathway 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 (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 pathway II and III, *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are very likely to survive during transport and storage of plants and plant parts, with a low level uncertainty.

3.2.5.3. Probability of survival to 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. In a non-regulated pathway, and for occasional importation by amateur, it is very likely that no management procedures would be implemented. Furthermore, there is no management procedure currently implemented in the RA area. *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* are therefore very likely to survive pest management procedure 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 plant 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 outbreaks inoculum 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 (see section 3.2.4.4., pathway III).

Budwood could likely 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 garden. 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 garden;
- 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 gardening amateur susceptible to import plant and planting material though passenger traffic;

the Panel considers that *X. citri* pv. *citri* or *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, ornamental citrus like *Citrus aurantium* (Sour orange) are widely cultivated in Europe in squares and avenues. Rutaceous species traded as ornamentals primarily consist of *Murraya* (whole plants and foliage) and to a lesser extent *Eremocitrus, Microcitrus, Severiana and Zanthoxylum*, either as garden plants or as bonsai (Mioulane, 2013; RHS,1996). 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 plant 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 alternate host is available. There is also a lack of information about possible latent infections or endo- an/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 other than *Murraya*, such as *Severiana, Eremocitrus, Microcitrus* and *Zanthoxylum* could be imported in the future. *Murraya* spp. 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 rate 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 of plant material, such as budwood or bonsai. Even if trade data is currently unavailable, up to 39 interceptions for the presence of harmful organisms on imported *Murraya koenigii* or *M. paniculata* have been recorded in Europe, from Australia, China, Dominican republic, India, Sri Lanka and USA (EUROPHYT, on line). These low volumes are submitted to fluctuations depending on EU consumer demands; imported *Murraya* plants are primarily bonsai but they are also used as hedges in public or private gardens, being used as source of spice for food (*Murraya koenigii*) or as traditional medicine.

Based on the current information available, the Panel considers that the association with the pathway at origin is moderately likely, with a high uncertainty. 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 a non regulated pathway.

3.2.6.2. Probability of survival during transport or storage

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

3.2.6.3. Probability of survival to existing pest management procedures

No preharvest or postharvest 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 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* strains can be present as latent infections and these are visually undetectable. Furthermore, there is no management procedure currently implemented in the RA area. *X. citri* pv. *citri* or *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 low level of uncertainty.

3.2.6.4. Probability of transfer to a suitable host

Ornamental rutaceous plants are intended to be planted. Consequently, their use could result in a direct transfer to suitable host or habitat.

If the imported plants are used as bonsai 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 the nurseries and nearby orchards or private gardens.

Therefore, taking into account that:

- that rutaceous ornamental species are extensively grown in the EU Mediterranean countries, in nurseries but also in private garden or public avenues or square;
- 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* or *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 garden, used as hedges or as bonsai (Mioulane, 2013; RHS, 1996). Since this pathway is of interest for gardening amateur, 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 touristic destinations (especially in Asia, eg Thailand, Vietnam, India, Sri Lanka …). The total concentration of imported inoculum will be dependent on the rate of infection. This parameter can vary according to several factors, including the susceptibility of the plant species, existing management procedures as for example cleaning and sorting of material. It is anticipated that, due a lack awareness of amateur, such procedures would be limited. High concentrations of citrus canker strains would be correlated to 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 of plant material, such as budwood or bonsai. The origin of these plants is not readily available, but based on data from France (Hostachy, 2013, personal communication) and unchecked information from the internet, the main origin is Asia. These low volumes are submitted to fluctuations depending on EU consumer demands; imported *Murraya* plants are primarily bonsai but they are also used as hedges in public or private gardens, being used as source of spice for food (*Murraya koenigii*) or as traditional medicine.

As mentioned for the pathway V, it is moderately likely that ornamental rutaceous plants for planting imported by passenger traffic would be associated with the pathway at origin, with 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* or *X. citri* pv. *aurantifolii* are very likely to survive during transport and storage of plants and plant parts.

3.2.7.3. Probability of survival to existing pest management procedures

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* are also very likely to survive on ornamental rutaceous species that are reported to be susceptible hosts. Imported plants 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. Consequently, their use directly could result in transfer to suitable host or habitat.

If the imported plants are used as bonsai or mother plants for propagation in garden, then the risk of transfer is very 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 the 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 private garden or public avenues or square;
- 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 gardening amateur susceptible to import plant and planting material though passenger traffic;

the Panel considers that *X. citri* pv. *citri* or *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: Leaves and branches from *Citrus* and other rutaceous plants

Importation of leaves which could be sometimes attached to small branches is considered as a pathway even though the small volume of importation due to the very specific end use of these plant parts for asiatic cooking purposes. Kaffir lime (*Citrus hystrix*) represents the main pathway for citrus canker on leaves (ABC News, 2012; MVCB, 2012.) with curry leaves (*Murraya koenigii*).

216 import interceptions of citrus leaves have been notified by MS between 2003–2012 (Table 9). Such interceptions mostly result from limited surveys of non-declared packages and passenger baggage and reflect only a fraction of the total import of citrus leaves. In 7 of these cases *X. axonopodis* pv. *citri* was reported: 1 in 2008, 5 in 2009 and 1 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 MS, notably Germany, United Kingdom and the Netherlands; one interception was reported by a Mediterranean MS. This may be partly explained by differences in survey plans between Member States and between years, the possibly larger import volume of citrus leaves in Nordic MS, and the possibility to grow *C. hystrix* in Mediterranean countries.

The number of interceptions found in these limited survey programs 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 9: Number of intercepted lots of citrus leaves by Member States between 2003 and 2012 (EUROPHYT, 2013)

Year	Austria	Czech Republic	Germany	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 citrus canker is endemic.

It is very likely that citrus leaves imported from third countries would arrive in the RA area during the months of the year most appropriate for establishment in EU areas where citrus are grown. Citrus have persistant foliage and several flushes of leaves can occur along the year. Kaffir lime leaves and curry leaves are sold via internet where are proposed either fresh or freeze dryed.

The importation of citrus detached leaves is currently banned in the EU. So no data are available on the volume of importation are available. However, lots of citrus leaves are intercepted frequently in the EU (Table 9) and also other countries report on illegal entry, e.g. in 2012 in Australia an illegal consignment of kaffir leaves (*C. histrix*) was intercepted and found infected by *X. citri* pv. *citri* (ABC News, 2012).

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

Citrus leaves and branches 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 resistance, iii) the existence of phytosanitary measures in the area of production, iv) the use of integrated pest management strategies and v) cleaning, sorting and treatment of leaves and branches.

X. citri pv. *citri* or *X. citri* pv. *aurantifolii* are likely to be associated with citrus leaves and branches, with a medium uncertainty due 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 branches. *C. hystrix* which is the major species used in cooking is highly susceptible to *X. citri* pv. *citri* (Table 4) The level of susceptibility of *Murraya koenigii* is not known.

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 branches. Concentrations of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* are correlated to 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 branches, with a low uncertainty in fresh leaves. However, Kaffir lime leaves are often dried before shipping and the impact of heavy drying on bacterial survival is not known, which increases the level of uncertainty.

3.2.8.3. Probability of survival to existing pest management procedures

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

3.2.8.4. Probability of transfer to a suitable host

Importation of leaves and branches are currently illegal and the volume is impossible to assess. It should be low because of the specific end uses of leaves and branches for Asiatic cooking. However, import (although illegal) already exists (see table 9) 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 low population sizes (Civerolo, 1984; Graham et al., 1987; Leite and Mohan, 1990). For specific conditions see the section 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 branches 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 establishement and spread.

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, ii) the lack of extensive information on transfer under natural condition.

3.2.9. Conclusions on the probability of entry

The above-mentionned components of probability of entry of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the RA 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 *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* official EU regulation, the probability of entry has been rated as unlikely for the fruit pathways and as likely for the plants for planting pathways.

For fruits, the probability of entry is rated unlikely because:

- the association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruits imported within the EU from countries where citrus canker is reported, with documented reports of interceptions. 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 to 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 no specific measure is currently in place in the RA area;
- the probability of transfer to a suitable host is rated unlikely, based on the litterature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur because of presence of waste near to orchards and sometime short distance between tree canopy and soil in the RA area and because of occurrence of climatic conditions suitable for the transfer.

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

- the association with the pathway at origin is likely because leaves and cut branches 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 procedure 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 as it is for infected fruit.

For plants for planting, through both the commercial trade and passengers pathways, the probability is rated as likely for plants for planting for citrus production and moderately likely for plants for planting for ornamental Citrus and other rutaceous, 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, due to the fact that 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 ornamental Citrus and other rutaceous, through both the commercial trade and passengers pathways, due to the lack of recent information on the rutaceous ornamental host plants susceptibility and a real difficulty in evaluating the level of trade under a non regulated pathway;
- as for the fruit pathways, the ability to survive during transport is very likely;
- the probability of the pest to survive any existing management procedure is very likely since no specific measure is currently in place in the RA area. Such probability would even be 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 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 RA

area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of gardening amateur likely to import through the passenger traffic.

2079 **Assessment of probability of entry and uncertainty for relevant entry pathways**

Pathway		Probability of the pest being associated with the pathway at origin		Probability of survival during transport or storage		Probability of pest surviving existing pest management procedure against other pests		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	**Commercial trade**	Moderately likely	High	Very likely	Low	Very likely	Low	Very likely	High
	Passengers	Moderately likely	High	Very likely	Low	Very likely	Low	Very likely	High
Leaves and branches	**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, due to the lack of records of transfer of bacteria from fruit to plants as well as on the limited topical literature available; • the association with the pathway at origin is likely, due to the high volume of citrus fruit imported within the EU, especially from countries where citrus canker is present and the 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 pest surviving existing pest management procedure is very likely, since no measure is currently established within the RA area.
Likely for plants for planting for citrus production	The probability of entry is rated likely for plants for planting for citrus production because: • citrus and rutaceous ornamental species are extensively grown in the 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 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 lack of awareness of gardening amateur susceptible to import plant and planting material though passenger traffic.
Moderately likely for plants for planting for ornamental Citrus and other rutaceous	The probability of entry is rated moderately likely for plants for planting for ornamental Citrus and other rutaceous because: • of lack of recent information on the rutaceous ornamental host plants susceptibility and a real difficulty in evaluating the level of trade under a non regulated pathway; • citrus and rutaceous ornamental species are extensively grown in the 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 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 lack of awareness of gardening amateur susceptible to import plant and planting material though passenger traffic.

Unlikely for leaves and branches	The probability of entry is rated unlikely for leaves and branches because: • the association with the pathway at origin is likely because leaves and cut branches 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 procedure 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 as it is for infected fruit.

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 is not clearly stated. The two published papers on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of much more experimental data;
- partial data on effective presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country at 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 fruits 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 fruits 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 fruits;
- the extent of importation of citrus material via passenger traffic is not well documented;
- the susceptibility of *Murraya* and other ornamental rutaceous species to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the possibility of latent infection and/or endophytic and/or epiphytic presence of *X. citri* pv. *citri* in *Murraya* plants.

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 to 494 913 ha in 2007 and located in 8 countries (see Table 10): 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 10: The citrus production area (in hectares) in the EU in 2007. Data extracted from EUROSTAT (on line) on 21/02/2013

Country /region	Orange varieties	Lemon varieties	Small-fruited citrus varieties	All citrus varieties (*)
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
Corse	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, Kriti	883	308	213	1 405
Kriti	3 410	277	356	4 044
Other Greek regions	266	885	2 598	3 750
Malta[a]				193
Italy	73 785	16 633	21 997	112 417
Piemonte	0	0	0	0
Liguria	7	17	3	28
Toscana (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
Sicilia	43 731	14 338	3 106	61 176
Sardegna	3 387	86	1 138	4 612
Portugal	12 416	494	3 235	16 145
Norte	734	52	133	920
Centro (PT) (NUTS95)	401	27	54	482
Lisboa e Vale do Tejo (NUTS95)	256	196	37	490
Alentejo (NUTS95)	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
Illes 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
Canarias (ES)	538	104	0	643

(*) = calculated by summing the area for all orange, lemon and small fruited citrus varieties.

[a] Data for citrus production area for Malta are provided according FAOSTAT (on line) for the year 2011.The detailed production structure is as follow: tangerins, mandarins, clementines (6 ha); grapefruit including pomelo (1 ha); lemons and limes (38 ha); oranges (95 ha); citrus fruit others (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)).

1. Greece: 825,813 plants in 2006 and 542,300 in 2007 (estimation, Holeva 2013, personal communication),
2. France: 818,568 plants in 2005 (estimation, Hostachy 2013, personal communication),
3. Portugal: 844,000 plants (estimated according to Aubert and Vullin (1997),
4. Spain: 10,665,000 plants (estimated according to Aubert and Vullin (1997),
5. 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 *Poncirus 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 (July) and early autumn (September), respectively. 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 the Mediterranean conditions (Colombo, 2004) but lemons or limes can produce up to four blooms. In addition, harvest periods vary according to citrus species and cultivars. For instance, 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 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 - *Citrus aurantium*) are commonly present along the streets and in the parks of Mediterranean MS 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 27: *Microcitrus* and *Zanthoxylum* are present in Italy (Recupero et al., 2001, Ducci and Malentacchi, 1993). 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. Other rutaceous genera are present in the RA area but their host status is presently unknown.

No alternate host is required to complete the citrus canker disease cycle (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 is widely distributed around the Mediterranean Basin since the 1990’s (Argov and Rössler, 1996, EPPO PQR database – EPPO online).

3.3.2. Suitability of environment

Originating from Asia where tropical conditions are prevalent, *X. citri* pv. *citri* has been widely disseminated over the XXth century and was able to establish in subtropical conditions (e.g. South Africa, New Zealand). 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 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 at the freezer. Infection may occur at temperatures more than 5°C and remains latent until temperature increases (Peltier, 1920).

Some severe weather events exist in the RA area. It can be large hailstorms (i.e. hailstones observed having a diameter (in the longest direction) of 2.0 centimetres or more, or smaller hailstones that form a layer of 2.0 centimetres thickness 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 1 hour, 60 mm in 6 hours, 90 mm in 12 hours, 150 mm in 24 hours) are 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 11 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 11: Number of severe weather events occurring over land in countries where citrus is grown (from 01-01-2000 to 30-04-2013 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*	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**

*Restricted to Corsica and Côte d’Azur.

In addition to irrigation applied during the dry periods of the year, in the citrus-producing MSs citrus groves and nurseries are located in coastal areas, next to rivers, (Agustí, 2000) in these areas the relative humidity is higher than 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 plantation depends on climatic conditions and different citrus types. Currently, density plantation can vary from about 333 to 420 trees/ha for sweet oranges and clementines in the Mediterranean Basin corresponding to 7 x 4 m or 6 x 4 m spacings for instance (Tucker and Wheaton, 1978). High density citrus plantation, aimed at improving the effectiveness and profitability of the system and facing land use and disease management issues, yields planting up to 1000 trees/ha and is experienced in different regions of the RA 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 a good vigour of trees 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* (Goto, 1992; Kuo et al., 1994; Unnamalai and Gnanamanickam, 1984) but there is no evidence of an efficient control under natural conditions.

Few management practices are currently undertaken in the RA 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; Vicent et al., 2009; Migheli et al., 2009). When applied, these copper programs may reduce but not prevent the establishment of citrus canker. But repetitive applications of copper products generate accumulation of copper in soils and water, and consequently pollution and toxicity problems. Copper-based products reduction is then desired. Furthermore in alkaline soils with high calcium content as in the coastal areas of Spain, the effects of copper toxicity are increased (Rooney et al., 2006).

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 the EU citrus orchards. In this sense it should be noted that the irrigation management and the system employed might influence the Citrus Canker disease incidence, by affecting the release and dispersal of bacteria, the local canopy micro-environment, and the leaf decomposition at the ground level (Dewdeney et al. 2011). Overhead irrigation is still applied at least in some parts of the EU where it is used for frost protection and irrigation. This way of dispersal can be of great concern in unprotected nurseries producing young trees to be introduced to new groves.

- Different types of irrigation systems

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

<u>Surface irrigation</u>

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 with a frequency of 13-25 days. In this case, most of the fallen citrus leaves will be mostly wetted and will increase citrus leaves decay.

Sprinkler irrigation

In these systems water is supplied in a pressurized network and emitted from sprinkler heads mounted on either fixed or moving supports. In the 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 applications are applied over the tree canopy, so the irrigation water completely wets tree canopy, similarly to a rainfall event. Irrigation water applications are generally applied with 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 relaease and dispersal of the bacteria.

Micro irrigation

It includes the method more commonly known as drip or trickle irrigation and other low pressure system. In the 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 orchard where part of the bottom part of the canopy is also directly wetted by the irrigation system.

- Regional differences in citrus irrigation

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

Spain

The Spanish citrus irrigation 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 the Valencia citrus orchard plantations, where they are employed to also provide for some frost protection. However, this sprinkler system is not overhead and only wets 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) which uses low pressure sprayers that often wet most part of the orchard floor (Liberati, 2008). Irrigation is applied in turns of 8 to 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 citrus irrigated 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 citrus irrigated area with overhead sprinkler systems in these two regions are of 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 orchard 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 trees canopies. During winter months, sprayers are used for the protection of citrus trees from frost in an area of 2.000-3.000 ha.

<u>Cyprus</u>

In Cyprus, traditionally farmers have used the flooding method to irrigated citrus orchards. However, after new pilot projects modernization took place, 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).

<u>Malta</u>

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 the irrigated Maltese agriculture. Drip irrigation use has steadily increasing in the last 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 other systems apart from 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 programs (Spain, France, Italy …) (Navarro et al., 2002). Such programs prevent the establishment of citrus canker through certified nurseries. However, in some EU regions, such programs are not fully operational.

As citrus are perennial host, no crop rotation is undertaken which destroy the crop annually. However, pruning of the trees may reduce the presence of disease inoculum but will also create wounds of the tissues that are susceptible. Pruning regularity will depend on citrus species and different sorts of pruning will be done prior to bloom: for shaping the trees after plantation, for opening the tree and removal of the sprouts… Rootstock suckers elimination can be also practice at other periods.

Fertilizers are applied which favor longer flush period and their intensity. This will generate greater volume of young susceptible tissues.

Time of harvest can favour establisment. Even though many citrus species are harvested from automn to early spring, some species like grapefruit, lemon or late sweet oranges can be harvested during spring or summer when temperature is more suitable to infection.

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

Xanthomonads are bacteria that reproduce asexually (i.e. organisms that have a strong potential to exponentially multiply 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 many times its life cycle during the host-growing period conducing 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 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 citrus host (non-citrus host, soil, inert surfaces) is most likely very limited although recent data warrants 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). 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 in 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 non-treated orchards in Jeju island (South Korea) where it is registered to control citrus canker (Hyun et al., 2012). Streptomycin resistance could 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 RA area. New hosts encountered by the pathogen in the RA 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 will not face any host adaptation barriers that would constraint its establishment.

One citrus canker lesion can host approximately between 10^6 to about 10^7 bacteria whatever the lesion size but can show a significant decrease when exposed to a marked winter season (Koizumi, 1977; Pruvost and Gagnevin, 2002; Stall et al., 1980). Release of *X. citri* pv. *citri* populations ranges from 10^4 to 10^6 bacteria/ml (Pruvost and Gagnevin 2002; Timmer et al., 1991). 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 entered the leaf tissues, a single bacterial cell is theoretically able to induce a lesion (Gottwald and Graham, 1992). Thus, in suitable conditions, one lesion would be sufficient for establishment.

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 were suggested and supports their role in colonization and adherence of *X. citri* pv. *citri* prior to development of canker disease (Cubero et al., 2011;Rigano et al., 2007). Moreover, a reversible viable but not culturable (VBNC) state has been suggested for *X. citri* pv. *citri* in response to copper ions (Del Campo et al., 2009; Golmohammadi et al., 2012).

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 the risk assessment area and environmental conditions are frequently suitable. The host is susceptible along 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) 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 would partially act as a barrier to establishment. Once the pathogen would enter in the risk assessment area, no host jump requiring pathological adaptation would be needed for establishment, as it would likely encounter susceptible host species.

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…; • environmental conditions are frequently suitable; • the host is susceptible along 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; • once the pathogen would enter in the risk assessment area, no host jump requiring pathological adaptation would be needed, as it would likely encounter susceptible host species.

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 PRA area is well documented. However, pieces of information are missing on the type of irrigation systems employed across the EU orchards and the plant host susceptibility under environmental conditions that occur in citrus groves in certain location of the PRA 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 as occurring 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* have 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) that allows an efficient spread over relatively short distances in nurseries and orchards (Gottwald et al., 1989; Graham et al., 2004; Pruvost et al., 1999). Citrus trees are grown in monoculture with susceptible species most of the time, and citrus groves are often established using rather high plantation densities (e.g. 400-500 trees/ha). Cultivation practices that enable a good vigour of trees are applied in intensive groves in Europe which is favorable to spreading of citrus bacterial canker. Overhead irrigation is in practice in groves and nurseries and favours symptom development and dispersal of inoculum (Gottwald et al., 2002a). Wind-driven rains readily spread bacteria over short distances, i.e. within trees and to neighboring trees when the wind speed exceeds 8m/s as soon as rainfall occurs (Serizawa et al., 1969; Serizawa and Inoue, 1975). These climatic conditions are not rare in the sites of citrus production (Figure 7 and Appendix G). Furthermore, the flushing period of leaf growth of the most cultivated varieties occurred when climatic conditions favorable for dispersal occur (spring and autumn).

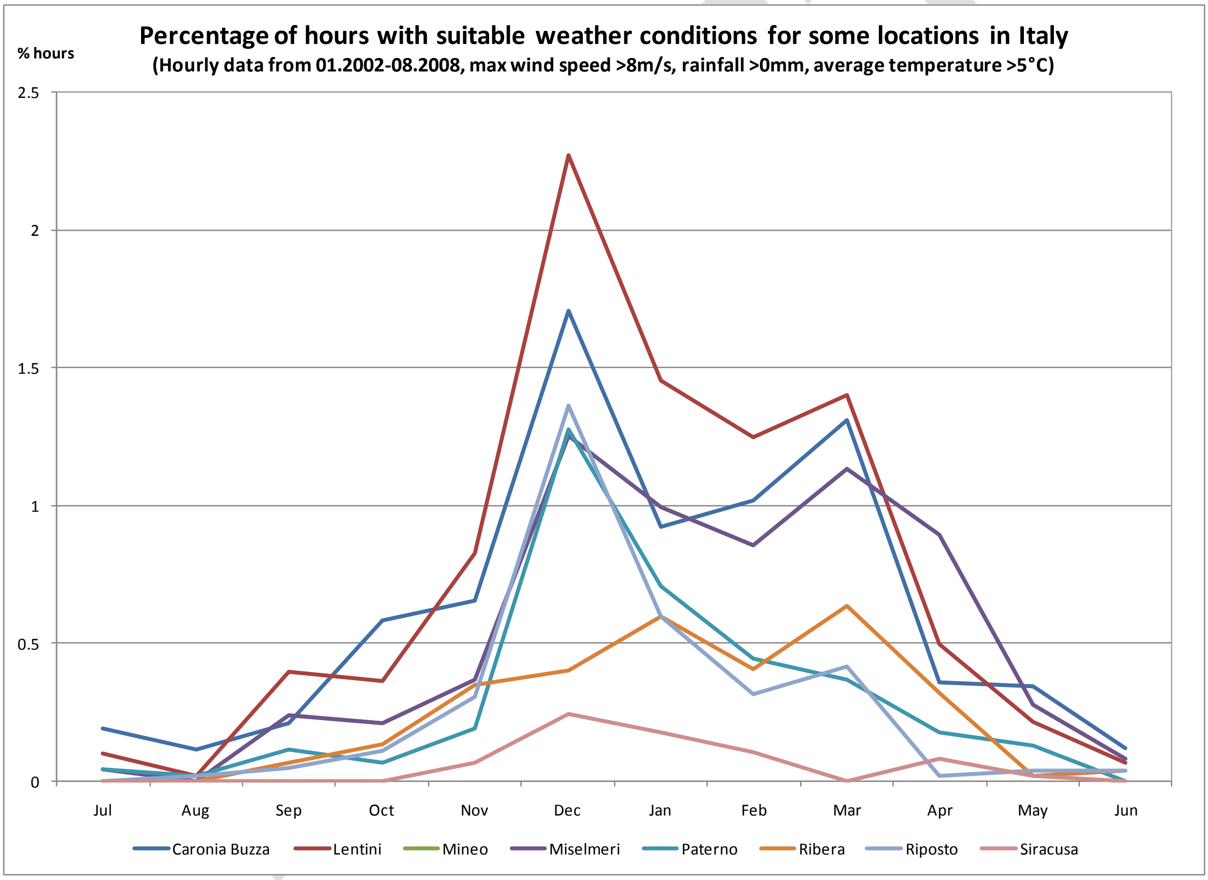


Figure 7: Monthly percentage of hours with suitable weather conditions (wind speed > 8 m/s, rainfall > 0 mm, average temperature > 5°C) in some locations in citrus growing area in Italy (Average from 01.2002 to 08.2008)

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* at a very localized 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 meters 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 (Gottwald and Graham, 1992; Gottwald et al, 2001; Stall et al., 1980). A distance of spread of up to 56 kms 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 > 10-15 ms^{-1} (Bock et al., 2010). This was associated with visible leaf injury evident when wind speed ≥ 13 ms^{-1} 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 rains with wind speeds ≥ 25 $m\ s^{-1}$) occur on a regular basis, although not frequently, in the RA area (n = 88 - Figure 8). Similarly, tornadoes (n = 389 from January 1st, 2000 until April 30th, 2013) have been recorded in the RA area (Table 11).

It is likely that such severe weather conditions occurring in the RA area could favor the dispersal between orchards.

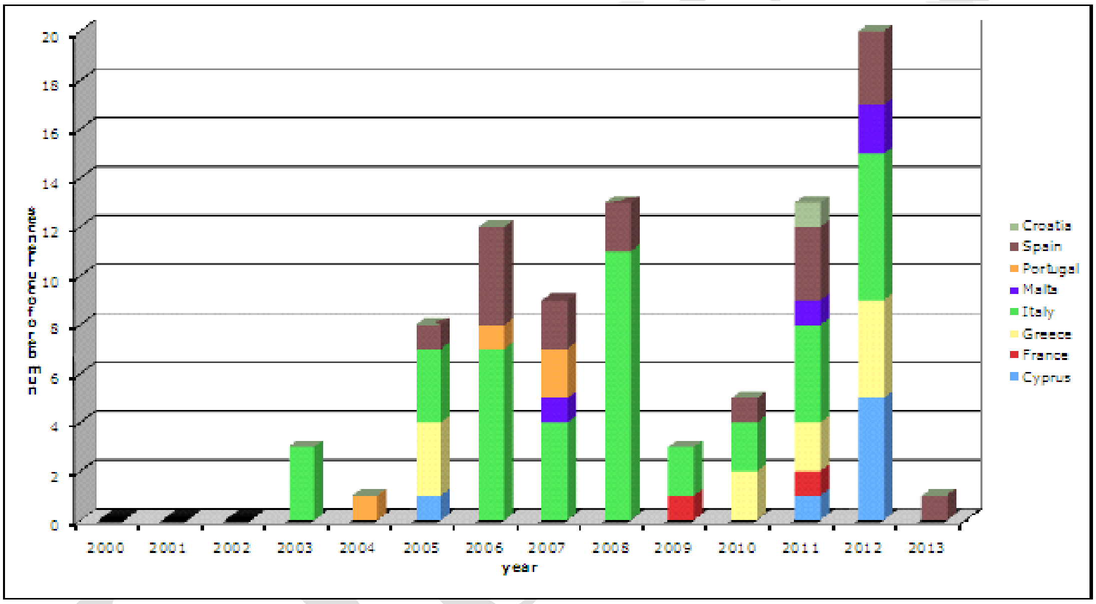


Figure 8: Number of occurrences of wind-driven rains with a recorded wind speed ≥ 25 $m\ s^{-1}$ occurring over land in areas where citrus is grown (from 01-01-2000 to 30-04-2013 as provided by the European Severe Weather Database (European Severe Weather Database, online). Occurrences for France are restricted to Corsica and Côte d'Azur.

3.4.2. Spread by human assistance

X. citri pv. *citri* or *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 including boxes (Gottwald et al., 1992; Gottwald et al., 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 propagative material during trade. Uncontrolled movement of contaminated or exposed plant propagative material is at high risk and would likely result in a fast spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the RA area.

Trade of fruit represents a high volume of commodities that circulate within the RA area (see Appendix D). Fruit are imported in citrus producing areas (see Appendix D). Contaminated fruit would represent a low risk of contamination for surrounding groves.

3.4.3. Containment of the pest within the risk assessment area

It is doubtful that citrus canker could be contained in areas where it is present based on the biological characteristics of the pest, and on the suitable environmental conditions that occur for disease development in risk assessment area. Human-driven unintentional spread could happen due to the massive presence of citrus trees in streets, private and public gardens. *X. citri* pv. *citri* is listed as ‘dual use technology and organism’ (Council Regulation EC 394/2006[14]) 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 RA area.

3.4.4. Conclusion on the probability of spread

Once established, 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 summer storms, which can be quite frequent 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.

Rating of probability of spread

Rating for spread	**Justification**
Likely	The probability of spread is rated as likely because: • wind driven rains that are requested for short scale dispersion frequently occur during period when citrus are the most susceptible to infection; • summer storms happen in citrus growing area 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 make a continuous network in the citrus growing area 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.

[14] 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.

3.4.5. Uncertainties on the probability of spread

Uncertainty on the probability of spread is rated as low. Citrus canker has been reported to spread in countries where climatic conditions are similar to those occurring in the pest risk area (China, Japan, and Argentina). Practices and citrus varieties used in the RA area are similar to those used in countries where the disease occurs.

3.5. Conclusion regarding endangered areas

Citrus are widely available as commercial crops in Southern Europe located in 8 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), and Malta (193 ha). Citrus nursery dedicated to fruit production and ornamentals are located in the same area 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, 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 area in 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 12. So, the all citrus growing area in the EU can be considered as the endangered area. Spain with more 300.000 ha of citrus is the first exporter of fresh citrus fruits of high quality in the world (see Table 12).

Where citrus canker occurs, the quantity and quality of the fruit production is impaired due to defoliation, the premature fruit drop, dieback and blemish on fruit and general tree decline. Although the internal quality of the fruit infected maturing on the tree is not affected, the blemished fruits are not marketable for fresh consumption. Based on scientific evidence, fruit drop is the primary factor in anticipated yield losses (Graham and Gottwald, 1991; Koizumi, 1985). Under conditions highly conducive to disease development, it is not uncommon that approximately 50% of the fruits and leaves of susceptible cultivars be infected. Early fruit drop as high as 50% was reported for sweet orange cv. Hamlin (Stall and Seymour, 1983). Furthermore, the level of susceptibility by cultivar translates into greater yield losses for some citrus cultivars over others (Gottwald el al., 1993; Graham et al., 1992). 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 (Biosecurity Australia, 2003, CABI, 2013).

Table 12: 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 Rep.	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 Rep.	106 492
Viet Nam	105 048

3.6.2. Control of citrus bacterial canker

Citrus bacterial canker 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 RA area, 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, suggest that the pathogen would be controlled in the RA area with difficulty even with the use of phytosanitary measures.

In practice, the most commonly used control measures involve Integrated pest Management System 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 efficient 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 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 the RA area are favourable to *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* but not as much as tropical environments and therefore eradication would likely be a valuable option, although its success would be very much dependent on task force and money involved for actions and how prompt and strict the latter are. In addition, since the pathogen has hosts out of groves (*Microcitrus*, *Zanthoxylum*, *Murraya*, ...) eradication programs 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 RA area.

Chemical control of citrus bacterial canker involves preventives sprays of copper based chemicals (Mc Guire, 1988) with the aim of reducing inoculums build up on new flushes and of protecting aerial plant part and particularly expending 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 additional control measures applied (Leite and Mohan, 1990; Stapleton and Medina, 1984; Stall et al., 1981). Bacterial copper resistance or tolerance has been reported in Argentina and Brasil respectively (Behlau et al., 2011a and b; Canteros et al., 2010). Although not likely, the development of plasmid borne copper resistance in *X. citri* pv. *citri* suggests that other pathogenic bacteria may also develop copper resistance by plasmid transfer from copper resistant selected strains and thus, integrated systems for control of other pests may be disrupted as well. These plasmid transfers occur on plant surface and in plant tissue within *Xanthomonas* and the plant associated microflora (Manceau et al., 1986). Besides, since many applications of copper conpounds are usually needed in control program, accumulation of copper in the soil may occur, contributing in the environment pollution.

3.6.3. Environmental consequences

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 a) ‘organisms providing Provisionary services’ affecting genetic resources and food provisions, and b) ‘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 RA 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 harboring 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 system (Brunings and Gabriel, 2003). In addition, copper resistance genes have been identified on the *X. citri* pv. *citri* plasmids (Canteros et al., 2010). In case these plasmids are mobilized 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 that are not usually regarded as ecologically sensitive. Commercial citrus are not rare, vulnerable or keystone species. However, several citrus-producing areas in the EU27 (e.g. Spain, Corsica) are the home of major resources of citrus germplasm that supply pest-free propagative material worldwide.

As the most appropriate and likely control strategy would be based on eradication (removal of diseased and exposed trees, quarantine areas…) destruction of orchards would be unavoidable, in case 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, nor 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 RA 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 RA area. The disease would cause losses of yield and costly control measures. It would have negative social incidence in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies should close part of their market places. The occurrence of the disease would lead to increase chemical application in groves and to use copper coumpounds that should create environmental concerns such as copper accumulation in soil, selection of resistance gene 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 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 the RA area are favourable to X. citri pv. citri or X. citri pv. aurantifolii but not as much as tropical environments and therefore eradication would likely be a valuable option, although its success would be very much dependent on task force and money involved for actions and how prompt and strict the latter are; • copper usage should create environmental concerns such as copper accumulation in soil, selection of resistance gene that could spread in the plant-associated microflora and beyond; • Citrus breeders are located in the RA area (Spain, Corsica, …) and produce citrus germplasm that supply pest-free propagative materials worldwide. The presence of citrus canker in their vicinity should close part of their market places; • crop production standards are reduced.

3.6.5. Uncertainties on the assessment of consequences

Once citrus bacterial canker would enter the RA area, uncertainties on the assessment of consequences would rated as medium because, even though eradication would likely be a valuable option, it uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions prevailing the RA area that are favourable to citrus bacterial canker.

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 still apply measures voluntarily or as required by non EU importing countries, the conclusions of the pest risk assessment are as follows:

<u>Entry</u>

Under a scenario of absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* official EU regulation, the probability of entry has been rated as unlikely for the fruit pathways and as likely for the plants for planting pathways.

For fruits, the probability of entry is rated unlikely because:

- the association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruits imported within the EU from countries where citrus canker is reported, with documented reports of interceptions. 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 to 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 no specific measure is currently in place in the RA area;
- the probability of transfer to a suitable host is rated unlikely, based on the litterature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur because of presence of waste near to orchards and sometime short distance between tree canopy and soil in the RA area and because of occurrence of climatic conditions suitable for the transfer.

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

- the association with the pathway at origin is likely because leaves and cut branches 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 procedure 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 as it is for infected fruit.

For plants for planting, through both the commercial trade and passengers pathways, the probability is rated as likely for plants for planting for citrus production and moderately likely for plants for planting for ornamental Citrus and other rutaceous, 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, due to the fact that 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 ornamental Citrus and other rutaceous, through both the commercial trade and passengers pathways, due to the lack of recent information on the rutaceous ornamental host plants susceptibility and a real difficulty in evaluating the level of trade under a non regulated pathway;
- as for the fruit pathways, the ability to survive during transport is very likely;
- the probability of the pest to survive any existing management procedure is very likely since no specific measure is currently in place in the RA area. Such probability would even be 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 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 RA area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of gardening amateur likely to import through the 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 is not clearly stated. The two published papers on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of much more experimental data;
- partial data on effective presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country at 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 fruits 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 fruits 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 fruits;
- the extent of importation of citrus material via passenger traffic is not well documented;
- the susceptibility of *Murraya* and other ornamental rutaceous species to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the possibility of latent infection and/or endophytic and/or epiphytic presence of *X. citri* pv. *citri* in *Murraya* plants.

<u>Establishment</u>

The probability of establishment is rated as moderately likely to likely because host plants are widely present in the risk assessment area and environmental conditions are frequently suitable. The host is susceptible along 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) 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 would partially act as a barrier to establishment. Once the pathogen would enter in the risk assessment area, no host jump requiring pathological adaptation would be needed for establishment, as it would likely encounter susceptible host species.

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

Spread

Once established, 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 summer storms, which can be quite frequent 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 been reported to spread in countries where climatic conditions are similar to those occurring in the pest risk area (China, Japan, and Argentina). Practices and citrus varieties used in the RA area are similar to those used in countries where the disease occurs.

Endangered areas

Citrus are widely available as commercial crops in Southern Europe located in 8 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), and Malta (193 ha). Citrus nursery dedicated to fruit production and ornamentals are located in the same area 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, 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 area in 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 RA area. The disease would cause losses of yield and costly control measures. It would have negative social incidence in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies should close part of their market places. The occurrence of the disease would lead to increase chemical application in groves and to use copper coumpounds that should create environmental concerns such as copper accumulation in soil, selection of resistance gene that could spread in the plant associated microflora and beyond.

Once citrus bacterial canker would enter the RA area, uncertainties on the assessment of consequences would rated as medium because, even though eradication would likely be a valuable option, it uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions prevailing the RA area that are favourable to citrus bacterial canker.

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 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 risk reduction option is evaluated as a stand-alone measure, assuming that no other risk reduction options are in effect neither for that pathway, nor for the other pathways. Systems approaches integrating two or more risk reduction options 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 risk reduction option 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 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 1 (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 medium uncertainty (Overview in section 3.2). This rating is based on the assumption that phytosanitary requirements by the EU are absent, but recognizing that 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 voluntarily or in response to requirements by non-EU countries. Risk reduction options may be considered for this pathway by the EU in order to reach the acceptable level of risk of entry and the acceptable level of uncertainty. The effectiveness of these risk reduction options is assessed relative to the ‘unlikely’ probability of entry in the absence of measures.

<u>A. Options for consignments</u>

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 effectiveneness 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 (potentially carrying *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*, such as leaves and peduncles) than fruit in the the consignment can be prohibited. This RRO is implemented in the EU for the import of fruits 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).

Effectiveness:

The effectiveness for the pathway of citrus fruit commercial trade is high. 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.

Technical feasibility:

The technical feasibility is very high, since it is already implemented.

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 risk reduction option 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 inspection, sampling and laboratory testing. Inspection and sampling of the consignment should be performed according to guidelines in the IPPC Standards ISPM No 23 and No 31 (FAO, 2005), 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 or 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 phytosanitary measures 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 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 latent infections or mildly infected fruits escaping detection in the sample. Such fruits would be detected by laboratory testing, but only the PCR-based screening test with specific primers is considered an effective method for rapid analysis of suspected samples. The effectiveness of other methods is low. Immunofluorescence is not currently recommended for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* and no commercial antibodies have been evaluated for this method. Monoclonal antibodies are available for ELISA, but are mostly advised for identification of pure cultures, due to low sensitivity (EPPO 2005). Furthermore, some strains designated as pathotype A* did not react with monoclonal antibodies specific for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* (Vernière et al., 1998; Alvarez et al., 1991).

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 assessed as moderate and of laboratory testing as high, if PCR-based screening techniques are applied.

Technical feasibility:

The technical feasibility is assessed as high.

Uncertainty:

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

4.1.1.5. Pre- or post-entry quarantine system.

Pre- or post-entry quarantine systems are not applicable to citrus fruit commercial trade, due to the size of the consignments.

4.1.1.6. Preparation of the consignment

Preparation of the consignment includes several stages, 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 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 disinfection 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 packing house operations and tracking and tracing of consignments to the production site and to information on the pest management program. General hygienic measures and sanitation of equipment, the use of new or disinfected packaging material and implementation of waste management procedures preventing the release of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* to the environment (Guidelines for handling of such biowaste are given in EPPO Standard PM 3/66(2) are basic requirements for all packinghouses.

Fruit originating from official pest free areas and official pest free places of production should be packed at dedicated packing stations, where handling of fruit from other places of production is not allowed.

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

During harvesting, packing and shipping of fruits mechanical injuries should be avoided, since these affects the overall fruit quality. 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 slightly decrease over time (Stall et al., 1980; Pruvost et al., 2002; Bui Thi Ngoc et al., 2010).

Effectiveness:

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 standardization 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 these measures even when implemented as official import requirement.

Technical feasibility:

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

Uncertainty:

The uncertainty on these ratings is medium, because of unknown variability in the fraction of infected fruit passing the measures.

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 can 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. Commonly recommended treatments are washing with solutions of (1) chlorine (2 minutes at 200 ppm sodium hypochlorite, pH 6.0-7.5), (2) sodium orthophenylphenate (SOPP) (45 seconds to 1 minute, depending on detergent concentration, SOPP at 1.86-2.0%) or (3) peroxyacetic acid (PAA) (1 minute at 85 ppm of peroxyacetic acid) Code of Federal Regulations, 2008a, Biosecurity Australia, 2009; Council Directive 2000/29/EC). 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. They also 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.

Effectiveness:

The regulation of such measures would result in a standardization for all imported fruit and thereby further reduce the probability of entry. The effectiveness of this RRO is assessed as moderate, because they cannot eliminate *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* on asymptomatic infected fruit and fruit with small lesions (Gottwald et al, 2009; EFSA, 2011).

Technical feasibility: very high

Uncertainty: low

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

It is not possible to identify periods of the year when citrus fruit is 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 fruit is not applicable.

Theoretically, restricting the end use of citrus fruit imported in the EU from areas where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* occurs to fruit processing facilities that employ strict containment and waste processing measures (according to the guidelines for handling of such biowaste in EPPO Standard PM 3/66(2)), might reduce the probability of transfer to a suitable host. However, large citrus processing plants are located in vulnerable citrus producing areas of the EU and high safety standards would have to be set for these facilities. Moreover, a large fraction of citrus fruit imported in the EU is destined for direct consumption via various markets ranging from supermarkets to small outdoor markets, where standards for waste management cannot be controlled other than by creating consumer's awareness about phytosanitary risk. A general restriction on end use of citrus fruit is therefore not effective, nor technically feasible.

A restriction on the distribution of citrus fruit imported in the EU from areas where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* occurs to areas in the EU without citrus production or where climate conditions are unsuitable for the development of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* populations, might reduce the probability of transfer to a suitable host. However, the free internal market of the EU allows for a large volume of citrus fruit being traded between EU Member States. 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 ktons of sweet orange and 170 ktons of grapefruit from various countries (including Florida, Argentina, Brazil and Uruguay) and re-exported almost 200 ktons of sweet orange and 115 ktons of grapefruit to other EU countries, including citrus producing countries (Eurostat, 2008). Because of this free market it is not feasible to implement differentiated import requirements for Member States without citrus production compared to citrus producing Member States.

Effectiveness:

The effectiveness of these measures is low.

Technical feasibility:

The technical feasibility is low.

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 J.H. 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).

<u>Chemical control</u>

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. (Leite and Mohan, 1990; Stapleton and Medina, 1984; Stall et al., 1981; Stein et al., 2007; Behlau et al., 2008; Behlau et al., 2010). However, copper resistance of *X. citri* pv. *citri* has been reported at least in Argentina (Rinaldi and Leite, 2000; Canteros et al., 2008). Copper resistance genes have been identified on the *X. citri* pv. *citri* plasmids (Canteros et al., 2010).

Copper bactericides 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 use plant extracts (Samavi et al., 2009; Khuntong and Sudprasert, 2008) as alternatives to copper bactericides, but further investigation is needed before applied in the field. Similarly, induced systemic resistance (ISR) compounds were evaluated but found ineffective (Graham and Leite, 2004).

<u>Planting of windbreaks</u>

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).

<u>Control of leafminers</u>

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.

<u>Other control measures</u>

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 disease 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 pathogen.
- Drip or mist irrigation has been suggested as alternative to overhead irrigation in order to minimize the spread of the pathogen in citrus nurseries (Pruvost et al., 1999).
- Collection and secure 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 US (Garcia, 2000; 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 ‘medium’.

4.1.1.10. 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).

Grapefruit (*Citrus 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).

Effectiveness:

There are no commercially important citrus varieties with a high level of resistance to *X. citri* pv. *citri*. Therefore the effectiveness of growing resistant or less susceptible varieties to reduce the incidence of infested harvested fruit is assessed as ‘low’.

Technical feasibility:.

The technical feasibility of growing resistant or less susceptible varieties is assessed as ‘high’.

Uncertainty:

The uncertainty on these ratings is ‘low’.

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

Not applicable to citrus fruit production on large areas.

4.1.1.12. 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.

4.1.1.13. 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 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 very 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

4.1.1.14. 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: EFSA, 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 designated packing houses, where no fruit from infested areas is handled, in order to prevent contamination with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* at that stage.

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 serological assays, pathogenicity tests, classical microbiological and molecular-based methods using fast, reliable and sensitive protocols and portable detection machinery in the field (OEPP/EPPO, 1990; Coletta-Filho et al., 2006; Mavrodieva et al., 2004; Davis et al., 2000; Jaciani et al., 2009; Derso 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., 2009a, 2009b, 2008). Besides, methods based on the spectral reflectance characteristics of citrus canker have been reported to aid detection of the disease on fruits and plants (Balasundaram et al., 2009; Lins et al., 2009; Borengasser et al., 2002). 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 programs (Graham et al., 1992).

Spatiotemporal analysis methods were applied to estimate the effectiveness of removing citrus canker affected trees at different distances from the source of inoculum (Danos et al., 1984; Gottwald et al., 2002a; Gottwald et al., 1988; Gottwald et al., 1992). Such models may assist the designation of buffer zones for pest free areas.

Predictive models to estimate spread of the disease from areas where *X. citri* pv. *citri* has established in relation with 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 12-by-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 programs are described in ISPM No 9 (FAO, 1998). Eradication programs have been extensively reviewed (Zalom et al., 1999; Gottwald et al. 2001; Schubert et al., 2001, Graham et al., 2004) Such programs rely on:

- destruction of the infected/infested material,
- determination of the possibly exposed to the pathogen area 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, cloths),
- suppression of any re-growth 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 programs may be optimized based on the topographical arrangement of the host landscape.

Effectiveness:

When the import of plants for planting of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* host species is restricted to material originating in pest free areas, the probability of introduction of these two pathogens 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 3.1.1.2). This option would require 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 intensity of monitoring

Technical feasibility: is high

Uncertainty:. Is high, due 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 combinations are proposed:

For fruit originating from pest free areas or pest free production places, harvest and transport to packing stations should be done using new or disinfected boxes, tools and machinery, applying strict hygiene protocols, and packing should be in designated packing houses registered for packing of fruit from *X. citri* pv. *citr-i* or *X. citri* pv. *aurantifoli* -free areas and production places only, in order to prevent any contamination with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* after harvest.

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 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', but the effectiveness of the integrated approach combining these three measures is assessed as high. The technical feasibility is high, and the uncertainty is assessed as medium.

For citrus fruit imported in the EU from areas where *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* occurs, the end use could be restricted in combination with a restriction of its distribution within the EU. For example, citrus fruit might be imported in Member States without citrus production, only if this fruit is immediately processed in that Member State and the waste disposal is under a strict protocol to prevent spread of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. The effectiveness is assessed as high. However, the technical feasibility is assessed as low due to the managerial problems for maintaining separate control systems for different citrus fruit pathways. The uncertainty is low.

Table 13: Summary of the applicable risk reduction options identified and evaluated for pathway Citrus fruit commercial trade

Category of options	Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)	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	High	Very high	Low
	Visual inspection for pest freedom	Before shipment and/or at import	Yes	Moderate	High	Medium
	Testing for pest freedom	Before shipment and/or at import	No	High	High	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	Low	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	Medium
	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	Pest free areas and production places combined with dedicated packing stations	Before shipment	No	Very high	High	Medium
	Infested production places: measures in fields combined with handling procedures and treatments during packing	Before shipment	No	High	High	Medium
	Combined restriction on end use and distribution of imported citrus fruit	After import	No	High	Low	Low

4.1.2. Pathway 2 (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 recognize citrus fruit and leaves, the frequency of passenger checks would have to be high in order to effectuate 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, due 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, due 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 and thousands of passengers arriving daily in the EU, the frequency of passenger checks would have to be high in order to effectuate 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 14: Summary of applicable risk reduction options identified and evaluated for pathway Citrus fruit and leaves passenger traffic

Category of options	Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)	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 3 (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 high.

Technical feasibility:

The technical feasibility is very high, because it can be 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.

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 to include 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 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 very high, but for limited import frequency of small consignments only. The risk reduction option 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.

<u>B. Options preventing or reducing infestation in the crop at the place of origin</u>

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* reduce 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 screened nurseries, its main purpose being to exclude insects (e.g., Florida Department of Agriculture and Consumer Service, 2011; Gonçalves et al, 2011). Such structures would also isolate the plants from wind and rain and thus prevent them from infection of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in these plants.

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.

4.1.3.11. 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.

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>

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

For discussion on pest free areas see 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 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 citrus nurseries in pest free areas, including 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 is assessed as high, with very high technical feasibility and low uncertainty.

3400 **Table 15:** Summary of the applicable risk reduction options identified and evaluated for pathway Citrus plants for planting for citrus fruit production

Category of options	Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	Before shipment	Yes	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	Very high	Low

4.1.4. Pathway 4 (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 without background or training in recognizing Citrus plants for planting.

Uncertainty:

The uncertainty on these ratings is high, due 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 due 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, 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 without background or training in recognition of Citrus plants for planting nor in plant health inspections.

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 16: Summary of applicable risk reduction options identified and evaluated for pathway Citrus fruit passenger traffic

Category of options	Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)	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 5 (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 high.

Technical feasibility:

The technical feasibility is high, because it can be implemented in port 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 to include 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 high, because of lack of data on inspection and testing on these 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 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.

Treatments of nurseries, growing rutaceous ornamental plants for planting, against *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* reduce 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 does not apply 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 (4.1.3.10),

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 scheme.

When certification schemes similar as 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.

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

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

Same as section 4.1.3.13.

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 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, including 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 is assessed as high, with high technical feasibility and low uncertainty.

Table 17: Summary of applicable risk reduction options identified and evaluated for pathway Ornamental rutaceous plants for planting commercial trade

Category of options	Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)	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	High
	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 pest free production places, low 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 6 (Ornamental rutaceous plants for planting import by passenger traffic)

4.1.6.1. Prohibition

Effectiveness:

A prohibition of 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 on 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 without background or training in recognizing ornamental citrus and other rutaceous plants for planting.

Uncertainty:

The uncertainty on these ratings is high, due 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 carried by passengers, for symptoms of citrus canker is low, mainly due 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 negligble. 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, 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 without background or training in recognition of Citrus plants for planting nor in plant health inspections.

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

Category of options	**Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)**	**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 7 (Citrus and rutaceous leaves commercial trade)

A. Options for consignments

4.1.7.1. Prohibition

Effectiveness:

Prohibition of import of citrus and rutaceous leaves 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 can be send in non-declared 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 risk reduction option 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 and No 31 (FAO, 2005), 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 or 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 phytosanitary measures 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 and rutaceous leaves depends 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 latent infections or mildly infected leaves escaping detection in the sample. Such leaves would be detected by laboratory testing, but only the PCR-based screening test with specific primers is considered an effective method for rapid analysis of suspected samples. The effectiveness of other methods is low. Immunofluorescence is not currently recommended for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* and no commercial antibodies have been evaluated for this method. Monoclonal antibodies are available for ELISA, but are mostly advised for identification of pure cultures, due to low sensitivity (EPPO 2005). Furthermore, some strains designated as pathotype A* did not react with monoclonal antibodies specific for *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* (Vernière et al., 1998; Alvarez et al., 1991).

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 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 due 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 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 moderate.

Technical feasibility:

The technical feasibility is assessed as high.

Uncertainty:

The uncertainty on these ratings is medium.

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

Citrus and rutaceous leaves imported as dried leaves for consumption might be submitted to heat treatment at 85°C for 8 hours, as recommended by the IIGB, Australia (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 method is also not applicable for fresh leaves which are the most appreciated ones.

Technical feasibility:

The technical feasibility is assessed as high, with regards to the easiness 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 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 is not applicable. Because of the free internal market of the EU it is not possible to implement restrictions on distribution of citrus and rutaceous leaves within the EU.

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. The regulation of such measures would result in their standardization 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 harvest 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 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 ‘high’.

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 screenhouses.

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 scheme.

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 is discussed in section 4.1.1.14.

Effectiveness

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.

4.1.7.15. 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: is high.

Uncertainty: Is high, due 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 19: Summary of the applicable risk reduction options identified and evaluated for pathway Citrus and rutaceous leaves commercial trade

Category of options	Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
Options for consignments	Prohibition	Before shipment	No	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	Moderate	High	Medium
	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	Moderate	High	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	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	No	High	High	High

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

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 (Section 3.1.1.2 and Section 3.2.2.4). This event is more likely to occur in public areas (streets, parks, 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. Abandoned citrus groves also form a risk for establishment of early populations of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii.*

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 organize and maintain the required program for large area.

Uncertainty:

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

2) Surveillance

A surveillance program including regular detection surveys in public areas, abandoned citrus groves, in areas with host plants production and on production sites of 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 intensity of the surveys and the inclusion of visual inspection and laboratory testing. The effectiveness is assessed as high, the technical feasibility is moderate, due to the difficulty to organize surveys in public areas, and the uncertainty is medium.

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 programs have been extensively reviewed (Section 4.1.1.15). Complete eradication is often difficult to achieve (reference) and depends on 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 succesful (ref).

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

4) Systems approach

Combine hygienic measures and plant cultivation in public areas, early detection procedures both in production places and in public areas (appropriate surveys), programmes for eradication and containment, specific for different regions within EU.

Effectiveness is high, technical feasibility is moderate and uncertainty is high.

3848 **Table 20:** Summary of the risk reduction options to reduce the probability of establishment and spread

Category of options	Type of measure (for details, see EFSA Panel on Plant Health (PLH), 2012a)	Position in the pathway	Existing measure	Effectiveness	Technical feasibility	Uncertainty
	Cultivation and hygienic measures	After entry	No	Moderate	Low	High
	Surveillance	After entry	No	High	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	High	Moderate	High

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

The current phytosanitary measures of the EU against introduction into and spread within the EU are presented in section 3.1.3.

The combined regulations for all pathways have shown to be highly effective 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.

Concerning entry pathway 1 (citrus fruit commercial trade)
Relative to the total volume of imported citrus fruit, very few consignments of citrus fruit have been 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 control of implementing the special requirements of the EU. Several suggestions to improve the regulations have been identified.

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 probability of entry, it is recommended that all packinghouses in third countries handling citrus fruit to be imported in EU member states are registered. 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. This would facilitate traceability of exported fruit.

Currently there are no special requirements for packinghouses handling citrus fruit originating in pest-free areas, allowing direct or indirect (via equipment or personnel) contact between this fruit and infected fruit or fruit originating from infested fields. In order to maintain the pest-free quality of fruit from pest-free area, the Panel recommends that fruit from pest-free areas is handled and packed 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. This fruit for the EU may satisfy all requirements of the Directive, but consignments may nevertheless have become contaminated with fruit infected with *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the packing station, even after the disinfection treatment. *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* may thus enter the EU despite the special requirements.

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. For example, this special requirement was interpreted by USDA-APHIS as a buffer zone being “the first 50 feet of the adjacent subblock on all sides”, or “a road, canal or wide middle” separating two blocks of citrus plants (USDA, 2009e). This distance (50 feet, or 15,24 m) is less than the distance of natural spread that is possible during a growing season (Section 3.4.1.). In addition, the Panel thinks that the ‘official control and examination regime’ should specify the required confidence and minimum detection levels and the frequency of inspections for this inspection regime.

Concerning entry pathway 2 (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 B need 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, Art. 5 paragraph 4; Art 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 3 (plants for planting for citrus fruit production, commercial trade)

During 2003-2012 no consignments containing plants for planting for citrus fruit production have been intercepted, indicating that the prohibition of this material by Annex III of Council Directive 2000/29/EC has been highly effective.

Concerning entry pathway 4 (plants for planting for citrus fruit production, 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 states the need to check passengers and their baggage for planting material.

Concerning entry pathway 5 (ornamental citrus and other rutaceous, 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 6 (ornamental citrus and other rutaceous, passenger traffic)

According to Council Directive 2000/29/EC, Article 13b point 3, small quantities of plants, plant products, foodstuffs or animal feedingstuffs, that are not listed in Annex III of the Directive, and 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 7 (citrus and rutaceous leaves, 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 large number of 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) than in citrus production places (Section 4.2). However, if *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* should become established in public areas it may spread to production places. The implementation of cultivation and hygienic measures aimed at preventing splash transfer of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* from discarded fruit and fruit waste to branches of host plants (Section 4.2) might support requirements for import of host plants for *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii*. In addition the Panel suggests the implementation of regular detection surveys in public areas for early detection of citrus canker outbreaks, allowing timely eradication if necessary.

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. The enormous investments for preventing outbreaks and for eradication in response to outbreaks of citrus canker made by various countries (Gottwald et al, 2002a; Gambley et al, 2009; Alam & Rolfe, 2006) indicate the high importance of 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. Once established, the 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 current set of EU regulations for all pathways have shown to be highly effective in preventing introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in the EU, because there have been no outbreaks of citrus canker in the EU territory.

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 methods under strict post-entry quarantine conditions. The potential of a systems approach combining production of plants for planting in nurseries in officially controlled pest free areas according to a certification scheme, including 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, might be further explored.

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 the the 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 on this pathway. The current measures to prevent entry of the EU are evaluated as effective, although exporting countries do not always comply. Additional options are suggested to further reduce the risk of entry.

The possible 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 by 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 high number of interceptions of citrus leaves imported via non-declared 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 still apply measures voluntarily or as required by non EU importing countries, the conclusions of the pest risk assessment are as follows:

<u>Entry</u>

Under a scenario of absence of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* official EU regulation, the probability of entry has been rated as unlikely for the fruit pathways and as likely for the plants for planting pathways.

For fruits, the probability of entry is rated unlikely because:

- the association with the pathway at origin is likely for commercial trade based on the high volume of citrus fruits imported within the EU from countries where citrus canker is reported, with documented reports of interceptions. 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 to 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 no specific measure is currently in place in the RA area;
- the probability of transfer to a suitable host is rated unlikely, based on the litterature currently available on effective fruit transfer to plants. The rating is not very unlikely as this transfer could occur because of presence of waste near to orchards and sometime short distance between tree canopy and soil in the RA area and because of occurrence of climatic conditions suitable for the transfer.

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

- the association with the pathway at origin is likely because leaves and cut branches 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 procedure 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 as it is for infected fruit.

For plants for planting, through both the commercial trade and passengers pathways, the probability is rated as likely for plants for planting for citrus production and moderately likely for plants for planting for ornamental Citrus and other rutaceous, 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, due to the fact that 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 ornamental Citrus and other rutaceous, through both the commercial trade and passengers pathways, due to the lack of recent information on the rutaceous ornamental host plants susceptibility and a real difficulty in evaluating the level of trade under a non regulated pathway;
- as for the fruit pathways, the ability to survive during transport is very likely;

- the probability of the pest to survive any existing management procedure is very likely since no specific measure is currently in place in the RA area. Such probability would even be 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 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 RA area, in commercial orchards as well as in private and public areas. Additionally, there is a lack of awareness of gardening amateur likely to import through the 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 is not clearly stated. The two published papers on this issue (Gottwald et al., 2009; Shiotani et al., 2009) are insufficient for fully addressing this question, which deserves the production of much more experimental data;
- partial data on effective presence of *X. citri* pv. *citri* or *X. citri* pv. *aurantifolii* in the country at 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 fruits 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 fruits 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 fruits;
- the extent of importation of citrus material via passenger traffic is not well documented;
- the susceptibility of *Murraya* and other ornamental rutaceous species to *X. citri* pv. *citri* reported worldwide and the associated symptomatology has not been fully assessed. No studies have investigated the possibility of latent infection and/or endophytic and/or epiphytic presence of *X. citri* pv. *citri* in *Murraya* plants.

<u>Establishment</u>

The probability of establishment is rated as moderately likely to likely because host plants are widely present in the risk assessment area and environmental conditions are frequently suitable. The host is susceptible along 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) 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 would partially act as a barrier to establishment. Once the pathogen would enter in the risk assessment area, no host jump requiring pathological adaptation would be needed for establishment, as it would likely encounter susceptible host species.

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

Spread

Once established, 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 summer storms, which can be quite frequent 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 been reported to spread in countries where climatic conditions are similar to those occurring in the pest risk area (China, Japan, and Argentina). Practices and citrus varieties used in the RA area are similar to those used in countries where the disease occurs.

Endangered areas

Citrus are widely available as commercial crops in Southern Europe located in 8 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), and Malta (193 ha). Citrus nursery dedicated to fruit production and ornamentals are located in the same area 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, 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 area in 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 RA area. The disease would cause losses of yield and costly control measures. It would have negative social incidence in area where citrus is the main crop. The presence of citrus canker in the vicinity of plant breeding companies should close part of their market places. The occurrence of the disease would lead to increase chemical application in groves and to use copper coumpounds that should create environmental concerns such as copper accumulation in soil, selection of resistance gene that could spread in the plant associated microflora and beyond.

Once citrus bacterial canker would enter the RA area, uncertainties on the assessment of consequences would rated as medium because, even though eradication would likely be a valuable option, it uncertain that the impact would be low. The success of eradication would depend upon the early detection of the establishment whatever the environmental conditions prevailing the RA area that are favourable to citrus bacterial canker.

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. The enormous investments for preventing outbreaks and for eradication in response to outbreaks of citrus canker made by various countries (Gottwald et al, 2002a; Gambley et al, 2009; Alam & Rolfe, 2006) indicate the high importance of 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. Once established, the 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 current set of EU regulations for all pathways have shown to be highly effective in preventing introduction of *X. citri* pv. *citri* and *X. citri* pv. *aurantifolii* in the EU, because there have been no outbreaks of citrus canker in the EU territory.

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 methods under strict post-entry quarantine conditions. The potential of a systems approach combining production of plants for planting in nurseries in officially controlled pest free areas according to a certification scheme, including 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, might be further explored.

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 the the 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 on this pathway. The current measures to prevent entry of the EU are evaluated as effective, although exporting countries do not always comply. Additional options are suggested to further reduce the risk of entry.

The possible 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 by 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 high number of interceptions of citrus leaves imported via non-declared 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 Health and Consumers Directorate-General.

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 Health and Consumers Directorate-General.

REFERENCES

ABC News (Australian Broadcasting Corporation), 2012. Citrus canker found in leaf imports, 2pp, available from http://www.abc.net.au/news/2012-07-06/citrus-canker-risk-lime-leaves-imported/4114354

Agustí M, 2000. Citricultura. Ediciones Mundi-Prensa, Madrid, 416 pp.

Ah-You N, Gagnevin L, Grimont PAD, Brisse S, Nesme X, Chiroleu F, Bui Thi Ngoc L, Jouen E, Lefeuvre P, Vernière C and Pruvost O, 2009. Polyphasic characterization of xanthomonads pathogenic to Anacardiaceae and their relatedness to different Xanthomonas species. International Journal of Systematic and Evolutionary Microbiology, 59, 306-318.

Alam K and Rolfe J, 2006. Economics of plant disease outbreaks. Agenda: a journal of policy analysis and reform, 13, 133-146.

Almeida NF, Yan S, Cai R, Clarke CR, Morris CE, Schaad NW, Schuenzel EL, Lacy GH, Sun X, Jones JB, Castillo JA, Bull CT, Leman S, Guttman DS, Setubal JC and Vinatzer BA, 2010. PAMDB, a multilocus sequence typing and analysis database and website for plant-associated microbes. Phytopathology, 100, 208-215.

Al-Saleh MA and Ibrahim YE, 2010. Population dynamics of Xanthomonas citri subsp citri on symptomless citrus fruits under Saudi Arabia conditions and effect of post-harvest treatments on survival of the bacteria. Journal of Plant Pathology, 92, 601-605.

Alvarez AM, 2004. Integrated approaches for detection of plant pathogenic bacteria and diagnosis of bacterial diseases. Annual Review of Phytopathology, 42, 339-366.

Alvarez AM, Benedict AA, Mizumoto CY, Pollard LW and Civerolo EL, 1991. Analysis of Xanthomonas campestris pv. citri and X. c. citrumelo with monoclonal antibodies. Phytopathology, 81, 857-865.

Anonymous (Economic and Market Research Department, Florida Department of Citrus), 2007. Florida citrus production trends 2008-09 through 2017-08. CIR 2007-1, 22 pp.

Argov Y and Rössler Y, 1996. Introduction, release and recovery of several exotic natural enemies for biological control of the citrus leafminer, Phyllocnistis citrella, in Israel. Phytoparisitica 24, 33-38.

Aubert B and Vullin G, 1997. Pépinières et plantations d'agrumes. CIRAD Publications, Montpellier, France, 184 pp.

Australian Citrus Propagation Association Inc., undated. Australian Citrus Nursery certification Scheme, Nursery Operators Manual, Version 1.0., 16pp. Available from: http://www.auscitrus.com.au/pdfs/Australian_Citrus_Nursery_Certification_Scheme_nursery_manual_ver1_0.pdf

Baker R, Caffier D, Choiseul JW, De Clercq P, Dormannsné-Simon E, Gerowitt B, Karadjova OE, Lövei G, Lansink AO, Makowski D, Manceau C, Manici L, Perdikis D, Puglia AP, Schans J, Schrader G, Steffek R, Strömberg A, Tiilikkala K, Van Lenteren JC and Vloutoglou I, 2008. Pest risk assessment and additional evidence provided by South Africa on Guignardia citricarpa Kiely, citrus black spot fungus – CBS, Scientific Opinion of the Panel on Plant Health. EFSA Journal, 925, 1-108.

Balestra GM, Sechler A, Schuenzel E and Schaad NW, 2008. First report of citrus canker caused by Xanthomonas citri in Somalia. Plant Disease, 92, p. 981.

Balogh B, Canteros BI, Stall RE and Jones JB, 2008. Control of citrus canker and citrus bacterial spot with bacteriophages. Plant Disease, 92, 1048-1052.

Bassanezi RB, Belasque Jr J and Massari CA, 2008. Current situation, management and economic impact of citrus canker in São Paulo and Minas Gerais, Brazil. Proceedings of the International Society of Citriculture, pp. 10.

Behlau F, Belasque J, Graham JH and Leite RP, 2010. Effect of frequency of copper applications on control of citrus canker and the yield of young bearing sweet orange trees. Crop Protection, 29, 300-305.

Behlau F, Belasque Jr J, Bergamin Filho A, Graham JH, Leite Jr RP and Gottwald TR, 2008. Copper sprays and windbreaks for control of citrus canker on young orange trees in southern Brazil. Crop Protection, 27, 807-813.

Behlau F, Canteros BI, Jones JB and Graham JH, 2012a. Copper resistance genes from different xanthomonads and citrus epiphytic bacteria confer resistance to Xanthomonas citri subsp citri. European Journal of Plant Pathology, 133, 949-963.

Behlau F, Canteros BI, Minsavage GV, Jones JB and Graham JH, 2011a. Molecular characterization of copper resistance genes from Xanthomonas citri subsp. citri and Xanthomonas alfalfae subsp. citrumelonis. Applied and Environmental Microbiology, 77, 4089-4096.

Behlau F, Da Silva TG and Belasque J Jr, 2011b. Copper bactericides for control of citrus canker: is there room for improvement? Proceedings of the International Workshop on Citrus Canker, November 17-18, 2011, Ribeirao Preto, Brazil, 44-47.

Behlau F, Jones JB, Myers ME and Graham JH, 2012b. Monitoring for resistant populations of Xanthomonas citri subsp. citri and epiphytic bacteria on citrus trees treated with copper or streptomycin using a new semi-selective medium. European Journal of Plant Pathology, 132, 259-270.

Belasque J, Parra-Pedrazzoli AL, Neto JR, Yamamoto PT, Chagas MCM, Parra JRP, Vinyard BT and Hartung JS, 2005. Adult citrus leadminers (Phyllocnistis citrella) are not efficient vectors for Xanthomonas axonopodis pv. citri. Plant Disease, 89, 590-594.

Biosecurity Australia, 2003. Citrus fruit from Florida, USA: draft import risk analysis report, part b. Department of Agricultural, Fisheries and Forestry, Australia, 119 pp.

Biosecurity Australia (2009) Final import risk analysis report for fresh unshu mandarin fruit from Shizuoka Prefecture in Japan. Biosecurity Australia, Canberra, 256 pp.

Bock C, Graham JH, Gottwald TR, Cook AZ and Parker PE, 2010. Wind speed and wind-associated leaf injury affect severity of citrus canker on Swingle citrumelo. European Journal of Plant Pathology, 128, 21-38.

Bock CH, Cook AZ, Parker PE, Gottwald TR and Graham JH, 2012. Short-distance dispersal of splashed bacteria of Xanthomonas citri subsp. citri from canker-infected grapefruit tree canopies in turbulent wind. Plant Pathology, 61, 829-836.

Bock CH, Gottwald TR and Parker PE, 2011. Distribution of canker lesions on the surface of diseased grapefruit. Plant Pathology, 60, 986-991.

Bonn G, Taylor E, Riley T, Gottwald T and Schubert T, 2009. Survival of Xanthomonas citri subsp. citri on symptomatic fruit under prolonged ambient and cold storage conditions. APS meeting 2009 Caribbean Division Meeting Abstracts, May 16-19, 2009 - Orlando, Florida, (Joint with The Florida Pathological Society). Available from: http://www.apsnet.org/members/divisions/carib/meetings/Pages/CaribbeanMeetingAbstracts2009.aspx

Bordas M, Torrents J, Arenas FJ and Hervalejo A, 2012. High density plantation system of the Spanish citrus industry. Acta Horticulturae, 965, 123-130.

Borchert DC, Thayer L, Brown N and Magarey R, 2007. NAPPFAST-GIS model for citrus canker ad-hoc project report. USDA APHIS PPQ CPHST Plant Epidemiology and Risk Analysis Laboratory, Raleigh, NC, USA. 74 pp.

Broadbent P, Fahy PC, Gillings MR, Bradley JK and Barnes D, 1992. Asiatic citrus canker detected in a pummelo orchard in Northern Australia. Plant Disease, 76, 824-829.

Brugnara EC, Theodoro GdF, Nesi CN, Verona LAF and Maringoni AC, 2012. Damage caused by citrus canker on Valencia sweet orange yield. IDESIA, 30, 109-113.

Brunings AM and Gabriel DW, 2003. Xanthomonas citri: breaking the surface. Molecular Plant Pathology, 4, 141-157.

Bui Thi Ngoc L, Vernière C, Belasque J, Vital K, Boutry S, Gagnevin L and Pruvost O, 2008. Ligation-mediated PCR, a fast and reliable technique for insertion sequence-based typing of Xanthomonas citri pv. citri. FEMS Microbiology Letters, 288, 33-39.

Bui Thi Ngoc L, Vernière C, Jarne P, Brisse S, Guérin F, Boutry S, Gagnevin L and Pruvost O, 2009. From local surveys to global surveillance: three high throughput genotyping methods for the epidemiological monitoring of Xanthomonas citri pv. Citri pathotypes. Applied and Environmental Microbiology, 75, 1173-1184.

Bui Thi Ngoc L, Vernière C, Jouen E, Ah-You N, Lefeuvre P, Chiroleu F, Gagnevin L and Pruvost O, 2010. Amplified fragment length polymorphism and multilocus sequence analysis-based genotypic relatedness among pathogenic variants of Xanthomonas citri pv. citri and Xanthomonas campestris pv. bilvae. International Journal of Systematic Evolutionary Microbiology, 60, 515-525.

Canteros BI, Gochez AM, Rybak M, Minsavage G, Jones JB and Stall RE, 2010. Management and characterization of plasmid-encoded copper resistance in Xanthomonas axonopodis pv. citri. In: Proceedings of the 12th International Conference of Plant Pathogenic Bacteria, Saint Denis, Reunion, France, 7-11 June 2010, p. 145.

Carr MKW, 2012. The water relations and irrigation requirements of citrus (Citrus spp.): a review. Experimental Agriculture, 48, 347-377.

CDFA (Californian Department of Food and Agriculture), 2005. Plant health and pest prevention services annual report 2004, 93 pp.

Centner TJ and Ferreira S, 2012. Ability of governments to take actions to confront incursions of diseases. A case study: citrus canker in Florida. Plant Pathology, 61, 821-828.

Christiano RSC, Dalla Pria M, Jesus Jr WC, Parra JRP, Amorim L and Bergamin Filho A, 2007. Effect of citrus leaf-miner damage, mechanical damage and inoculum concentration on severity of symptoms of Asiatic citrus canker in Tahiti lime. Crop Protection, 26, 59-65.

Civerolo EL, 1984. Bacterial canker disease of citrus. Journal of the Rio Grande Valley Horticultural Society, 37, 127-145.

Civerolo EL and Fan F, 1982. Xanthomonas campestris pv. citri detection and identification by enzyme-linked immunosorbent assay. Plant Disease, 66, 231-236.

Coletta-Filho HD, Takita MA, De Souza AA, Neto JR, Destéfano SAL, Hartung JS and Machado MA, 2006. Primers based on the rpf gene region provide improved detection of Xanthomonas axonopodis pv. citri in naturally and artificially infected citrus plants. Journal of Applied Microbiology, 100, 279-285.

Colombo A 2004. Coltivare gli Agrumi,Ornamentali da Frutto. Le specie e le varietà, le forme di allevamento, le potature, la propagazione, le cure, la raccolta. De Vecchi Edizioni -Abstract http://www.agraria.org/coltivazioniarboree/coltivazioneagrumi.htm

Consoli, S, 2010. Individuazione degli interventi per razionalizzare la gestione dei Consorzi di Bonifica. CESEI Catania pp 1-64.

Cubero J, Gell I, Johnson EG, Redondo A and Graham JH, 2011. Unstable green fluorescent protein for study of Xanthomonas citri subsp. citri survival on citrus. Plant Pathology, 60, 977-985.

Cubero J and Graham JH, 2002. Genetic relationship among worldwide strains of Xanthomonas causing canker in citrus species and design of new primers for their identification by PCR. Applied and Environmental Microbiology, 68, 1257-1264.

Cubero J and Graham JH, 2005. Quantitative real-time polymerase chain reaction for bacterial enumeration and allelic discrimination to differentiate Xanthomonas strains on citrus. Phytopathology, 95, 1333-1340.

Dalla Pria M, Christiano RCS, Furtado EL, Amorim L and Bergamin Filho A, 2006. Effect of temperature and leaf wetness duration on infection of sweet oranges by Asiatic citrus canker. Plant Pathology, 55, 657-663.

Das AK, 2003. Citrus canker: a review. Journal of Applied Horticulture, 5, 52-60.

Del Campo R, Russi P, Mara P, Mara H, Peyrou M, Ponce de León I and Gaggero C, 2009. Xanthomonas axonopodis pv. citri enters the VBNC state after copper treatment and retains its virulence. FEMS Microbiology Letters, 298, 143-148.

Delcourt S, Vernière C, Boyer C, Pruvost O, Hostachy B and Robène-Soustrade I, 2013. Revisiting the specificity of PCR primers for diagnostics of Xanthomonas citri pv. citri by experimental and in silico analyses. Plant Disease, 97, 373-378.

De Rogatis A, Ducci F and Tocci A, 1990. An exotic forest tree of possible use in Italy: Zanthoxylum simulans. Italia Forestale e Montana, 45, 361-370.

Dewdney MM and Graham JH, 2012. 2012 Florida citrus pest management guide: citrus canker. University of Florida, Institute of Food and Agricultural Sciences, FL, USA, 4 pp.

Dowson WJ, 1939. On the systematic position and generic names of the Gram negative bacterial plant pathogens. Zentralblatt fur Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, 2, 177-193.

Ducci F and Malentacchi L, 1993. Preliminary micropropagation trials of Zanthoxylum L. simulans. Italia Forestale e Montana, 48, 1, 45-53.

Dye DW and Lelliott RA, 1974. Genus II. Xanthomonas Dowson 1939, 187. In: Bergey's Manual of Determinative Bacteriology. Williams and Wilkins, Baltimore, Maryland, USA, 243-249.

EFSA (European Food Safety Authority) Panel on Plant Health (PLH), 2006. Opinion of the Scientific Panel on plant health (PLH) on an evaluation of asymptomatic citrus fruit as a pathway for the introduction of citrus canker disease (Xanthomonas axonopodis pv. citri) made by the US Animal and Plant Health Inspection Service (APHIS). EFSA Journal, 439, 1-41.

EFSA (European Food Safety Authority), Panel on Plant Health (PLH), 2008. Scientific Opinion of the Panel on Plant Heath on a request from the European Commission on Guignardia citricarpa Kiely. EFSA Journal, 925, 108 pp.

EFSA (European Food Safety Authority) Panel on Plant Health (PLH), 2010. Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options by EFSA. EFSA Journal, 8, 1495, 68 pp.

EFSA (European Food Safety Authority) Panel on Plant Health (PLH), 2011. Scientific Opinion on the request from the USA regarding export of Florida citrus fruit to the EU. EFSA Journal, 9, 2461, 99 pp.

EFSA (European Food Safety Authority) Panel on Plant Health (PLH), 2012. Guidance on methodology for evaluation of the effectiveness of options for reducing the risk of introduction and spread of organisms harmful to plant health in the EU territory. EFSA Journal, 10, 2755, 92 pp.

Egel DS, Graham JH and Stall RE, 1991. Genomic relatedness of Xanthomonas campestris strains causing diseases of citrus. Applied Environmental Microbiology, 57, 2724-2730.

Elena K, 2006. Alternaria brown spot of Minneola in Greece; evaluation of citrus species susceptibility. European Journal of Plant Pathology, 115: 259-262.

El Yacoubi B, Brunings AM, Yuan Q, Shankar S and Gabriel DW, 2007. In planta horizontal transfer of a major pathogenicity effector gene. Applied and Environmental Microbiology, 73, 1612-1621.

EPPO (European and Mediterranean Plant Protection Organisation), 2005. EPPO Standards Diagnostic PM7/44(1) Xanthomonas axonopodis pv. citri. OEPP/EPPO Bulletin, 35, 271-273.

EPPO (European and Mediterranean Plant Protection Organisation), online. EPPO Reporting Service. Available from http://www.eppo.int/PUBLICATIONS/reporting/reporting_service.htm

EPPO (European and Mediterranean Plant Protection Organisation), online. EPPO Plant Quarantine Data Retrieval System. Available from http://www.eppo.int/DATABASES/pqr/pqr.htm

Erickson LC, 1968. The General Physiology of Citrus. Pages 86-91 in Reuther W, Batchelor LD and Webber HJ, (eds.). The Citrus Industry. Vol. II. Anatomy, Physiology, Genetics, and Reproduction. University of California. Division of Agricultural Science, Berkeley, California

Escalon A, Javegny S, Vernière C, Noël LD, Vital K, Poussier S, Hajri A, Boureau T, Pruvost O, Arlat M and Gagnevin L, 2013. Variations in type III effector repertoires, pathological phenotypes and host range of Xanthomonas citri pv. citri pathotypes. Molecular Plant Pathology, 14, 483-496.

European Severe Weather Database, online. Available from www.eswd.eu

EUROPHYT, online. The European Network of Plant Health Information System. EUROPHYT database. Available from:https://europhyt.ec.europa.eu

Eurostat, online. European Commission, Statistical Office of the European Communities. Available from: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1493,1&_dad=portal&_schema=PORTAL

Falico de Alcaraz L, 1986. Multiplication de Xanthomonas campestris pv. citri en el tejido foliar de distintas especies citricas. Fitopatologia, 21, 52-60.

FAO/IBPGR (Food and Agriculture Organization of the United Nations)/(International Board for Plant Genetic Resources), 1991. Technical guidelines for the safe movement of citrus germplasm. Eds Frison EA and Taher MM, Rome, 50 pp. Available from: http://www.bioversityinternational.org/fileadmin/bioversity/publications/pdfs/501_Citrus.pdf?cache=1360066965

FAO (Food and Agriculture Organization of the United Nations), 1995. ISPM No. 4. Requirements for the establishment of pest free areas. Available from https://www.ippc.int/index.php?id=13399

FAOSTAT, online. Available from: http://faostat.fao.org/default.aspx

Fernandes A and Franquinho Aguiar AM, 2001. Development of quarantine pests Toxoptera citricida (Kirkaldy) and Trioza erytreae (Del Guercio) in the Archipelago of Madeira. Boletin de Sanidad Vegetal, Plagas, 27, 51-58.

Florida Department of Agriculture and Consumer Service, 2011. Florida Regulations 5B-62.010 - Requirements for Citrus Nursery Structure. Available from: http://www.lawserver.com/law/state/florida/regulations/florida_regulations_chapter_5b-62

Fulton HR and Bowman JJ, 1929. Infection of fruit of Citrus by Pseudomonas citri. Journal of Agricultural Research, 39, 403-426.

Gabriel DW, Kingsley MT, Hunter JE and Gottwald T, 1989. Reinstatement of Xanthomonas citri (ex Hasse) and X. phaseoli (ex Smith) to species and reclassification of all X. campestris pv. citri strains. International Journal of Systematic Bacteriology, 39, 14-22.

Gambley CF, Miles AK, Ramsden M, Doogan V, Thomas JE, Parmenter K and Whittle PJL, 2009. The distribution and spread of citrus canker in Emerald, Australia. Australasian Plant Pathology, 38, 547-557.

Golmohammadi M, Cubero J, Penalver J, Quesada JM, Lopez MM and Llop P, 2007. Diagnosis of Xanthomonas axonopodis pv. citri, causal agent of citrus canker, in commercial fruits by isolation and PCR-based methods. Journal of Applied Microbiology, 103, 2309-2315.

Golmohammadi MI, Llop P, Cubero J and Lopez MM, 2012. The causal agent of citrus canker, Xanthomonas citri subsp. citri enters in a reversible viable but non culturable state induced by copper, that can be reverted by citrus leaf extract. In: Book of abstract of the XII International Citrus Congress, Valencia, Spain, p. 209.

Golmohammadi M, Llop P, Scuderi G, Gell I, Graham JH and Cubero J, 2012. mRNA from selected genes is useful for specific detection and quantification of viable Xanthomonas citri subsp. citri. Plant Pathology, 61, 479-488.

Gonçalves FP, Stuchi ES, Silva SRd, Reiff ET and Amorim L, 2011. Role of healthy nursery plants in orange yield during eight years of Citrus Variegated Chlorosis epidemics. Scientia Horticulturae, 129, 343-345.

Goto M, 1962. Studies on citrus canker. Bulletin of the Faculty of Agriculture, Shizuoka University, 12, 3-72.

Goto M, 1970. Studies on citrus canker disease. III. Survival of Xanthomonas citri (Hasse) Dowson in soils and on the surface of weeds. Bulletin of the Faculty of Agriculture, Shizuoka University, 20, 21-29.

Goto M, 1972. Survival of Xanthomonas citri in the bark tissues of citrus trees. Canadian Journal of Botany, 50, 2629-2635.

Goto M, 1992. Citrus canker. In: Plant diseases of international importance: diseases of fruit crops. Eds Kumar J, Chaube HS, Sing US and Mukhopadhyay AN. Prentice Hall, Englewood Cliffs, NJ, USA, 170-208.

Goto M, Ohta K and Okabe N, 1975. Studies on saprophytic survival of Xanthomonas citri Hasse Dowson 2. Longevity and survival density of the bacterium on artificially infested weeds, plant residues and soil. Annals of the Phytopathological Society of Japan, 41, 141-147.

Goto M, Tadauchi Y and Okabe N, 1979. Interaction between Xanthomonas citri and Erwinia herbicola in vitro and in vivo. Annals of the Phytopathological Society of Japan, 45, 618-624.

Goto M, Toyoshima A and Tanaka S, 1978. Studies on saprophytic survival of Xanthomonas citri (Hasse) Dowson. 3. Inoculum density of the bacterium surviving in the saprophytic form. Annals of the Phytopathological Society of Japan, 44, 197-201.

Gottwald T, McGuire R and Garran S, 1988. Asiatic citrus canker: spatial and temporal spread in simulated new planting situations in Argentina. Phytopathology, 78, 739-745.

Gottwald TR, Bassanezi RB, Amorim L and Bergamin Filho A, 2007. Spatial pattern analysis of citrus canker-infected plantings in São Paulo, Brazil, and augmentation of infection elicited by the Asian leafminer. Phytopathology, 97, 674-683.

Gottwald TR and Graham JH, 1992. A device for precise and nondisruptive stomatal inoculation of leaf tissue with bacterial pathogens. Phytopathology, 82, 930-935.

Gottwald TR, Graham JH, Bock C, Bonn G, Civerolo EL, Irey M, Leite R, McCollum G, Parker P, Ramallo J, Riley T, Schubert T, Stein B and Taylor E, 2009. The epidemiological significance of post-packinghouse survival of Xanthomonas citri subsp. citri for dissemination of Asiatic citrus canker via infected fruit. Crop Protection, 28, 508-524.

Gottwald T, Graham J, Civerolo E, Barrett H and Hearn C, 1993. Differential host range reaction of citrus and citrus relatives to citrus canker and citrus bacterial spot determined by leaf mesophyll susceptiblity. Plant Disease, 77, 1004-1009.

Gottwald TR, Graham JH and Egel DS, 1992. Analysis of foci of Asiatic citrus canker in a Florida citrus orchard. Plant Disease, 76, 389-396.

Gottwald TR, Graham JH and Schubert TS, 1997. An epidemiological analysis of the spread of citrus canker in urban Miami, Florida, and synergistic interaction with the Asian citrus leafminer. Fruits, 52, 383-390.

Gottwald TR, Graham JH and Schubert TS, 2002a. Citrus canker: the pathogen and its impact. Plant Health Progress, 10.

Gottwald TR, Hughes G, Graham JH, Sun X and Riley T, 2001. The citrus canker epidemic in Florida: the scientific basis of regulatory eradication policy for an invasive species. Phytopathology, 91, 30-34.

Gottwald TR, Sun X, Riley T, Graham JH, Ferrandino F and Taylor EL, 2002b. Georeferenced spatiotemporal analysis of the urban citrus canker epidemic in Florida. Phytopathology 92(4), 361-377.

Gottwald TR and Timmer LW, 1995. The efficacy of windbreaks in reducing the spread of citrus canker caused by Xanthomonas campestris pv. citri. Tropical Agriculture, 72, 194-201.

Gottwald TR, Timmer LW and McGuire RG, 1989. Analysis of disease progress of citrus canker in nurseries in Argentina. Phytopathology 79, 1276-1283.

Graham JH and Gottwald TR, 1989. Variation in aggressiveness of Xanthomonas campestris pv. citrumelo associated with citrus bacterial spot (CBS) in Florida. Phytopathology, 79, 1182.

Graham JH and Gottwald TR, 1990. Variation in aggressiveness of *Xanthomonas campestris* pv. *citrumelo* associated with citrus bacterial spot in Florida Citrus nurseries. Phytopathology, 80, 190-196.

Graham JH and Gottwald TR, 1991. Research perspectives on eradication of citrus bacterial diseases in Florida. Plant Disease, 75, 1193-1200.

Graham JH, Gottwald TR, Cubero J and Achor DS, 2004. Xanthomonas axonopodis pv. citri: factors affecting successful eradication of citrus canker. Molecular Plant Pathology, 5, 1-15.

Graham JH, Gottwald TR, Civerolo EL and McGuire RG, 1989. Population dynamics and survival of Xanthomonas campestris in soil in citrus nurseries in Maryland and Argentina. Plant Disease, 73, 423-427.

Graham JH, Gottwald TR, Riley TD and Bruce MA, 1992. Susceptibility of citrus fruit to bacterial spot and citrus canker. Phytopathology, 82, 452-457.

Graham JH, Gottwald TR, Riley TD, Cubero J and Drouillard DL, 2000. Survival of Xanthomonas campestris pv. citri (Xcc) on various surfaces and chemical control of Asiatic citrus canker (ACC). Proceedings of the 1st International Citrus Canker Research Workshop, Fort Pierce, FL, USA, p. 7.

Graham JH and Leite RP, 2004. Lack of control of citrus canker by induced systemic resistance compounds. Plant Disease, 88, 745–750.

Graham JH, McGuire RG and Miller JW, 1987. Survival of Xanthomonas campestris pv. citri in citrus plant debris and soil in Florida and Argentina. Plant Disease, 71, 1094-1098.

Hailstones DL, Weinert MP, Smith MW, Ghalayini A and Gambley CF, 2005. Evaluating potential alternative hosts of citrus canker. Proceedings of the International Citrus Canker and Huanglongbing Research Workshop, Orlando, Florida, USA, 2005, 71.

Hall DG, Gottwald TR and Bock CH, 2010. Exacerbation of citrus canker by citrus leafminer Phyllocnistis citrella in Florida. Florida Entomologist, 93, 558-566.

Hartung JS, Daniel JF and Pruvost OP, 1993. Detection of Xanthomonas campestris pv. citri by the polymerase chain reaction method. Applied Environmental Microbiology, 59, 1143-1148.

Hartung JS, Pruvost OP, Villemot I and Alvarez A, 1996. Rapid and sensitive colorimetric detection of Xanthomonas axonopodis pv. citri by immunocapture and a nested-polymerase chain reaction assay. Phytopathology, 86, 95-101.

Hasse CH, 1915. Pseudomonas citri, the cause of citrus canker. Journal of Agricultural Research, 4, 97-99.

Hyun JW, Kim HJ, Yi PH, Hwang RY and Park EW, 2012. Mode of action of streptomycin resistance in the citrus canker pathogen (Xanthomonas smithii subsp citri) in Jeju Island. Plant Pathology Journal, 28, 207-211.

IIGB (Interim Inspector General of Biosecurity), 2011. An examination of the performance of the systems that the biosecurity divisions of the Department of Agriculture, Fisheries and Forestry has in place to manage biosecurity risks along entry pathways Citrus canker, Audit report, 39 pp.

Irey M, Gottwald TR, Graham JH, Riley TD and Carlton G, 2006. Post-hurricane analysis of citrus canker spread and progress towards the development of a predictive model to estimate disease spread due to catastrophic weather events. Plant Health Progress, 10.

Jaciani FJ, Destefano SAL, Neto JR and Belasque Jr. J, 2009. Detection of a new bacterium related to Xanthomonas fuscans subsp. aurantifolii infecting Swingle citrumelo in Brazil. Plant Disease, 93, p. 1074.

Janssen P, Coopman R, Huys G, Swings J, Bleeker M, Vos P, Zabeau M and Kersters K, 1996. Evaluation of the DNA fingerprinting method AFLP as a new tool in bacterial taxonomy. Microbiology, 142, 1881-1893.

Jehle RA, 1917. Susceptibility of non-citrus plants to bacterium citri. Phytopathology, 7, 339-344.

Jetter KM, Summer DA and Civerolo EL, 2000. Ex ante economics of exotic disease policy: citrus canker in California. Proceedings of the Integrating Risk Assessment and Economics for Regulatory Decisions, Washington, DC, USA, 57 pp.

Kalita P, Bora LC and Bhagabati KN, 1997. Goat weed, a new host of citrus canker (Xanthomonas campestris pv. citri). Journal of Mycology and Plant Pathology, 27, 96-97.

Kingsley MT and Fritz LK, 2000. Identification of the citrus canker pathogen Xanthomonas axonopodis pv. citri A by fluorescent PCR assays. Phytopathology, 90, S42.

Koizumi M, 1972. Studies on the symptoms of citrus canker formed on satsuma mandarin fruit and existence of causal bacteria in the affected tissues. Bulletin of the Horticultural Research Station, B, 12, 229-243.

Koizumi M, 1976. Incubation Period of Citrus Canker ln Relation to Temperature. Bulletin of the Fruit Tree Research Station, B, 3, 33-46.

Koizumi M, 1977. Behaviour of Xanthomonas citri (Hasse) Dowson and histological changes of diseased tissued in the process of lesion extension. Annals of the Phytopathological Society of

Japan, 43, 129-136.

Koizumi M, 1978. Resistance of Citrus plants to bacterial canker disease. Shokubutsu boeki (Plant Protection), 32, 207-211.

Koizumi M, 1979. Ultrastructural changes in susceptible and resistant plants of Citrus following artificial inoculation with Xanthomonas citri (Hasse) Dowson. Annals of the Phytopathological Society of Japan, 45, 635-644.

Koizumi M, 1985. Citrus canker: the world situation. In: Citrus canker: an international perspective. Ed Timmer LW. Institute of Food and Agricultural Sciences, University of Florida, Lake Alfred, FL, USA, 2-7.

Kuan TL, Minsavage GV and Schaad NW, 1986. Aerial dispersal of Xanthomonas campestris pv. campestris from naturally infected Brassica campestris. Plant Disease, 70, 409-413.

Kuhara S, 1978. Present epidemic status and control of the citrus canker disease (Xanthomonas citri (Hasse) Dowson) in Japan. Review of Plant Protection Research, 11, 132-142.

Kuo TT, Chiang CC, Chen SY, Lin JH and Kuo JL, 1994. A long lytic cycle in filamentous phage Cf1Tv infecting Xanthomonas campestris pv. citri. Archives of Virology, 135, 253-264.

Leduc A, Vernière C, Boyer C, Vital K, Pruvost O, Niang Y and Rey JY, 2011. First report of Xanthomonas citri pv. citri pathotype A causing Asiatic citrus canker on grapefruit and Mexican lime in Senegal. Plant disease, 95, p. 1311.

Lee HA, 1918. Further data on the susceptibility of rutaceous plants to citrus canker. Journal of Agriculcural Research, 15, 661-665.

Leite JRP and Mohan SK, 1987. Survival of Xanthomonas campestris pv. citri (Hasse) Dye in soil and in association with some gramineous plants. Proceedings of the International Society of Citriculture, Sao Paulo, Brazil, 365-368.

Leite JRP and Mohan SK, 1990. Integrated management of the citrus bacterial canker disease caused by Xanthomonas campestris pv. citri in the State of Paraná, Brazil. Crop Protection, 9, 3-7.

Leite JRP, Mohan SK, Pereira ALG and Campacci CA, 1987. Integrated control of citrus canker: effect of genetic resistance and application of bactericides. (Controle integrado de cancro cítrico: efeito da resistência genética e da aplicação de bactericidas). Fitopatologia Brasileira, 12, 257-263.

Liberati C, 2008. Uso irriguo dell’acqua e principali implicazioni di natura ambientale. Rapporto Irrigazione. CD pp 1-289.

MAGRAMA (Ministerio de Agricultura, Alimentacion y medio ambiante), 2013. Encuesta sobre superficies y rendimientos de cultivos: informe sobre regadíos en España. 42 pp.

Manceau C, Gardan L and Devaux M, 1986. Dynamics of RP4 plasmid transfer between Xanthomonas campestris pv. corylina and Erwinia herbicola in hazelnut tissues, in planta. Canadian Journal of Microbiology, 32, 835-841.

Mavrodieva V, Levy L and Gabriel DW, 2004. Improved sampling methods for real-time polymerase chain reaction diagnosis of citrus canker from field samples. Phytopathology, 94, 61-68.

McGuire RG, 1988. Evaluation of bactericidal chemicals for control of Xanthomonas on citrus. Plant

Disease, 72, 1016-1020.

McInnes TB, Gitaitis RD, McCarter SM, Jaworski CA and Phatak SC, 1988. Airborne dispersal of bacteria in tomato and pepper transplant fields. Plant Disease, 72, 575-579.

MacLeod A, Anderson H, Follak S, van der Gaag DJ, Potting R, Pruvost O, Smith J, Steffek R, Vloutoglou I, Holt J, Karadjova O, Kehlenbeck H, Labonne G, Reynaud P, Viaene N, Anthoine G, Holeva M, Hostachy B, Ilieva Z, Karssen G, Krumov V, Limon P, Meffert J, Niere B, Petrova E, Peyre J, Pfeilstetter E, Roelofs W, Rothlisberger F, Sauvion N, Schenck N, Schrader G, Schroeder T, Steinmöller S, Tjou-Tam-Sin L, Ventsislavov V, Verhieven K and Wesemael W, 2012. Pest risk assessment for the European Community plant health: a comparative approach with case studies. EFSA supporting publications, EN-319, 1053 pp.

Magarey, R.D., Borchert, D.M. & Schlegel, J.W. 2008. Global plant hardiness zones for phytosanitary risk analysis. Scientia Agricola, 65: 54-59.

Mehmet O and Ali Biçak H, 2002. Modern and traditional irrigation technologies in the Eastern Mediterranean. International Development Research Centre. 27-73.

Migheli Q, Cacciola SO, Balmas V, Pane A, Ezra D and di San Lio GM, 2009. Mal secco disease caused by Phoma tracheiphila: a potential threat to lemon production worldwide. Plant Disease, 93, 852-867.

Mioulane P, 2013. Bonsaï d'intérieur. Hachette Pratique, 93 pp.

Miyoshi T, Sawada H, Tachibana Y and Matsuda I, 1998. Detection of Xanthomonas campestris pv. citri by PCR using primers from the spacer region between the 16S and 23S rRNA genes. Annals of the Phytopathological Society of Japan, 64, 249-254.

MVCB (Murray Valley Citrus Board), 2012. Message from the Chairman, Murray Valley Citrus Board Newsletter, 3 July 2012, Avalable from http://mvcitrus.org.au/mvcb/wp-content/uploads/2012/09/Citrus-Board-News-for-3rd-July-2012.pdf

Namekata T and Oliveira DDA, 1972. Comparative serological studies between Xanthomonas citri and a bacterium causing canker on mexican lime. Proceedings of the 3rd International Conference on Plant Pathogenic Bacteria, Wageningen, Netherlands, 151-152.

National Statistics Office, Malta (2010). Estimating volume of water usage for irrigation in Malta. Eurostat Grant Ref. No. 40701.2008.001 – 2008.130. pp 1-26.

Navarro L, Pina J, Juárez J, Ballester-Olmos J, Arregui J, Ortega C, Navarro A, Duran-Vila N, Guerri J and Moreno P, Cambra M, Medina A and Zaragoza S, 2002. Surveys and certification: the citrus variety improvement program in Spain in the period 1975-2001. Fiftheenth Conference of the International Organisation of Citrus Virologists, 306-316.

Norberto JC, 2011. General Agricultural Census 2009 for the culture of citrus Algarve. CD edition.

Palm ME and Civerolo EL, 1994. Isolation, pathogenicity and partial host range of Alternaria limicola, causal agent of mancha foliar de los citricos in Mexico. Plant Disease, 78, 879-883.

Park DS, Hyun JW, Park YJ, Kim JS, Kang HW, Hahn JH and Go SJ, 2006. Sensitive and specific detection of Xanthomonas axonopodis pv. citri by PCR using pathovar specific primers based on hrpW gene sequences. Microbiological Research, 161, 145-149.

Parker PE, Bock CH, Cook AZ and Gottwald T, 2008. Dispersal of Xanthomonas citri subsp. citri bacteria downwind from harvested, infected fruit. Phytopathology, 98, S121.

Parkinson N, Aritua V, Heeney J, Cowie C, Bew J and Stead D, 2007. Phylogenetic analysis of Xanthomonas species by comparison of partial gyrase B gene sequences. International Journal of Systematic and Evolutionary Microbiology, 57, 2881-2887.

Passos OS, da Cunha Sobrinho AP and Santos Filho HP, 2000. Citrus Certification Programs in Brazil, Fourteenth IOCV Conference, 2000—Short Communications, 391-399.

Patel MK, Allayyanavaramath SB and Kulkarni YS, 1953. Bacterial shot-hole and fruit canker of Aegle marmelos Correa. Current Science, 22, 216-217.

Peltier GL, 1920. Influence of temperature and humidity on the growth of pseudomonas citri and its host plants and on infection and development of the disease. Journal of Agricultural Research, 20, 447-506.

Peltier GL and Frederich WJ, 1920. Relative susceptibility to citrus-canker of different species and hybrids of the genus Citrus, including the wild relatives. Journal of Agricultural Research, 19, 339-362.

Peltier GL and Frederich WJ, 1924. Further studies on the relative susceptibility to citrus canker of different species and hybrids of the genus Citrus, including the wild relatives. Journal of Agricultural Research, 28, 227-239.

Peltier GL and Frederich WJ, 1926. Effect of weather on the world distribution and prevalence of citrus canker and citrus scab. Journal of Agricultural Research, 32, 147-164.

Pons E, 2008. El regadío valenciano modernización, eficiencia, sostenibilidad. Jornada Técnica sobre la gestión eficiente de los sistemas de riego en agricultura. Valencia, 16 abril 2008. Inst. Ing. Agua y MA- Univ. Politécnica de Valencia.

Praloran JC, 1971. Les agrumes. GP Maisonneuve and Larose, Paris, 520 pp.

PRATIQUE, 2011, No 212459, Deliverable number 3.3: Protocol for mapping endangered areas, Annex 4: Rating Guidance for Climatic Suitability,Date 17/06/2011, 20pp.

Pruvost O, Boher B, Brocherieux C, Nicole M and Chiroleu F, 2002. Survival of Xanthomonas axonopodis pv. citri in leaf lesions under tropical environmental conditions and simulated splash dispersal of inoculum. Phytopathology, 92, 336-346.

Pruvost O and Gagnevin L, 2002. Population structure of xanthomonads with endophytic and epiphytic phases: the example of the pathovar mangiferaeindicae/mango pathosystem. In: Phyllosphere Microbiology. Eds Lindow SE, Hecht-Poinar EI, Elliott VJ. American Phytopathological Society Press, Minneapolis, MN, USA, 209-221.

Pruvost O, Gottwald TR and Brocherieux C, 1999. The effect of irrigation practices on the spatio-temporal increase of Asiatic citrus canker in stimulated nursery plots in Reunion Island. European Journal of Plant Pathology, 105, 23-37.

Pruvost O, Roumagnac P, Gaube C, Chiroleu F and Gagnevin L, 2005. New media for the semi-selective isolation and enumeration of Xanthomonas campestris pv. mangiferaeindicae, the causal agent of mango bacterial black spot. Journal of Applied Microbiology, 99, 803-815.

Rademaker JLW, Hoste B, Louws FJ, Kersters K, Swings J, Vauterin L, Vauterin P and De Bruijn FJ, 2000. Comparison of AFLP and rep-PCR genomic fingerprinting with DNA-DNA homology studies: Xanthomonas as a model system. International Journal of Systematic and Evolutionary Microbiology, 50, 665-677.

Rademaker JLW, Louws FJ, Schultz MH, Rossbach U, Vauterin L, Swings J and De Bruijn FJ, 2005. A comprehensive species to strain taxonomic framework for Xanthomonas. Phytopathology, 95, 1098-1111.

Recupero S, Caruso A and Russo G, 2001. Comparison between some ornamental Citrus genotypes on six rootstocks. Rivista di Frutticoltura, 63, 61-67.

Reddy MRS, 1997. Sources of resistance to bacterial canker in Citrus. Indian Journal of Mycology and Plant Pathology, 27, 80-81.

RHS (The Royal Horticultural Society), 1996. A-Z encyclopedia of garden plants. Ed Brickell C. Dorling Kindersley, London, 1136 pp.

Rigano LA, Marano MR, Castagnaro AP, Do Amaral AM and Vojnov AA, 2010. Rapid and sensitive detection of Citrus Bacterial Canker by loop-mediated isothermal amplification combined with simple visual evaluation methods. BMC Microbiology, 10, 176.

Rigano LA, Siciliano F, Enrique R, Sendin L, Filippone P, Torres PS, Questa J, Dow JM, Castagnaro AP, Vojnov AA and Marano MR, 2007. Biofilm formation, epiphytic fitness, and canker development in Xanthomonas axonopodis pv. citri. Molecular Plant-Microbe Interactions, 20, 1222-1230.

Roberto SR, Gottwald TR, Graham JH and Riley T, 2001. Xanthomonas axonopodis pv. citri aerosol production in Miami, Florida. Summa Phytopathologica, 27, 56-60.

Rodriguez LM, Grajales A, Arrieta-Ortiz ML, Salazar C, Restrepo S and Bernal A, 2012. Genomes-based phylogeny of the genus Xanthomonas. BMC Microbiology, 12.

Rodriguez SG, Garza JGL, Stapleton JJ and Civerolo EL, 1985. Citrus bacteriosis in Mexico. Plant Disease, 69, 808-810.

Rooney CP, Zhao FJ and McGrath SP, 2006. Soil factors controlling the expression of copper toxicity to plants in a wide range of European soils. Environmental Toxicology and Chemistry, 25, 726-732.

Rossetti V, 1977. Citrus Canker in Latin America: a review. Proceedings of the International Society of Citriculture, Florida, USA, 3, 918-924.

Rossetti V, 1981. Identificaçao do cancro citrico. Biologico Sao Paulo, 47, 145-153.

Rybak M, Minsavage GV, Stall RE and Jones JB, 2009. Identification of Xanthomonas citri ssp. citri host specificity genes in a heterologous expression host. Molecular Plant Pathology, 10, 249-262.

Schaad NW, Postnikova E, Lacy GH, Sechler A, Agarkova I, Stromberg PE, Stromberg VK and Vidaver AK, 2005. Reclassification of Xanthomonas campestris pv. citri (ex Hasse 1915) Dye 1978 forms A, B/C/D, and E as X. smithii subsp. citri (ex Hasse) sp. nov. nom. rev. comb. nov., X. fuscans subsp. aurantifolii (ex Gabriel 1989) sp. nov. nom. rev. comb. nov., and X. alfalfae subsp. citrumelo (ex Riker and Jones) Gabriel et al., 1989 sp. nov. nom. rev. comb. nov.; X. campestris pv. malvacearum (ex Smith 1901) Dye 1978 as X. smithii subsp. smithii nov. comb. nov. nom. nov.; X. campestris pv. alfalfae (ex Riker and Jones, 1935) Dye 1978 as X. alfalfae subsp. alfalfae (ex Riker et al., 1935) sp. nov. nom. rev.; and "var. fuscans" of X.

campestris pv. phaseoli (ex Smith, 1987) Dye 1978 as X. fuscans subsp. fuscans sp. nov. Systematic and Applied Microbiology, 28, 494-518.

Schaad NW, Postnikova E, Lacy GH, Sechler A, Agarkova I, Stromberg PE, Stromberg VK and Vidaver AK, 2006. Amended classification of xanthomonad pathogens on citrus. Systematic and Applied Microbiology, 29, 690-695.

Schubert T, Rizvi S, Sun X, Gottwald T, Graham J and Dixon W, 2001. Meeting the challenge of eradicating citrus canker in Florida - again. Plant Disease, 85, 341-356.

Scuderi G, Golmohammadi M, Cubero J, M.M. L, Cirvilleri G and Llop P, 2010. Development of a simplified NASBA protocol for detecting viable cells of the citrus pathogen Xanthomonas citri subsp. citri under different treatments. Plant Pathology, 59, 764-772.

Serizawa S and Inoue K, 1975. Studies on citrus canker. III. The influence of wind on infection. Bulletin of the Shizuoka Citrus Experiment Station, 11, 54-67.

Serizawa S, Inoue K and Goto M, 1969. Studies on citrus canker disease. I. Dispersal of the citrus canker organism. Bulletin of the Faculty of Agriculture, Shizuoka University, 8, 81-85.

Shiotani H, Yoshioka T, Yamamoto M and Matsumoto R, 2008. Susceptibility to citrus canker caused by Xanthomonas axonopodis pv. citri depends on the nuclear genome of the host plant. Journal of General Plant Pathology, 74, 133-138.

Shiotani H, Uematsu H, Tsukamoto T, Shimizu Y, Ueda K, Mizuno A and Sato S, 2009. Survival and dispersal of Xanthomonas citri pv. citri from infected Satsuma mandarin fruit. Crop Protection 28, 19-23.

Shirgure PS, 2012. Micro-irrigation systems, automation and fertigation in citrus. Scientific Journal of Review 1:156-169.

Spreen TH, Zansler ML, Muraro RP and Roka F, 2003. The costs and benefits associated with eradicating citrus canker in Florida. Proceedings of the The American Agricultural Economics Association Annual Meeting, Montreal, Canada, 2003, pp. 24.

Stall RE and Civerolo EL, 1991. Research relating to the recent outbreak of citrus canker in Florida. Annual Review of Phytopathology, 29, 399-420.

Stall RE and Civerolo EL, 1993. Xanthomonas campestris pv. vesicatoria: cause of bacterial spot of tomato and pepper. In: Xanthomonas. Eds Swings JG and Civerolo EL. Chapman and Hall, London, UK, 57-60.

Stall RE, Miller J, Marco GM and Echenique BIC, 1980. Population dynamics of Xanthomonas citri causing cancrosis of citrus in Argentina. Proceedings of the Florida State Horticultural Society, 10-14.

Stall RE, Miller JW, Marco GM and Canteros de Echenique BIC, 1981. Timing of sprays to control cancrosis of grapefruit in Argentina. Proceedings of the International Society of Citriculture, 1, 414-417.

Stall RE, Marco GM and Canteros BIC, 1982. Importance of mesophyll in mature-leaf resistance to cancrosis of Citrus. Phytopathology, 72, 1097-1100.

Stall RE, Miller JW and Canteros De Echenique BI, 1980. Population dynamics of Xanthomonas citri causing cancrosis of citrus in Argentina. Proceeding of the Florida State Horticultural Society, 93, 10-14.

Stall RE and Minsavage GV, 1990. The use of hrp genes to identify opportunistic xanthomonads. Proceedings of the 7th International Conference on Plant Pathogenic Bacteria, Budapest, Hungary, 369-374.

Stall RE and Seymour CP, 1983. Canker, a threat to citrus in the Gulf-Coast states. Plant Disease, 67, 581-585.

Stapleton JJ and Medina VM, 1984. Evaluation of copper oxychloride sprays to control bacteriosis disease of Mexican lime trees in Colima, Mexico. Phytopathology, 74, 879.

Stein B, Ramallo J, Foguet J and Graham JH, 2007. Citrus leafminer control and copper sprays for management , Argentina. Procedings of the Forida State Horticultural Society, 120, 127-131.

Stewart BA and Nielsen DR, 1990. Irrigation of Agricultural Crops. Agronomy Monography 80, 436-467.

Stover E, Castle WS and Spyke P, 2008. The citrus grove of the future and its implications for Huanglongbing management. Proceedings of the Florida State Horticultural Society, 155-159.

Sun XA, Stall RE, Jones JB, Cubero J, Gottwald TR, Graham JH, Dixon WN, Schubert TS, Chaloux PH, Stromberg VK, Lacy GH and Sutton BD, 2004. Detection and characterization of a new strain of citrus canker bacteria from key Mexican lime and Alemow in South Florida. Plant Disease, 88, 1179-1188.

Timmer L, 1988. Evaluation of bactericides for control of citrus canker in Argentina. Proceedings of the Florida State Horticultural Society, 6-9.

Timmer LW, Garnsey SM and Graham JH, 2000. Compendium of citrus diseases. APS Press, Saint Paul, MN, USA, 92 pp.

Timmer LW, Gottwald TR and Zitko SE, 1991. Bacterial exudation from lesions of Asiatic citrus canker and citrus bacterial spot. Plant Disease, 75, 192-195.

Timmer LW, Zitko SE and Gottwald TR, 1996. Population dynamics of Xanthomonas campestris pv. citri on symptomatic and asymptomatic citrus leaves under various environmental conditions. In: Proceedings of the International Society of Citriculture. Eds Manicom B, Robinson J, Du Plessis SF, Joubert P, Van Zyl JL and Du Preez S. International Society of Citriculture, Sun City, 448-451.

Traoré YN, Bui Thi Ngoc L, Vernière C and Pruvost O, 2008. First report of Xanthomonas citri pv. citri causing citrus canker in Mali. Plant Disease, 92, 977.

Tucker D and Wheaton TA, 1978. Trends in higher citrus planting densities. Proceedings of the Florida State Horticultural Society, 36-40.

Unnamalai N and Gnanamanickam SS, 1984. Pseudomonas fluorescens is an antagonist to Xanthomonas citri (Hasse) Dye, the incitant of citrus canker. Current Science, 53, 703-704.

USDA (United States Department of Agriculture), 1995. Importation of Japanese Unshu orange fruits (Citrus reticulata Blanco var. Unshu Swingle) into citrus producing states: pest risk assessment. USDA, APHIS, PPQ, Riverdale, MD.

USDA (United States Department of Agriculture), 2006. Evaluation of asymptomatic citrus fruit (Citrus spp.) as a pathway for the introduction of citrus canker disease (Xanthomonas axonopodis pv. citri). Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, MD, USA.

USDA (United States Department of Agriculture), 2007a. Evaluation of asymptomatic citrus fruit (Citrus spp.) as a pathway for the introduction of citrus canker disease (Xanthomonas axonopodis pv. citri). Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, MD, USA

USDA (United States Department of Agriculture), 2007b. Risk management analysis, movement of commercially packet Citrus fruit from Citrus canker disease quarantine area. USDA, APHIS, June 2007. Available from: http://www.aphis.usda.gov/peer_review/downloads/3Citrus-ScientificDocumentPriortoPeerReview.pdf

USDA (United States Department of Agriculture), 2007c. Revised risk management analysis, movement of commercially packet Citrus fruit from Citrus canker disease quarantine area. Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, MD, USA. Available from: http://www.aphis.usda.gov/peer_review/downloads/07-022-3RMA11-13-07.pdf

USDA (United States Department of Agriculture), 2007d. Citrus canker peer review, final report. November 2007 Available from: http://www.aphis.usda.gov/peer_review/downloads/0210675_001_001_citrus_report_psg11-8-07.pdf

USDA (United States Department of Agriculture), 2008. An updated evaluation of Citrus fruit (Citrus spp.) as a pathway for the introduction of Citrus canker disease (Xanthomonas axonopodis pv citri). Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, MD, USA. Available from: http://www.aphis.usda.gov/peer_review/downloads/citrus_movement/CitrusCankerUpdate_12-31-08.pdf

USDA (United States Department of Agriculture), 2009a. An Updated Evaluation of Citrus Fruit (Citrus spp.) as a Pathway for the Introduction of Citrus Canker Disease (Xanthomonas citri subsp. citri). Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, MD, USA.

USDA (United States Department of Agriculture), 2009b. Peer Review of Supplemental Risk Management Analysis for Movement of Citrus Fruit from Citrus Canker Disease Quarantine Area. Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, MD, USA.

USDA (United States Department of Agriculture), 2009c. Peer review of supplemental risk management analysis for movement of Citrus fruit from Citrus canker disease quarantine area, final report. March 2009. Available from: http://www.aphis.usda.gov/peer_review/downloads/citrus_movement/Revised%20citrus%20RMA%20peer%20review%20final%20report.pdf

USDA (United States Department of Agriculture), 2009d. Response to peer review, movement of Citrus fruit from Citrus canker disease quarantine area, supplemental risk management analysis. Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, MD, USA. Available from: http://www.aphis.usda.gov/peer_review/downloads/citrus_movement/APHIS_Peer_review_re sponse.pdf.

USDA (United States Department of Agriculture), 2009e. Fresh Fruit Shipment Procedures. Effective October 22, 2009; Version 2.0, 10 pp. Available from: http://stlucie.ifas.ufl.edu/pdfs/citrus/Fresh%20Fruit%20Shipment%20Procedures%2010-22-09%20Ver%202%200%20_2_.pdf

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 – see first reference in the section Documentation provided to EFSA) Available from: http://registerofquestions.efsa.europa.eu/roqFrontend/?wicket:interface=:1::::

Vauterin L, Hoste B, Kersters K and Swings J, 1995. Reclassification of *Xanthomonas*. Int. J. Syst. Bacteriol., 45, 472-489.

Vauterin L and Swings J, 1997. Are classification and phytopathological diversity compatible in *Xanthomonas* ? J. Ind. Microbiol. Biotechnol., 19, 77-82.

Vernière C, Gottwald TR and Pruvost O, 2003. Disease development and symptom expression of *Xanthomonas axonopodis* pv. *citri* in various citrus plant tissues. Phytopathology, 93, 832-843.

Vernière C, Hartung JS, Pruvost OP, Civerolo EL, Alvarez AM, Maestri P and Luisetti J, 1998. Characterization of phenotypically distinct strains of Xanthomonas axonopodis pv. citri from Southwest Asia. European Journal of Plant Pathology, 104, 477-487.

Vernière C, Vital K, Boyer C, Pruvost O and Carter BA, 2013. First report of sequence type 1, pathotype A Xanthomonas citri pv. citri from lime and lemon fruit originating from Bangladesh. Plant Disease, 97, p. 836.

Vicent A, Armengol J and García-Jiménez J, 2009. Protectant activity of reduced concentration copper sprays against Alternaria brown spot on 'Fortune'mandarin fruit in Spain. Crop Protection, 28, 1-6.

Vidalakis G, da Graça JV, Dixon WN, Ferrin D, Kesinger M, Krueger RR, Lee RF, Melzer MJ, Olive J, Polek ML, Sieburth PJ, Williams LL and Wright GC,2010. Citrus Qarantine Sanitary and Certification Programs in the USA, Prevention of Inroduction and Distribution of Citrus Diseases, Part 1 — Citrus quarantine and introduction programs, Citrograph, May-June 2010, 26-39.

Von Broembsen L and Lee A, 1988. South Africa's citrus improvement programme. Proceedings of the Proceedings of the 10th Conference of the International Organization of Citrus Virologists"(LW Timmer, SM Garnsey and L. Navarro, Eds.), 407-416.

Wallace A, Zidan ZI, Mueller RT and North CP, 1954. Translocation of nitrogen on citrus trees. Proceedings of the American Society of Horticulture Science 64:87-104.

Wardowski WF, 1981. Packinghouse operations and shipping conditions of citrus for export. Proceedings of the Florida State Horticultural Society, 94, 254-256.

Wills R, McGlasson B, Graham D and Joyce D, 1998. Post harvest: an introduction to the physiology and handling of fruit, vegetables and ornamentals. CAB International, Wallingford, UK, 262 pp.

Wu W, Chung K and Chang W, 1995. Stability of the Xanthomonas campestris pv. citri phages CP115 and CP122. Plant Pathology Bulletin,4, 1-7.

Young JM, Bradbury JF, Davis RE, Dickey RS, Ercolani GL, Hayward AC and Vidaver AK, 1991. Nomenclatural revisions of plant pathogenic bacteria and list of names 1980-1988. Rev. Pl. Pathol. 70:211-221.

Young JM, Bull C, De Boer S, Firrao G, Gardan L, Saddler G, Stead D and Takikawa Y, 2001. International standards for naming pathovars of phytopathogenic bacteria. Available from: http://www.isppweb.org/about_tppb_naming.asp

Young JM, Park DC, Shearman HM and Fargier E, 2008. A multilocus sequence analysis of the genus Xanthomonas. Systematic and Applied Microbiology, 31, 366-377.

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, 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 *Xanthomonas campestris* (all strains pathogenic to *Citrus)* for the EU territory and the evaluation of the effectiveness of the risk reduction options, 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

Rating for spread	**Descriptors**
Very unlikely	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.
Unlikely	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.
Moderately likely	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.
Likely	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.
Very likely	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; 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 risk reduction options to reduce the level of risk.

3.1. Rating of the effectiveness of risk reduction options

Rating of the effectiveness of RRO	Descriptors
Negligible	The risk reduction option has no practical effect in reducing the probability of entry or establishment or spread, or the potential consequences.
Low	The risk reduction option reduces, to a limited extent, the probability of entry or establishment or spread, or the potential consequences.
Moderate	The risk reduction option reduces, to a substantial extent, the probability of entry or establishment or spread, or the potential consequences.
High	The risk reduction option reduces the probability of entry or establishment or spread, or the potential consequences, by a major extent.
Very high	The risk reduction option essentially eliminates the probability of entry or establishment or spread, or any potential consequences.

3.2. Rating of the technical feasibility of risk reduction options

Rating of technical feasibility of RRO	Descriptors
Negligible	The risk reduction option 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 risk reduction option 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 risk reduction option 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 risk reduction option is not in use in the risk assessment area, but it can be implemented in practice (e.g., changing or abandoning the current practices, implement new practices and or measures) with limited technical difficulties.
Very high	The risk reduction option 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 X. citri pv. *citri* and *X. citri* pv. *aurantifolii* as extracted from the EPPO-PQR database on March 5th, 2013 (EPPO, online)

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
Reunion		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	Parana	Present, no details
Brazil	Rio Grande do Sul	Present, no details
Brazil	Santa Catarina	Present, no details
Brazil	Sao 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 Dem. People's Republic		Present, no details
Korea, Republic		Present, no details
Lao		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
Viet Nam		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 MS in 2008 -2012

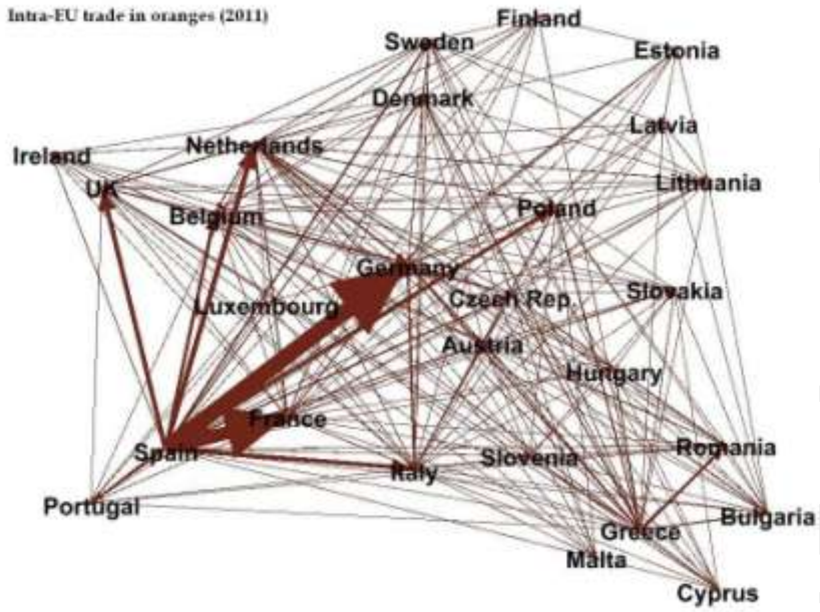
Table C.1: Number of consignments inspected for citrus canker by MS according the information provided by the MS

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	1002	955
France	Not provided	Not provided	Not provided	Not provided	Not provided
Germany	1532	986 Data incomplete	1403 Data incomplete	1325	1292
Greece	294	888	403	664	453
Hungary	137	84	233	109	107
Ireland	1 965	1 694	1 637	1 399	1 774
Italy	1153	1108	1058	1170	1166
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

Appendix D. Citrus fruit movement within the EU

<u>Sweet oranges</u>

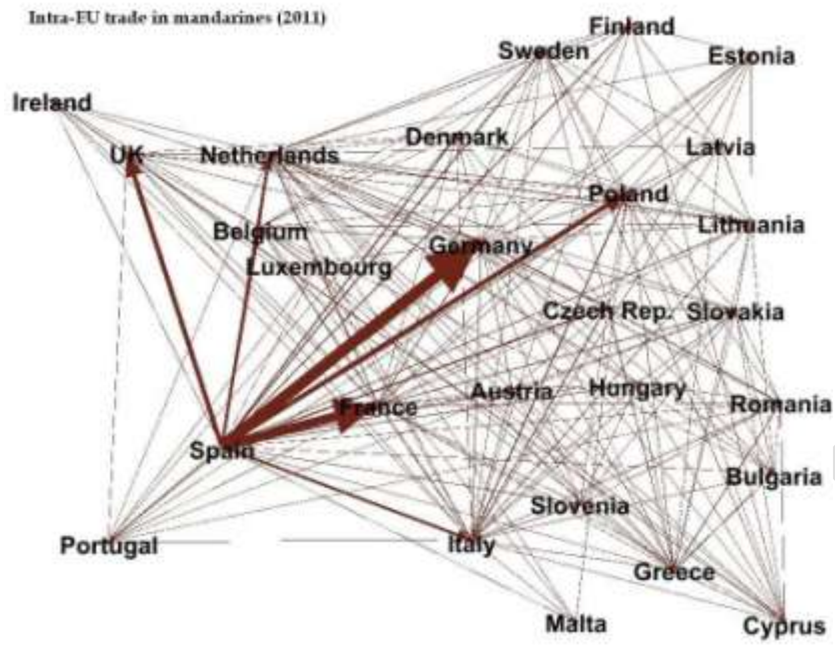
The network based on the intra-EU (thus without Switzerland and Norway) trade data for oranges in 2011 is shown in the following graph. The weight of the links is proportional to trade volume. The network has N = 27 nodes and L = 310 links (310 incoming and 310 outgoing), and thus a connectance ($C = L/N^2$) of 0.44. This means that 44% of the potential links are realized. The total amount of oranges traded in 2011 is about 2 million tons.



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).

<u>Mandarins</u>

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).

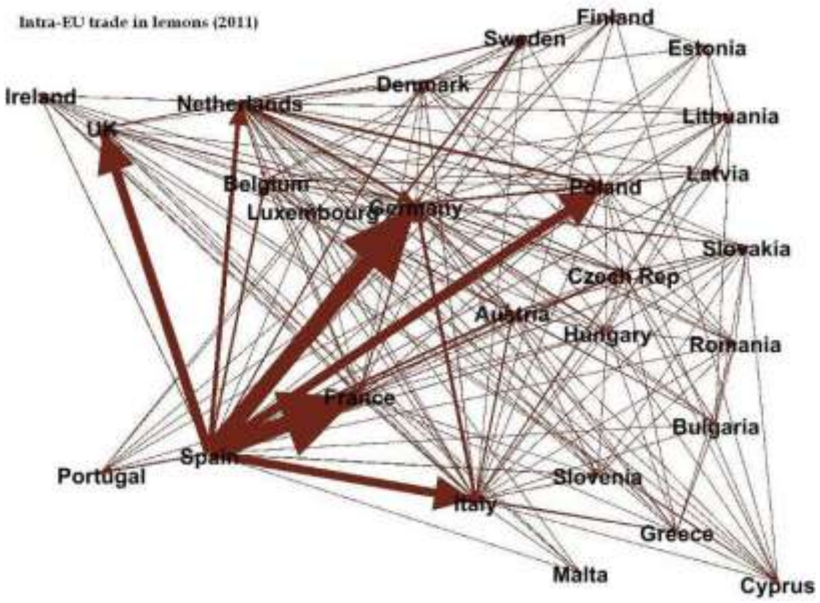


There are six countries exporting mandarins to at least 20 EU countries: the Netherlands (to 26 countries), Spain (25), Italy (25), Germany (22), France (21) and Greece (20).

No EU country imports mandarins from 20 EU countries, with Italy importing them from 17 countries and Spain and Poland from 16.

<u>Lemons</u>

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 addition of Italy, Poland and the UK).



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, 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, under preparation).

Appendix E. Stockhouses and shipping centers in zones of citrus production in Spain

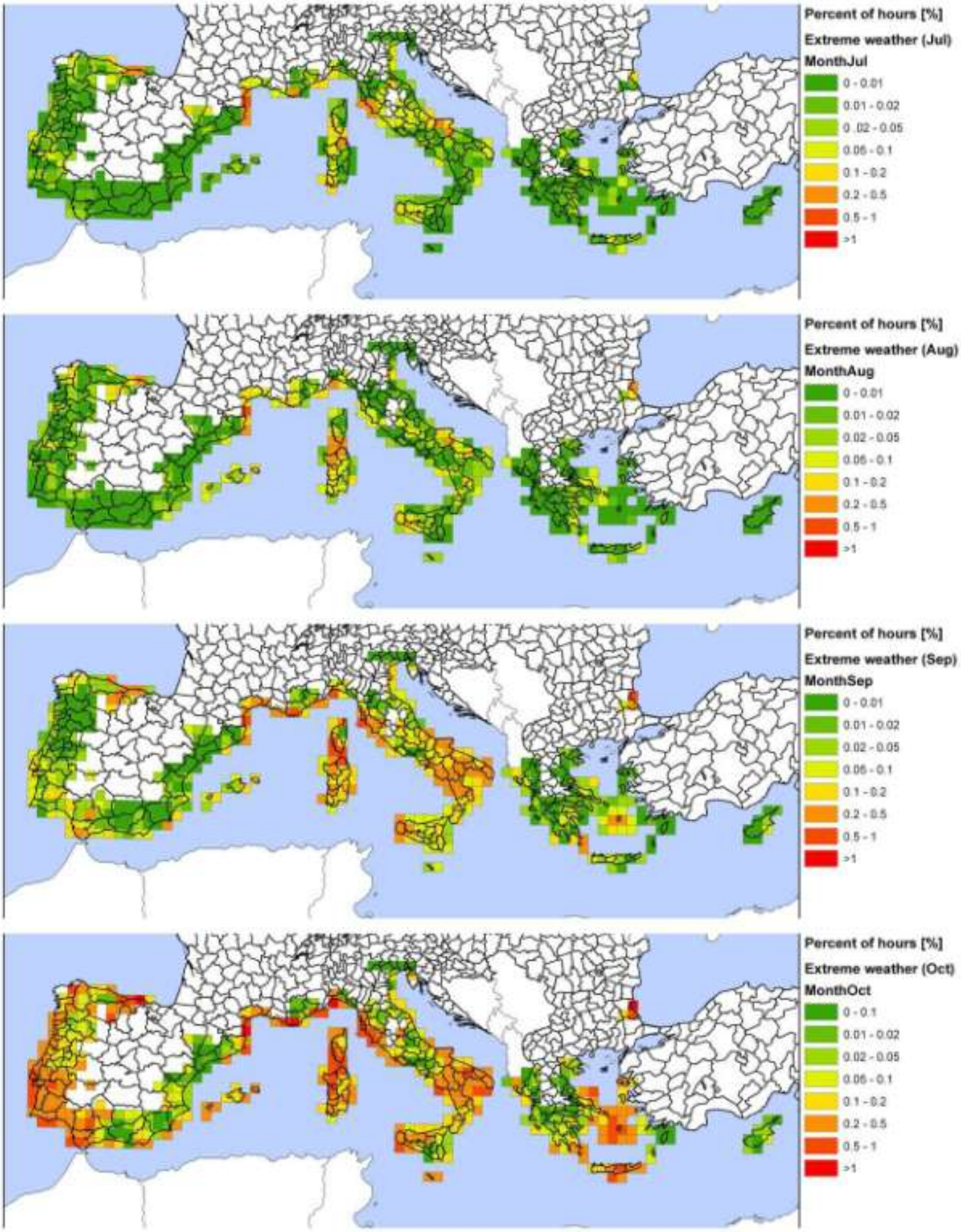
Table E.1: Stockhouses and shipping centers in zones of citrus production in Spain (EFSA, 2008)

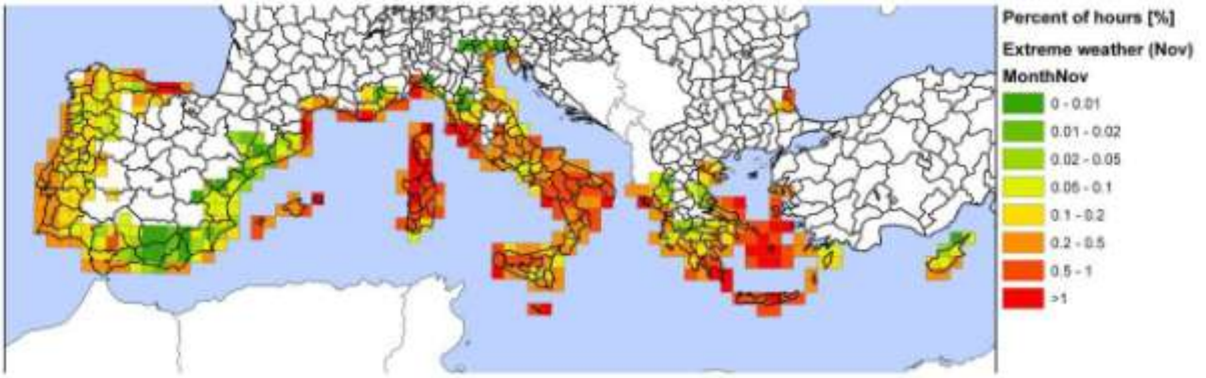
AUTONOMOUS COMMUNITY	PROVINCE	MUNICIPALITY	NUMBER OF STOCKHOUSES/SHIPPING CENTERS
ANDALUCIA	**ALMERIA**	Roquetas	1
		Vera	1
		TOTAL	**2**
	CÁDIZ	Algeciras	1
		Chipiona	3
		Conil de la Frontera	1
		Jimena de la Frontera	3
		San Roque	1
		TOTAL	**9**
	GRANADA	Lecrin	1
		Santa Fe	1
		TOTAL	**2**
	HUELVA	Campillo	1
		Cartaya	1
		Gibraleón	1
		Lepe	3
		Moguer	1
		San Juan del Puerto	2
		Villarrasa	1
		TOTAL	**10**
	MÁLAGA	Alhaurín de la Torre	3
		Benamargosa	1
		Cartama	3
		Casares	1
		Estepona	1
		Málaga	1
		Pizarra	3
		Vélez-Málaga	2
		TOTAL	**15**
	SEVILLA	Brenes	1
		Cantillana	1
		Mairena del Alcor	1
		Tocina	1
		Villaverde del Río	1
		Viso del Alcor	1
		TOTAL	**6**
CATALUÑA	**TARRAGONA**	Ulldecona	1
		TOTAL	**1**
MURCIA		Abanilla	1
		Abarán	8
		Alguazas	1
		Alhama	6
		Archena	4
		Beniel	17
		Blanca	13
		Bullas	1
		Calasparra	2
		Cartagena	3
		Ceutí	1
		Cieza	7
		Librilla	2
		Lorca	3
		Lorquí	1
		Mazarrón	1
		Molina de Segura	4
		Mula	2
		Murcia	70
		San Javier	1
		San Pedro del Pinatar	3
		Santomera	9
		Torre Pacheco	3
		Totana	2

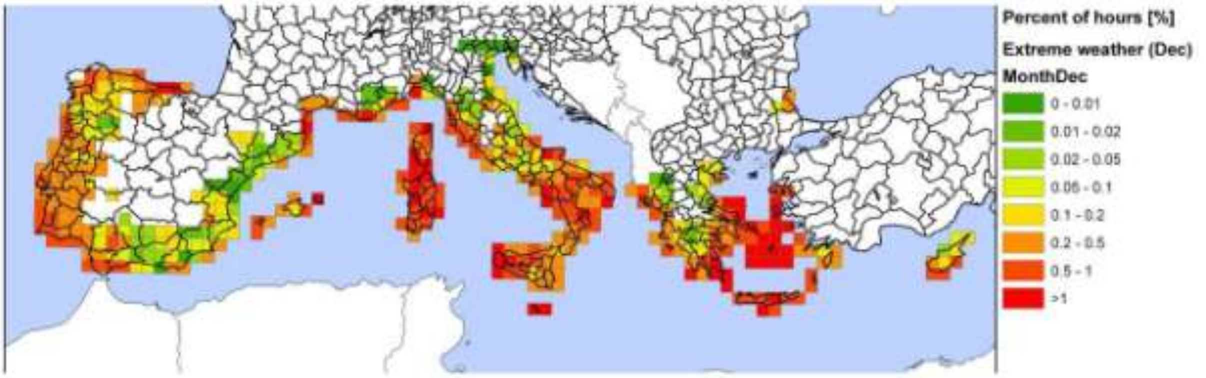
AUTONOMOUS COMMUNITY	PROVINCE	MUNICIPALITY	NUMBER OF STOCKHOUSES/SHIPPING CENTERS
		Ulea	3
		Villanueva del Rio Segura	1
		TOTAL	**167**
COMUNIDAD VALENCIANA	**ALICANTE**	Alicante	2
		Altea	1
		Bigastro	1
		Pilar de la Horadada	2
		San Juan	1
		TOTAL	**7**
	CASTELLÓN	Almassora	1
		Almenara	3
		Alqueries del Niño Perdido	1
		Betxí	5
		Burriana	4
		Castellón	1
		La Llosa	1
		Nules	1
		Xilxes	2
		Vall d'Uixó	1
		Vila-Real	2
		TOTAL	**22**
	VALENCIA	Albalat dels Sorells	1
		Albuixech	1
		Alcacer	1
		Alqueria de la Comtesa	1
		Alzira	1
		Benifairó de la Valldigna	4
		Canals	1
		Carlet	2
		Carcaixent	1
		Corbera	2
		Cullera	1
		Estubeny	1
		Faura	1
		La Pobla del Duc	1
		Miramar	1
		Museros	1
		Picanya	1
		Piles	1
		Puçol	1
		Puig	1
		Quartell	1
		Oliva	2
		Silla	1
		Tavernes de la Valldigna	1
		Valencia	17
		Villanueva de Castelló	2
		TOTAL	**49**

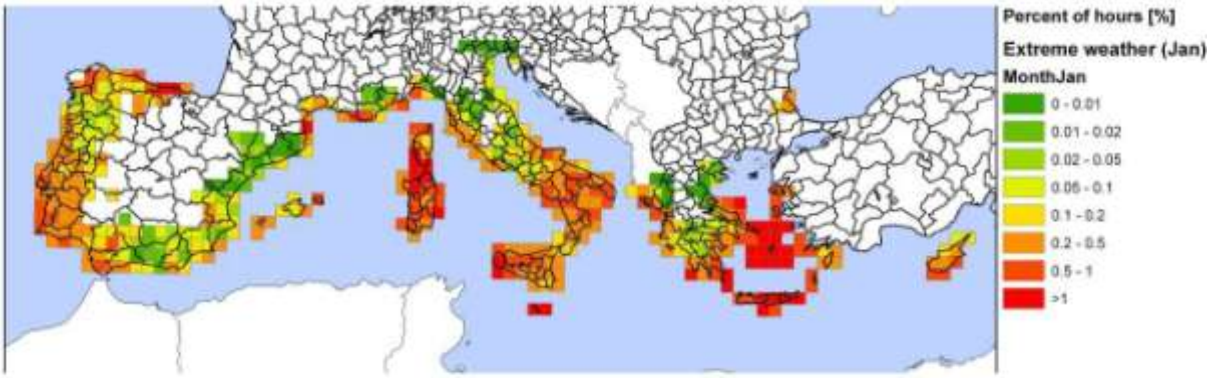
Appendix F. Monthly percentage of hours with suitable weather conditions

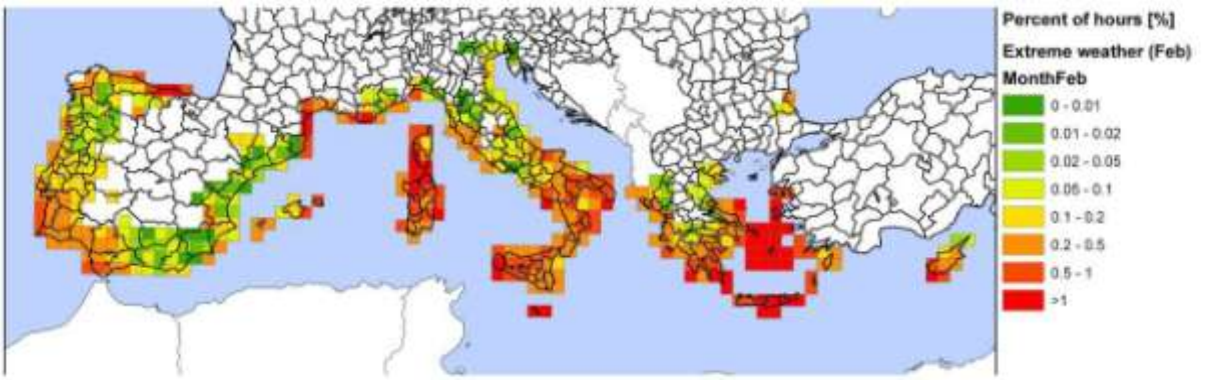
Figure F.1: Monthly percentage of hours with suitable weather conditions (wind speed > 8 m/s, rainfall > 0 mm, average temperature > 5°C) in citrus growing area of Europe (Average of the years 1998 – 2007, in a grid of 50x50 km (JRC 2008))

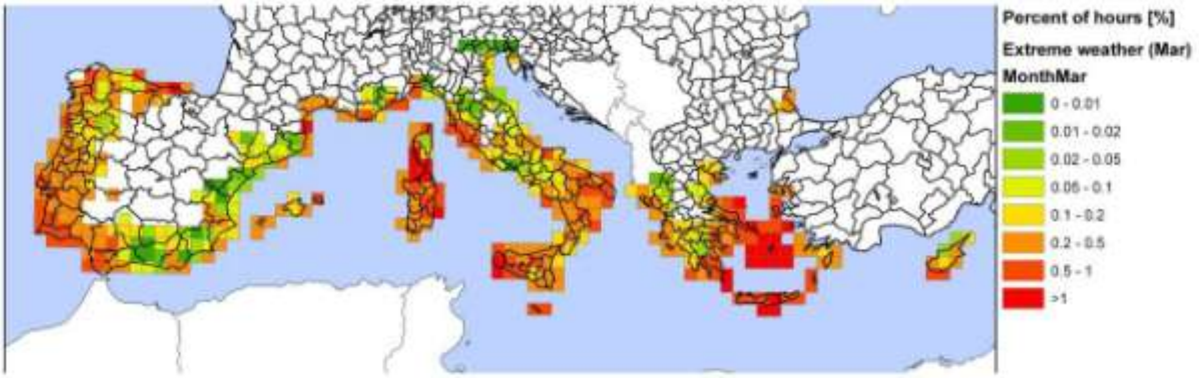


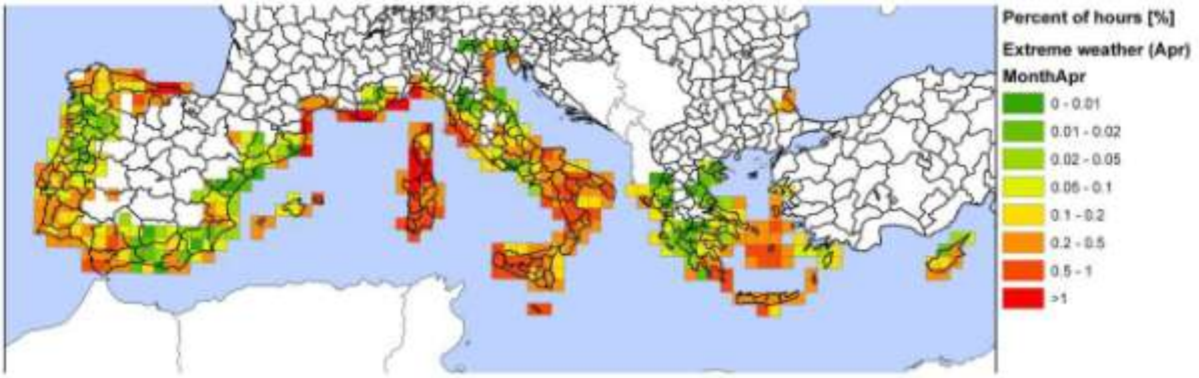

Percent of hours [%]
Extreme weather (Nov)
MonthNov
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1

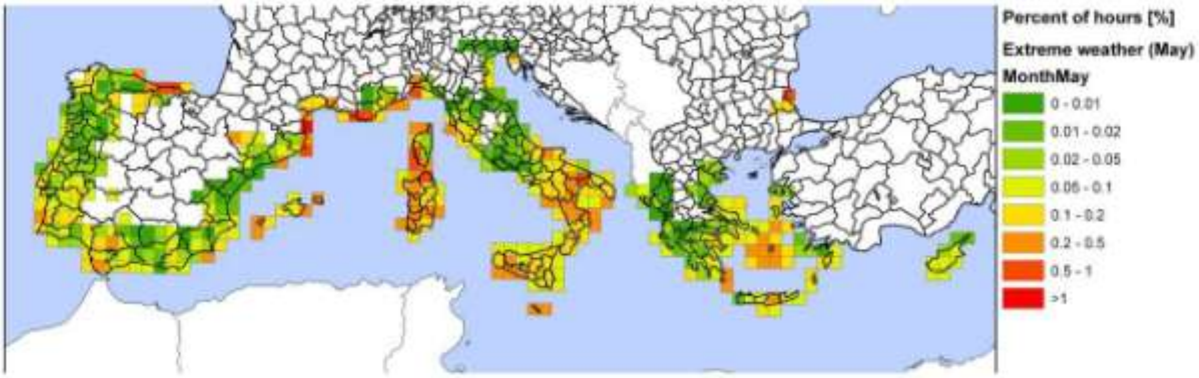

Percent of hours [%]
Extreme weather (Dec)
MonthDec
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1


Percent of hours [%]
Extreme weather (Jan)
MonthJan
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1


Percent of hours [%]
Extreme weather (Feb)
MonthFeb
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1


Percent of hours [%]
Extreme weather (Mar)
MonthMar
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1


Percent of hours [%]
Extreme weather (Apr)
MonthApr
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1


Percent of hours [%]
Extreme weather (May)
MonthMay
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1


Percent of hours [%]
Extreme weather (Jun)
MonthJun
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1
>1

Appendix G. Personal communications

1. 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 importation of citrus plant material to the quarantine facility in Spain for the last 10 years. The information provided is reflected in the Table 7.

Luis Navarro has been contacted to ask her if she is content with the way her contribution has been entered in the table.

2. 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 importation of citrus plant material to the quarantine facility in France for the last 10 years. The information provided is reflected in the Table 7.

Philippe Legrand has been contacted to ask him if he is content with the way his contribution has been entered in the table.

3. Christian Vernière, 2013

In April 2013 the Panel contacted Christian Vernire (Research Plant Pathologist in Laboratoire de Pathologie et Génétique Moléculaire, CIRAD Réunion, 7 chemin de l'IRAT, 97410 St. Pierre, Reunion Island,France) in order to obtain information regarding the evaluation of the citrus canker situation in Mali based on his visit in 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 him if he is content with the way his contribution has been presented in the opinion.

4. Bruno Hostachy, 2013

In May 2013 the Panel contacted Bruno Hostachy (Head of tropical pest and diseases, Laboratoire de la santé des végétaux, Station de la Réunion, Pôle de Protection des Plantes, Bât. CIRAD, Ligne Paradis, 7 chemin de l'IRAT, 97410 SAINT PIERRE, 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 table F.1. and F.2.).

Bruno Hostachy has been contacted to ask him if he is content with the way his contribution has been presented in the 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 frais	INDE	2	Roissy (PEC)	0
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
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 ...)	ITALIE	1	Aéroport Nice Côte d'Azur (PEC	0
2002	*Citrus limon*	Plantes finies, semi-finies (plante en pot, arbre ...)	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	VIET NAM	1	Roissy (PEC)	0.001

		frais				
2004	Citrus sinensis	Inflorescence seules	TUNISIE	1	Orly (PEC)	0.001
2004	Fortunella sp.	Plantes finies, semi-finies (plante en pot, arbre ...)	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 ...)	EGYPTE	1	Marseille port (PEC)	0
2005	*Citrus sinensis*	Plantes finies, semi-finies (plante en pot, arbre ...)	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 secs	IRAN	1	Le Havre port (PEC)	4.939
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

5. Maria Holeva

'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 the section 3.3.1.

Maria Holeva has been contacted to ask her if she is content with the way her contribution has been presented in the opinion."

Acknowlegements: the Panel wished to aknowledge Luis Navarro, Philippe Legrand, Christian Vernière, Bruno Hostachy and Maria Holeva for their contributions.