SCIENTIFIC OPINION

Scientific opinion on the risks to plant health posed by *Stagonosporopsis chrysanthemi* (Stevens) Crous, Vaghefi and Taylor [*Didymella ligulicola* (Baker, Dimock and Davis) Arx var. *ligulicola*; syn. *Didymella ligulicola* (Baker, Dimock and Davis) Arx] in the EU territory, with identification and evaluation of risk reduction options[1]

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

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ABSTRACT

The EFSA Panel on Plant Health conducted a risk assessment of *Didymella ligulicola* (current name *Stagonosporopsis chrysanthemi*) for the European Union territory, identified risk management options and evaluated their effectiveness in reducing the risk to plant health posed by the organism. The Panel also evaluated the effectiveness of the present EU requirements (Council Directive 2000/29/EC) against this organism. *S. chrysanthemi* causes ray blight of *Chrysanthemum* × *morifolium* and is present in the EU. The Panel conducted the risk assessment considering the current EU plant health legislation in place and reached the following conclusions. The probability of entry of *S. chrysanthemi* into the EU on the *Chrysanthemum* × *morifolium* plants for planting pathway and the cut flowers pathway is unlikely with a medium uncertainty. The probabilities of establishment and spread of *S. chrysanthemi* in the EU are very likely with low uncertainties, as the host is extensively grown in the EU and the climatic conditions are suitable for infection, sporulation, spread and survival of the pathogen. The damage caused by the pathogen in the EU is currently minor because of the existing agricultural practices applied to chrysanthemum crops. No negative environmental impacts are foreseen. The effectiveness of the current EU requirement of visual inspection of host plant material in reducing the risk of introduction into, and spread within, the EU of the pathogen is low with a high uncertainty, as it is not possible to distinguish the effect of the legislation from that of the voluntary certification schemes currently used for the production of chrysanthemum plant propagation material. If the current EU regulations regarding the pest were to be removed and the voluntary certification schemes remained in place, there would be no great effect on the risk of introduction, spread and impact of *S. chrysanthemi* in the EU territory.

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KEY WORDS

Didymella ligulicola, *Stagonosporopsis chrysanthemi*, *Chrysanthemum* × *morifolium*, *Chrysanthemum* spp., *Dendranthema* spp., florist's chrysanthemum, ray blight of chrysanthemum, risk reduction options

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SUMMARY

Following a request from the European Commission, the EFSA Panel on Plant Health (hereafter the Panel) was asked to deliver a scientific opinion on the pest risk of *Didymella ligulicola* for the European Union territory, to identify risk management options and to evaluate their effectiveness in reducing the risk to plant health posed by the organism. In particular, the Panel was asked to provide an opinion on the effectiveness of the current EU requirements against this organism, which are laid down in Council Directive 2000/29/EC, in reducing the risk of introduction of this pest into, and its spread within, the EU territory. EFSA was also requested to concentrate in particular on the analysis of the present spread of the organism in comparison with the endangered area, the analysis of the observed and potential impacts of the organism and the availability of effective and sustainable control methods.

In conducting the pest risk assessment, the Panel took into consideration the recent developments in the taxonomy of *D. ligulicola* (current name *Stagonosporopsis chrysanthemi*), the causal agent of ray blight of chrysanthemum (i.e. *Chrysanthemum* × *morifolium* referred to as *Dendranthema* in the EU legislation). 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 PLH Panel, 2012). Given the fact that *S. chyrsanthemi* is already present in some EU Member States and has been regulated by the EU for many years under the name *D. ligulicola*, the Panel conducted the risk assessment considering the scenario of the current EU plant health legislation in place.

"The PLH Panel also considers that the information on the presence of the organism in the risk assessment area should be treated with caution due to the uncertainty about the correspondence between the organism isolated in the past from *Chrysanthemum* × *morifolium* plants showing ray blight-like symptoms and the causal agent of ray blight under its current taxonomic status (i.e. *S. chrysanthemi*).

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

With regard to the assessment of the risk to plant health posed by *S. chrysanthemi* for the EU territory:

Entry

The probability of entry of *S. chrysanthemi* into the EU territory is **unlikely** for the *Chrysanthemum* × *morifolium* plants for planting excluding pot plants and seeds (i.e. rooted and unrooted cuttings) pathway. The pathogen (i) may be present on such material originating in infested third countries, (ii) can survive transport and storage conditions, and (iii) can be transferred from the pathway to *Chrysanthemum* × *morifolium* plants grown in close proximity in the risk assessment area by natural and human-assisted means. Nevertheless the standard certification schemes currently used for the production of chrysanthemum cuttings and the EU legislation have considerably reduced the risk of entry of the pathogen on such plant material into the EU territory.

However, the above rating is associated with a **medium uncertainty** because of lack of data on whether all chrysanthemum cuttings imported into the risk assessment area have been produced under an appropriate certification scheme. The probability of entry of *S. chrysanthemi* into the EU territory is **unlikely** for the *Chrysanthemum* × *morifolium* cut flowers pathway. Although the pathogen (i) may be present on such plant material, (ii) can survive transport and storage conditions, and (iii) can survive to some extent existing pest management procedures, it is unlikely to be transferred from the pathway to *Chrysanthemum* × *morifolium* grown within the vicinity in the risk assessment area, provided that cut flower waste is properly managed.

The above rating is associated with a **medium uncertainty** because of lack of data on the probability of infected cut flowers or their waste coming into contact with hosts grown in close proximity in the risk assessment area.

Establishment

The probability of establishment of *S. chrysanthemi* in the EU territory is **very likely**. The pathogen is present in some parts of the risk assessment area, although with a restricted distribution. *Chrysanthemum* × *morifolium* plants are widely distributed in the risk assessment area and are susceptible to infection by the pathogen throughout the whole growing period. The environmental conditions are suitable for infection, inoculum production and survival of the pathogen. Existing cultural practices and chemical control measures may reduce the disease severity, but they cannot prevent the establishment of the pathogen.

The **uncertainty** for the probability of establishment is rated as **low**, although there is a lack of precise information on the cultural practices and chemical control measures applied in the risk assessment area for the management of other chrysanthemum fungal pathogens.

Spread

The probability of spread of *S. chrysanthemi* following its establishment in the EU territory is **very likely**. The environmental conditions prevailing in parts of the EU territory are suitable for sporulation and dispersal of the pathogen. The pathogen can spread by both natural means and human assistance. *Chrysanthemum* × *morifolium* plants are widely grown in the EU territory.

The uncertainty associated with the above rating is **low**, despite the fact that there are no studies on the distance over which the pathogen can be spread by weather-related events.

With regard to the risk reduction options, the Panel evaluated the effectiveness of the current EU requirements (Council Directive 2000/29/EC) against *S. chrysanthemi*, explored the possible consequences if these measures were to be removed and identified additional risk reduction options to enhance the current measures.

The PLH Panel considered that the current EU requirement of visual inspection of host plant material is not reliable for detecting *S. chrysanthemi*, as infection might be latent and ray blight symptoms might be missed or confused with those of other diseases. The frequency and the exact timing for visual inspection are not specified and no alternative or complementary measures are envisaged in the current regulations. The **effectiveness** of visual inspection in reducing the risk of introduction into and spread within the EU territory of the pathogen is considered by the PLH Panel to be **low**. The **uncertainty** associated with this rating is **high** as, under the current situation, it is not possible to distinguish the effect of the current legislation from that of the voluntary certification schemes used for the production of chrysanthemum cuttings.

In the event that the current EU regulations regarding the pest were removed and the voluntary certification schemes remained in place, there would be no great effect on the risk of introduction into and spread within or on the impact of *S. chrysanthemi* in the EU territory. However, if the current EU legislation was to be removed and at the same time the chrysanthemum industry stopped the application of its certification schemes for the production of chrysanthemum plants for planting, the risk of introduction and spread, as well as the impact of *S. chrysanthemi*, in the risk assessment area would increase.

The PLH Panel identified the following additional risk reduction options that could enhance the current EU phytosanitary measures against the introduction into and spread within the EU of *S. chrysanthemi*.

Of the risk reduction options that could reduce the probability of entry of *S. chrysanthemi* into the risk assessment area, prohibition is a very highly effective measure, with very high technical feasibility and

low uncertainty. Pest freedom of the consignment can be detected by visual inspection and laboratory testing. The effectiveness of visual inspection is low, whereas that of laboratory testing is high, with high or moderate to high technical feasibility, respectively, and low uncertainty.

The effectiveness of cultural practices combined with sanitation measures and fungicide treatments of the crop applied at the place of origin is high with a high technical feasibility and low uncertainty. Growing chrysanthemum plants far from infected host crops can prevent infection very effectively. At shorter distances exclusion conditions can reduce but cannot fully prevent the infection, therefore the effectiveness is low. The technical feasibility in both cases is high. The level of uncertainty for the ratings given for the effectiveness and technical feasibility is medium and low, respectively. The effectiveness of a certification scheme for the production of host plant propagation material is considered very high, with high technical feasibility and low uncertainty.

The effectiveness of a pest-free area of production is very high, with moderate technical feasibility and low uncertainty. The effectiveness of a pest-free place of production or production site is very high, with a high technical feasibility and low uncertainty.

In terms of preventing establishment, the effectiveness of systematic surveillance as a risk reduction option is high with moderate technical feasibility and a low uncertainty. Eradication is a highly effective option, with high technical feasibility and low uncertainty but only in cases in which the pathogen was not present in the area in the past.

To reduce the probability of further spread of S. *chrysanthemi* within the EU territory, waste management of chrysanthemum cut flowers, which are discarded when they are no longer fresh, is highly effective with moderate technical feasibility and low uncertainty.

The options identified above for reducing the risk of entry, establishment and further spread of the pathogen in the EU territory are also appropriate for reducing its impact.

<u>Analysis of present spread of the organism in comparison with the endangered area</u>

The PLH Panel considers the whole EU as an endangered area, as *Chrysanthemum* × *morifolium* plants are extensively grown in the territory and the pathogen can infect, reproduce and survive over a wide range of temperature and humidity. The area of the pathogen's present distribution in the EU territory is limited compared with the endangered area. Nevertheless, there are uncertainties with respect to the real distribution of *S. chrysanthemi* in the risk assessment area because of the taxonomic confusion that occurred in the past over the pathogen.

<u>Analysis of the observed and potential impacts of the organism</u>

The damage caused by the pathogen in the risk assessment area is currently **minor** because of the existing agricultural practices applied to chrysanthemum crops, and no negative environmental impacts are foreseen. The **uncertainty** is **medium** because of lack of information on the level of resistance of the chrysanthemum cultivars grown in the EU, the efficacy of recent fungicides against the pathogen and the potential development of resistance of the pathogen to fungicides.

<u>Availability of effective and sustainable control methods</u>

The PLH Panel considers that the cultural practices and sanitation measures (e.g. use of pathogen-free propagation material, monitoring of the crop, avoiding overhead irrigation, proper management of waste plant material, soil disinfestation with steam, use of clean irrigation water, general hygiene measures, etc.) currently applied to chrysanthemum crops in the risk assessment area for the control of *S. chrysanthemi* and other chrysanthemum pathogens are effective in reducing the severity of ray blight disease. Resistance of *Chrysanthemum* × *morifolium* cultivars to ray blight has been reported in the past. However, because of the lack of recent studies on this aspect, there is uncertainty about the level of resistance present in the cultivars currently grown in the risk assessment area and worldwide. No biological control methods are available.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

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

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

Arabic mosaic virus, Tomato black ring virus, Raspberry ringspot virus, Strawberry latent ringspot virus, Strawberry crinkle virus, Strawberry mild yellow edge virus, *Daktulosphaira vitifoliae* (Fitch), *Eutetranychus orientalis* Klein, *Parasaissetia nigra* (Nietner), *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis et al., *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx, and *Phytophthora fragariae* Hickmann var. *fragariae* are regulated harmful organisms in the EU. They are all listed in Annex II, Part A, Section II of Council Directive 2000/29/EC, which means that they are organisms known to occur in the EU and whose introduction into and spread within the EU is banned if they are found present on certain plants or plant products.

Given the fact that these organisms are already locally present in the EU territory and that they are regulated in the EU since a long time, it is considered to be appropriate to evaluate whether these organisms still deserve to remain regulated under Council Directive 2000/29/EC, or whether, if appropriate, they should be regulated in the context of the marketing of plant propagation material, or be deregulated. In order to carry out this evaluation a recent pest risk analysis is needed which takes into account the latest scientific and technical knowledge on these organisms, including data on their agronomic and environmental impact, as well as their present distribution in the EU territory.

The revision of the regulatory status of these organisms is also in line with the outcome of the recent evaluation of the EU Plant Health Regime, which called for a modernisation of the system through more focus on prevention and better risk targeting (prioritisation).

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 Arabic mosaic virus, Tomato black ring virus, Raspberry ringspot virus, Strawberry latent ringspot virus, Strawberry crinkle virus, Strawberry mild yellow edge virus, *Daktulosphaira vitifoliae* (Fitch), *Eutetranychus orientalis* Klein, *Parasaissetia nigra* (Nietner), *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis et al., *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx, and *Phytophthora fragariae* Hickmann var. *fragariae*, for the EU territory.

For each organism EFSA is asked to identify risk management options and to evaluate their effectiveness in reducing the risk to plant health posed by the organism. EFSA is also requested to provide an opinion on the effectiveness of the present EU requirements against those organisms, which are laid down in Council Directive 2000/29/EC, in reducing the risk of introduction of these pests into, and their spread within, the EU territory.

Even though a full risk assessment is requested for each organism, in order to target its level of detail to the needs of the risk manager, and thereby to rationalise the resources used for its preparation and to speed up its delivery, EFSA is requested to concentrate in particular on the analysis of the present spread of the organism in comparison with the endangered area, the analysis of the observed and potential impacts of the organism as well as the availability of effective and sustainable control methods.

ASSESSMENT

1. Introduction

There has been a considerable amount of taxonomic confusion in the past over the causal agent of the disease ray blight of chrysanthemum. The current EU plant health legislation (Council Directive 2000/29/EC) is for *Didymella ligulicola*, but this species has been recently reclassified as *Stagonosporopsis chrysanthemi* (Stevens) Crous, Vaghefi and Taylor.

Two varieties had been identified in the past within the species *D. ligulicola*: (i) *D. ligulicola* var. *ligulicola* (syn. *Phoma ligulicola* var. *ligulicola*), and (ii) *D. ligulicola* var. *inoxydabilis* (syn. *P. ligulicola* var. *inoxydabilis*) (Van der Aa et al., 1990). Both varieties exist in Europe, and probably elsewhere, with the latter occurring on various wild and cultivated Asteraceae (Van der Aa et al., 1990).

The epithet *ligulicola* was introduced by Baker et al. (1949) after describing the teleomorph in *Mycosphaerella*, to avoid confusion with *Sphaerella chrysanthemi* (Tassi, 1900), a little-known fungus described in Italy. Also the names *Mycosphaerella chrysanthemi* (Tomilin, 1979) and *Didymella chrysanthemi* (basionym *Sphaerella chrysanthemi*), have been widely used erroneously, based on the supposed identity between *Mycosphaerella ligulicola*, described in the USA, and *S. chrysanthemi*, reported in Europe. Walker and Baker (1983) demonstrated that the American species is distinct and it did not reach Europe until the 1960s.

D. ligulicola var. *ligulicola* was recently recognised in the genus *Stagonosporopsis* (Aveskamp et al., 2010) and the name *Stagonosporopsis ligulicola* var. *ligulicola* was proposed, with *Mycosphaerella ligulicola* (Baker et al., 1949) as the basionym. However, after transferring the species to *Stagonosporopsis*, the older epithet, i.e. *chrysanthemi*, based on *Ascochyta chrysanthemi* (Stevens, 1907), was preferred over *ligulicola*, thus the combination *Stagonosporopsis chrysanthemi* is the current name (Vaghefi et al., 2012). In Vaghefi et al. (2012), *D. ligulicola* var. *inoxydabilis* has been redescribed as *Stagonosporopsis inoxydabilis*. In addition, a new species, *Stagonosporopsis tanaceti*, was recognised as the causal agent of ray blight disease of *Tanacetum cinerariifolium* (pyrethrum), *Tagetes patula* and *Chrysanthemum carinatum* in Australia.

Therefore, in the current risk assessment and in order to avoid further confusion, the Panel on Plant Health (hereinafter referred to as the (PLH) Panel) has used from this point onwards the name *Stagonosporopsis chrysanthemi* (Stevens) Crous, Vaghefi and Taylor for the fungus that causes the ray blight disease of chrysanthemum (i.e. cultivars of *Chrysanthemum* × *morifolium*, referred to as *Dendranthema* in the EU legislation).

1.1. Purpose

This document presents a risk assessment prepared by the PLH Panel for *S. chrysanthemi*, in response to a request from the European Commission. The opinion includes the identification and evaluation of risk management options in terms of their effectiveness in reducing the risk posed by the organism.

1.2. Scope

The scope of the opinion is (i) to assess the risks posed by *S. chrysanthemi* to the EU territory; (ii) to identify risk reduction options and evaluate their effectiveness in reducing the risk to plant health posed by *S. chrysanthemi* and (iii) to provide an opinion on the effectiveness of the present EU requirements in reducing the risk of introduction of this organism into and its spread within the EU territory. In addition the opinion concentrates on the analysis of (iv) the present spread of the organism in comparison with the endangered area, (v) the observed and potential impacts of *S. chrysanthemi*, and (vi) the availability of effective and sustainable methods for the control of the organism.

The species *S. inoxydabilis* and *S. tanaceti* 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) with 28 Member States (hereinafter referred to as EU MS),[4] restricted to the area of application of Council Directive 2000/29/EC, which excludes Ceuta and Melilla, the Canary Islands and the French overseas departments.

2. Methodology and data

2.1. Methodology

2.1.1. The guidance documents

The risk assessment is 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 detailed questions in the EFSA-adapted European and Mediterranean Plant Protection Organization (EPPO) risk assessment scheme, presented in the above-mentioned guidance document, were used as a checklist to ensure that all relevant elements were included. However, the terms of reference require the opinion to "concentrate in particular on the analysis of the present spread of the organism in comparison with the endangered area, the analysis of the observed and potential impacts of the organism as well as the availability of effective and sustainable control methods". The entry Section (Section 3.2) examines the different pathways that have been found to transport the pest species and assesses the effectiveness of the current measures in Council Directive 2000/29/EC in terms of preventing entry. The establishment Section (Section 3.3) focuses on determining the area of potential establishment.

The evaluation of risk reduction options is conducted in line with the principles described in the above-mentioned guidance document (EFSA Panel on Plant Health (PLH), 2010), as well as with those in "Guidance on methodology for evaluation of the effectiveness of options to reduce the risk of introduction and spread of organisms harmful to plant health in the EU territory" (EFSA PLH Panel, 2012).

In order to follow the principle of transparency, as described under Section 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 PLH Panel developed rating descriptors to provide clear justification when a rating was given, which are presented in Appendix A of this opinion.

2.1.2. Methods used for conducting the risk assessment

As *S. chrysanthemi* is already present in the EU territory and has been regulated for a long time under the name *D. ligulicola* (Annex IIAII of Council Directive 2000/29/EC[5]), the Panel not only took into account the existing legislation when conducting the pest risk assessment but also discussed the situation that might arise if these regulations were lifted.

The assessment of the probability of entry (Section 3.2) focused on the potential for entry of *S. chrysanthemi* from non-EU countries into the risk assessment area (i.e. EU territory), whereas the assessment of the probability of spread was conducted with regard to further spread of the pest within and between the EU MS.

[4] When the dataset utilised does not yet include Croatia (which joined the EU in July 2013), it is specified that it refers only to the EU 27.

[5] 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, p. 1–112.

The conclusions for entry, establishment, spread and impact are presented separately. The descriptors used to assign qualitative ratings are provided in Appendix A.

2.1.3. Methods used for evaluating the risk reduction options

The Panel identified potential risk reduction options and evaluated them with respect to their effectiveness and technical feasibility, i.e. consideration of the technical aspects that influence their practical application. The sustainability of the options was considered based on the definition of "sustainable agriculture" such as "capable of being continued with minimal long-term effect on the environment/capable of being maintained at a steady level without exhausting natural resources or causing severe ecological damage".[6] The evaluation of the efficiency of management options in terms of the potential cost-effectiveness of measures and their implementation is not within the scope of the Panel's remit.

The descriptors used to assign qualitative ratings for the evaluation of the effectiveness and technical feasibility of management 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 were rated separately.

The descriptors used to assign qualitative ratings to the level of uncertainty are shown in Appendix A.

2.2. Data

2.2.1. Literature search

An extensive literature search on *S. chrysanthemi* and its synonyms was conducted at the beginning of the mandate. The literature search followed the first three steps (preparation of protocols and questions, search, selection of studies) of the EFSA guidance on systematic review methodologies (EFSA Panel on Plant Health (PLH), 2010). Further references and information were obtained from experts and from citations within the references found.

2.2.2. Data collection

Owing to the scarcity of information concerning the current situation of the pest in the literature and online databases on pest distribution, damage and management and the importance of these topics to formulating the opinion, the Panel undertook two actions:

- The national plant protection organisations (NPPOs) of all the EU MS were requested to confirm or update the current status of the organism in their territory (contacted on 24 January 2013, with answers received until 21 March 2013). The NPPOs' replies are provided in Table 2.

- A hearing of technical experts from the ornamental plant sector was organised in 2012 in order to obtain data and information on the production of plant propagation material, cut flowers and pot plants of chrysanthemum in Europe (EFSA, in press).

For the evaluation of the probability of entry, the EUROPHYT database was consulted, searching for pest-specific notifications on interceptions. EUROPHYT is a web-based network launched by the Directorate General for Health and Consumers (DG SANCO), and is a sub-project of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The EUROPHYT

[6] Dictionary.com, "sustainable", in Collins English Dictionary—Complete and Unabridged 10th Edition. Source location: HarperCollins Publishers. http://dictionary.reference.com/browse/sustainable. Available online: http://dictionary.reference.com. Accessed 2 March 2013.

database manages notifications of interceptions of plants or plant products that do not comply with EU legislation (EUROPHYT, 2013).

3. Pest risk assessment

3.1. Pest categorisation

3.1.1. Identity of the pest

The taxonomy of *Didymella ligulicola* (current name *Stagonosporopsis chrysanthemi*), the causal agent of ray blight of chrysanthemum, has been confusing in the past.

S. chrysanthemi was first reported on *Chrysanthemum* × *morifolium* (florist's chrysanthemum) in 1904 in the USA (Stevens, 1907). The causal agent was originally described as *Ascochyta chrysanthemi* (Stevens, 1907). The teleomorph was first described as *Mycosphaerella ligulicola* (Baker et al., 1949), which was later transferred to the genus *Didymella* (Müller and von Arx, 1962). Since then, the taxonomy of the ray blight pathogen has undergone many changes (Figure 1). In 1990, *A. chrysanthemi* was reclassified as *Phoma ligulicola* and was divided into two varieties, namely *P. ligulicola* var. *ligulicola* and *P. ligulicola* var. *inoxydabilis* (Van der Aa et al., 1990). Although those two varieties are similar in morphology, they have a different host range and geographical distribution (Boerema and Höweler, 1967). In addition, they have a different reaction to sodium hydroxide (NaOH): variety *ligulicola* produces a colourless antibiotic metabolite 'E', which upon application of NaOH is oxidised to red pigment β, whereas variety *inoxydabilis* does not produce the metabolite and thus no oxidisation occurs upon NaOH application (hence the name *inoxydabilis*) (Van der Aa et al., 1990; de Gruyter et al., 2002; Boerema et al., 2004).

In 2010, during a taxonomic revision of the genus *Phoma* and other related genera, both varieties of *P. ligulicola* were transferred to the genus *Stagonosporopsis* based on morphological characters and molecular data (Aveskamp et al., 2010). However, the authors maintained the separation of the two varieties, i.e. *S. ligulicola* var. *ligulicola* and *S. ligulicola* var. *inoxydabilis* (Figure 1).

In 2012, based on morphological studies and phylogenetic analyses of a collection of cultures obtained from ray blight symptomatic pyrethrum plants (*Tanacetum cinerariifolium*) in Australia, overseas isolates associated with ray blight of chrysanthemum and strains of other *Stagonosporopsis* species, the two varieties of *S. ligulicola*, namely *S. ligulicola* var. *ligulicola* and *S. ligulicola* var. *inoxydabilis*, were elevated to species level as *S. chrysanthemi* and *S. inoxydabilis*, respectively, whereas a third species, *S. tanaceti*, was identified for the first time (Vaghefi et al., 2012) (Figure 1). According to Vaghefi et al. (2012), all the above-mentioned *Stagonosporopsis* species cause ray blight symptoms, but they differ in their host range and geographical distribution. More specifically:

- *S. chrysanthemi* is the causal agent of ray blight of chrysanthemum in the USA and Europe. The pathogen has been reported only to affect cultivars of *Chrysanthemum* × *morifolium* (Van der Aa et al., 1990) (syn. *C. morifolium*, *C. grandiflorum*, *Dendranthema morifolium*, *D. grandiflorum*; common name florist's chrysanthemum).

- *S. inoxydabilis* infects *T. cinerariifolium* (syn. *C. cinerariifolium*; common name pyrethrum) but only in Europe (Van der Aa et al., 1990; Vagethi et al., 2012), *T. parthenium* (syn. *C. parthenium*, *Pyrethrum parthenium*; common name feverfew), *Matricaria* sp. (syn. *M. recutita*; common name: chamomile) and *Zinnia elegans* (syn. *Z. violacea*, *Grassina elegans*; common name zinnia) (Van der Aa et al., 1990).

- *S. tanaceti* is the causal agent of ray blight disease of *T. cinerariifolium* (syn. *C. cinerariifolium*; common name pyrethrum) in Australia (Vaghefi et al., 2012). It has also been reported to infect, following artificial inoculation, other Asteraceae species, such as *Tagetes patula* (syn. *Tagetes lunulata*; common name French marigold) and *Glebionis carinata* (syn.

C. carinatum; common name annual chrysanthemum), but, in contrast with *S. inoxydabilis*, it does not infect *Z. elegans* (syn. *Z. violacea*, *Grassina elegans*; common name zinnia) (Pethybridge et al., 2008a; Vagheti et al., 2012).

Considering that, of the above-mentioned hosts of the three *Stagonosporopsis* species, only *Chrysanthemum* × *morifolium* has been included in the past in the genus *Dendranthema* (ISTA, 2007), the Panel concludes that the only host belonging to the former genus *Dendranthema*, addressed by the EU legislation, is *Chrysanthemum* × *morifolium*.

The current EU legislation refers to *S. chrysanthemi* (as *D. ligulicola*), which is the causal agent of ray blight of chrysanthemum. *S. chrysanthemi* is a single taxonomic entity and can be easily differentiated from other related *Stagonosporopsis* species based on cultural and morphological characters and its positive reaction to NaOH, as well as on molecular sequencing (see Section 3.1.1.2).

Vaghefi et al. (2012) noted that *S. chrysanthemi* should not be confused with *M. chrysanthemi* (Tassi) Tomilin (Basionym: *Sphaerella chrysanthemi* Tassi; syn. *Didymella chrysanthemi* (Tassi) Garib. and Gullino) and *Phomopsis chrysanthemi* (Voglino) M.E.A. Costa and Sousa da Câmara (Basionym: *Phoma chrysanthemi*). Nevertheless, in the EPPO PQR (2012), *M. chrysanthemi* has been erroneously used as a synonym of the causal agent of ray blight disease of chrysanthemum.

3.1.1.1. Taxonomy

Name: *Stagonosporopsis chrysanthemi* (F. Stevens) Crous, Vaghefi and P.W.J. Taylor, (Vaghefi et al., 2012).

Mycobank: MB 800037

Basionym: *Ascochyta chrysanthemi* F. Stevens (Stevens, 1907).

Synonyms:

Mycosphaerella ligulicola K.F. Baker, Dimock and L.H. Davis (Baker et al., 1949)

Didymella ligulicola K.F. Baker, Dimock and L.H. Davis (Müller and von Arx, 1962)

Didymella ligulicola (K.F. Baker, Dimock and L.H. Davis Arx) var. *ligulicola* (Van der Aa et al., 1990)

Phoma ligulicola Boerema var. *ligulicola* (Van der Aa et al., 1990).

Stagonosporopsis ligulicola (K.F. Baker, Dimock and L.H. Davis) Aveskamp, Gruyter and Verkley var. *ligulicola* Aveskamp et al., 2010).

Taxonomic position:

Fungi, Ascomycetes, Pleosporales, Didymellaceae

Common names:

Ray (flower) blight of chrysanthemum (English)

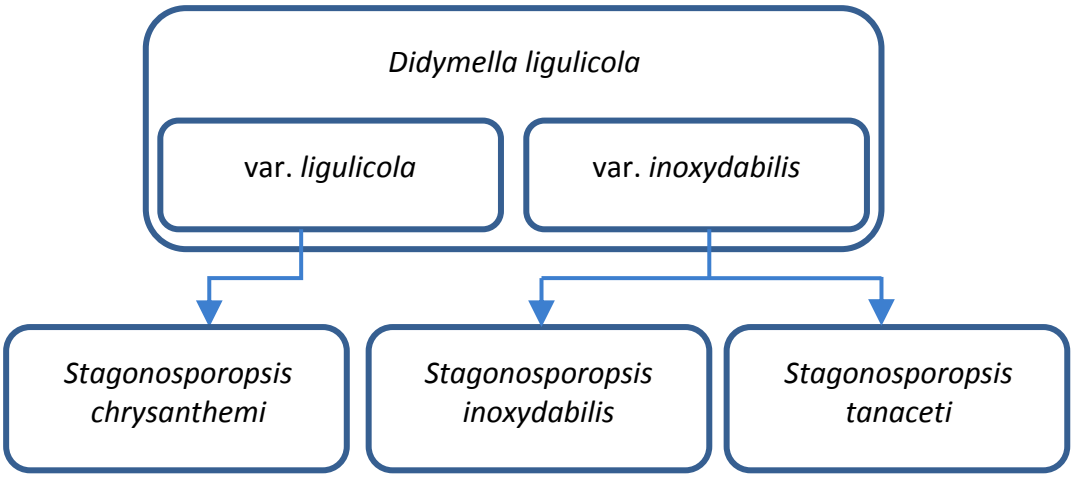

Figure 1: Taxonomic status of *Stagonosporopsis chrysanthemi* and related species

3.1.1.2. Detection and identification

Symptoms and signs

All host plant parts, including roots, may be infected by *S. chrysanthemi*, with flowers and cuttings being particularly susceptible (Baker et al., 1949, 1961).

Symptoms

On cuttings

Cuttings are usually attacked at the terminal bud, whence infection spreads downwards to the whole plant. On leaves, the fungus causes irregular brownish-black blotches, 2–3 cm across (Baker et al., 1949). Under favourable environmental conditions, the blotches rapidly coalesce resulting in leaf rotting. The symptoms on stems are associated with positions where the diseased leaves adjoin with wounds or with the cutting base. During rooting, symptom development may be arrested, but the pathogen survives in the infected plant, which constitutes a source of inoculum.

On adult plants

Stem lesions, which often appear at the stem base or the nodes, may girdle the stem resulting in an abnormal appearance of the corresponding shoots, without the latter being infected by the pathogen (Baker et al., 1961). This appearance is the result of the production of a phytotoxin (Schadler and Bateman, 1974, 1975), which induces drooping of the terminal shoot, makes leaves smaller, chlorotic and more or less brittle, and causes slight dwarfing of the plants.

On flowers

Following infection, spots develop, initially on one side of the blossom only. The spots appear reddish on light-coloured cultivars and brownish on darker ones. Infection subsequently spreads rapidly to all the florets. The affected petals turn tan to light brown and remain so except when invaded by secondary organisms (Stevens, 1907; Baker et al., 1949). Complete rotting of the flower head may also occur, with the infected florets sticking together. The fungus then grows down the peduncle, blackening and weakening the tissue, so that the head eventually droops and wilts. *S. chrysanthemi* has also been reported to infect unopened flower buds and their peduncles causing darkening of the bract and stem tissues (Baker et al., 1949).

Signs

Pycnidia are produced in large numbers on infected flower petals, buds and peduncles under conditions of fluctuating temperature and moisture, but are only rarely formed under continuously

moist conditions. They are also less abundant on stems or leaves of infected plants (Baker et al., 1949). Pycnidia are visible with a hand lens as depressed, thin-walled (one or two layers), globose, amber-coloured at first but later dark-coloured bodies of two sizes: (i) small (72–180 µm) and aggregated on the petals; and (ii) large (111 × 325 µm), scattered on the stems and leaves.

The conidia exude from pycnidia in gelatinous masses forming short columns; conidia are hyaline, one celled (10–40 %) or with more than one cell (60–90 % usually with only one septum, occasionally with more), ovoid to cylindrical with a pronounced tendency to irregularity and an extreme variability in dimensions. More specifically, one-celled conidia are 6–22 × 2.5–8 µm (mostly 8.5–13 × 3.5–5.5 µm), whereas septate conidia are 9–23 × 3–6.5 µm (mostly 13–15.5 × 4–5 µm) (Stevens, 1907; Baker et al., 1949; Boerema et al., 2004). Septation of conidia is a secondary process related to temperature, and is probably a function of conidia size.

Pseudothecia are formed only on infected host tissues and are thick-walled with dark brown outer cells, 96–224 µm in diameter and more erumpent than pycnidia. According to Baker et al. (1949), pseudothecia were formed in large numbers on infected petals, stems and leaves of host plants that had been kept dry in the laboratory for about 8 weeks. Nevertheless, they were produced less abundantly on infected stems and flowers exposed outdoors during the winter. Ascospores are hyaline to greyish, fusiform to elliptical, uniseptate, 12–16 × 4–6 µm (Baker et al., 1949).

Discrimination from other organisms causing similar symptoms on chrysanthemum

Symptoms of *S. chrysanthemi* on *Chrysanthemum* × *morifolium* are similar to those caused by other pathogens, such as *Botryotinia fuckeliana* (syn. *Botrytis cinerea*), *Stemphylium lycopersici*, *S. floridanum*, *Septoria* spp., *Pythium* spp. and *Erwinia chrysanthemi* (Baker et al., 1949; Sauthoff, 1963; Nishi et al., 2009).

It should be noted that the description of symptoms of ray blight of chrysanthemum, provided by Garibaldi and Gullino (1971) and Grouet (1974), probably refer to *S. inoxydabilis* or other *Stagonosporopsis* species.

Reliable detection and identification of *S. chrysanthemi* is only possible by laboratory testing based on the cultural and morphological characters of the pathogen as well as on its positive reaction to NaOH (i.e. production of red pigment β) (Van der Aa et al., 1990; de Gruyter et al., 2002; Vaghefi et al., 2012). However, it should be noted that identification of *Phoma*-like fungi based on morphological features alone requires special expertise and, thus, molecular sequencing would be necessary for correct identification (Aveskamp et al., 2008, 2009, 2010; de Gruyter et al., 2009, 2010, 2013). An EPPO standard (EPPO diagnostic protocol) for the detection and identification of *S. chrysanthemi* is lacking and there are no specific detection molecular methods available for *S. chrysanthemi*. The polymerase chain reaction (PCR) method described by Pethybridge et al. (2004) is not specific for the detection of *S. chrysanthemi*, as the primers used cannot differentiate between the three *Stagonosporopsis* species included in the *D. ligulicola* (syn. *P. ligulicola*) "complex".

3.1.1.3. Cultural and morphological characters in vitro

S. chrysanthemi can be easily isolated on pea agar (Stevens, 1907) or cherry decoction agar (CA) (Boerema et al., 2004). For morphological studies, potato dextrose agar (PDA) (Baker et al., 1949), CA, oat meal agar (OA) or malt agar (MA) can be used (de Gruyter et al., 2002; Boerema et al., 2004).

In vitro characters of *S. chrysanthemi* on OA and MA: colony diameter on OA approximately 7 cm after seven days, regular to slightly irregular, colourless/greenish olivaceous to dull green olivaceous, often in a zonate pattern; with sparse to abundant, felted to floccose, white to pale olivaceous grey aerial mycelium; reverse grey olivaceous to fawn/hazel or olivaceous grey, more or less discolouring to sienna due to a diffusible pigment. On MA, slower growth, 5–6 cm in diameter after seven days, sometimes with a pale luteous pigment production. All isolates showed a positive reaction with the

NaOH test: on application of a drop of NaOH, a green → red (E^+ reaction) occurs (Van der Aa et al., 1990; de Gruyter et al., 2002; Boerema et al., 2004).

Pycnidia developing on and in the agar medium: on OA, they are globose to subglobose, usually with one, sometimes slightly papillate ostiole, mostly 80–270 µm in diameter, glabrous or with mycelial outgrowths. The conidial matrix is saffron (de Gruyter et al., 2002; Boerema et al., 2004).

Conidia produced in pycnidia on OA are ellipsoidal to oblong, with several small guttules, mainly aseptate, 3.5–7.5(–12) × 2–3(–4) µm, some one septate, usually 9–15 × 3–5 µm, but occasionally distinctly large, up to 23 × 8 µm. At 20–22 °C, under common light/dark cycle, the majority of conidia remain one celled, 3.5–15 × 1.5–3.5 µm (mostly 4–8.5 × 2–3 µm) (de Gruyter et al., 2002; Boerema et al., 2004).

Only the anamorph of the pathogen is produced in culture (Van der Aa et al., 1990).

Comparison of *S. chrysanthemi* cultural and morphological characteristics with those of similar *Stagonosporopsis* species

S. inoxydabilis, in contrast with *S. chrysanthemi*, produces *in vitro* both the anamorph and teleomorph (Van der Aa et al., 1990; de Gruyter et al., 2002). It also differs in its slower growth rate, less conidial variability and the absence of antibiotic E (therefore, no discolouration and oxidation reaction with addition of a drop of NaOH occurs, hence '*inoxydabilis*') (Boerema et al., 2004; Vaghefi et al., 2012). *S. tanaceti* shows *in vitro* some resemblance to *S. inoxydabilis* but can be differentiated by its faster growth rate, larger conidia, presence of chlamydospores and lack of ascomata.

S. chrysanthemi isolates obtained from crops grown outdoors require exposure to ultraviolet light for the production of pycnidia, whereas *S. inoxydabilis* isolates from glasshouse crops sometimes produce pycnidia in darkness (Van der Aa et al., 1990).

3.1.1.4. Biology and life cycle

The ascospores, which are considered the principal primary inoculum, mature during the winter and early spring in pseudothecia formed on symptomatic plant tissue (Baker et al., 1949; Pethybridge et al., 2008b). Ascospores, which are discharged throughout the season and carried by air currents, cause scattered infections (Baker et al., 1949). It should also be noted that, according to McCoy et al. (1972) in studies conducted under artificial conditions, only a small number of pseudothecia were produced under wet conditions (i.e. at a moisture content ratio 8:1 (fresh weight–dry weight)/dry weight), and oozed out ascospores as gelatinous masses around the neck of the ascocarp instead of explosively discharging them.

Pycnidia are formed readily and abundantly on infected flowers, buds and peduncles and less so on stems and leaves (Baker et al., 1949). They have been observed to develop even under extremely dry conditions (in 18 weeks at 6 % relative humidity), although conidia are dispersed only in humid conditions. Conidia exude in gelatinous drops or cirri and are dispersed by rain splash, misting or by the black cloth covers that are pulled over the plants during the day to regulate daylength. In the last case, the pathogen causes characteristic streaks of infection in the crop.

Workers may also spread the conidia on clothing, tools, hands, etc. (Baker et al., 1949).

Given sufficient moisture, the conidia can infect the petals within six hours and over a wide temperature range (6–30 °C). According to Baker et al. (1949), germinating conidia may be checked by dry periods as long as five days and resume growth when rewetted. Following germination, conidia penetrate the host directly through or between the epidermal cells, and a characteristic, much branched, short-celled mycelium quickly grows through the tissue, both intra- and intercellularly, causing a moist, brown decay.

A translocatable symptom-inducing phytotoxin produced by the fungus was detected in culture filtrates (Schadler and Bateman, 1974) and appeared to be a low-molecular-weight mannoside (Schadler and Bateman, 1975). It should be also noted that in these studies the identity of the fungal strains used could not be verified.

Cardinal temperatures for pycnidia and pseudothecia formation differ significantly, the curve for pycnidia development being nearly identical to that for growth of cultures on PDA (minimum 3 °C, optimum 21 °C, maximum 24 °C) (McCoy et al., 1972). The optimum temperature for pseudothecia development is 20 °C, whereas no pseudothecia develop at 25 °C. The time between infection and pseudothecia maturation was found to be 7 days at 20 °C and 25 days at 10 °C. High moisture favours pycnidia formation, whereas dry conditions accelerate development of pseudothecia (McCoy et al., 1972).

The pathogen survives over a wide range of temperatures (–23 to 30 °C) and relative humidity (6–85 %) (Baker et al., 1949). The same authors reported that the pycnidia of the pathogen, produced on stems and flowers, are able to survive the winter and produce viable conidia in spring. Baker et al. (1949) showed that conidia obtained from infected plant material kept outdoors during winter (October–March) with a minimum temperature of –29 °C, remained viable and caused abundant flower infection. The same authors stated that the pathogen may also survive as pseudothecia and as mycelium in stems and plant debris.

Conidia apparently survive for a short time in non-sterile compost, while in sterile compost they may survive up to 46 days (Blakeman and Hornby, 1966). If batches of cuttings are raised subsequently on the same substrate without further sterilisation, effective carry-over and subsequent infection could result through conidia. The fungus may also survive as epiphytic mycelium on the root surface of host cuttings (Chesters and Blakeman, 1966).

In the literature preceding the recent taxonomic changes, the ray blight fungus has been reported to form “loose sclerotia” in culture. These have been described as having no regular form, lacking an outer protective layer (loose-type sclerotia) and having a size varying from 200 to 2 500 µm (Blakeman and Hornby, 1966). They survived at high percentages for at least 22 weeks in diverse types of garden soil, moist and dry, sterile and non-sterile. In sterile moist garden soil, 100 % of the buried sclerotia survived even after 30 weeks (end of the experiment). Nevertheless, their infectivity declined at a greater rate than their viability. A macerated and blended culture of a sclerotial isolate was buried in pots containing non-sterile compost. *Chrysanthemum* × *morifolium* cuttings (cv. Indianapolis) were planted in the pots at weekly to fortnightly intervals and infection was assessed. The infectivity of “loose sclerotia” and associated hyphae was lost after eight weeks (Blakeman and Hornby, 1966).

However, neither sclerotia nor other “thick-walled” survival structures (e.g. chlamydospores) are mentioned in the description of *P. ligulicola* var. *ligulicola* (de Gruyter et al. 2002), *S. ligulicola* var. *ligulicola* (Aveskamp et al., 2010) or *S. chrysanthemi* (Vaghefi et al., 2012). In addition, neither of the above-mentioned survival structures is described in the old American literature, such as Stevens (1907), Baker et al. (1949, 1961) and Walker and Baker (1983). Therefore, the description of these structures in some published papers should be considered with caution because of (i) the new delimitation of the species *S. chrysanthemi* within the ‘complex’ *D. ligulicola*, and (ii) the possible confusion with related species, including *M. chrysanthemi* (Tassi) Tomilin (syn. *D. chrysanthemi* (Tassi) Garibaldi and Gullino), which may have occurred in the past. It should be noted that Vaghefi et al. (2012) draw attention to avoiding confusion between *S. chrysanthemi* and *M. chrysanthemi*. This suggests that uncertainty on species identification, particularly in Europe, where several species related to *S. chrysanthemi* might have been present contemporarily in the same area, may be associated with papers/reports published over a long time-span in the past.

3.1.2. Current distribution

3.1.2.1. Global distribution

The pathogen seems to be indigenous to Japan, but it was first reported in 1904 in the south-eastern USA causing ray blight on *Chrysanthemum* × *morifolium* plants (Stevens, 1907; Van der Aa et al., 1990; de Gruyter et al., 2002). The disease remained localised and of little importance in the south-eastern USA until the late 1940s when, concurrent with the intensification of chrysanthemum flower and pot plant production and trade, it began to cause serious losses throughout the USA. In 1959, *S. chrysanthemi* was detected for the first time in Europe (southern England) in several nurseries on plants grown from cuttings imported from the USA (Baker et al., 1961).

The suggestion that the disease may have been present in Europe before its first observation in the USA is probably a result of a confusion with a different fungus described in Italy as *D. chrysanthemi* (Tassi) Galibaldi and Gullino (Van der Aa et al., 1990).

Figure 2 and Table 1 show the distribution of the pathogen worldwide based on the EPPO PQR (2012) (version 5.0, accessed on 26 May 2013). Table 2 summarises the most up-to-date information on the current distribution of the pathogen in the risk assessment area based on official data provided by the NPPOs of the EU MS, the EPPO PQR database and the literature.

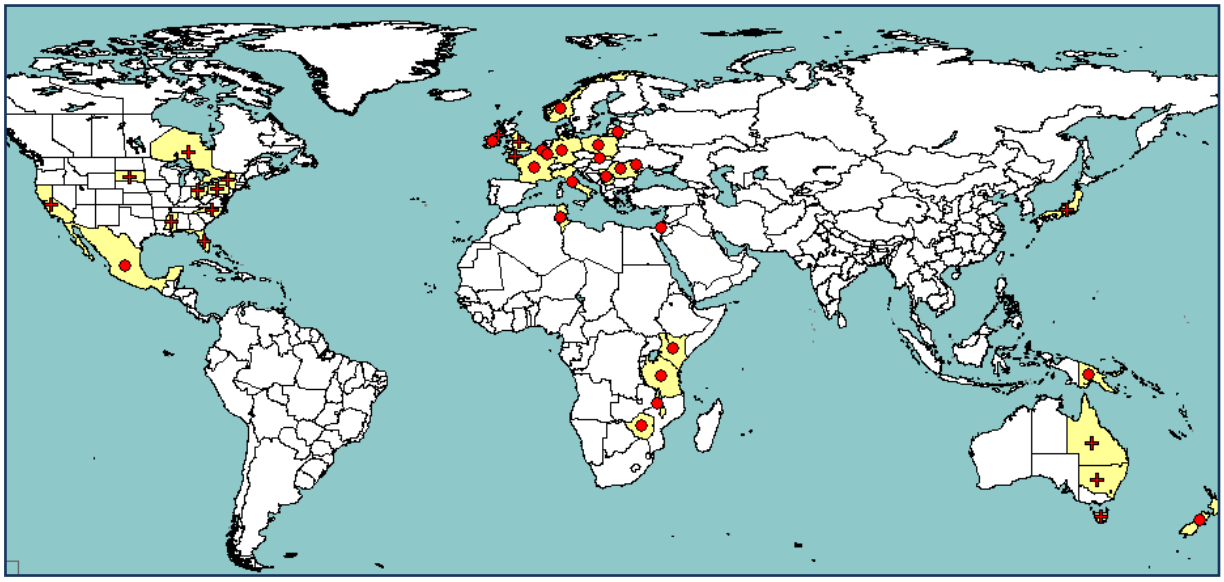

Figure 2: Global distribution of *Stagonosporopsis chrysanthemi*, as extracted from EPPO PQR (2012) (version 5.0, accessed on 26 May 2013). In the EPPO PQR (2012), the preferred name of the pathogen is erroneously referred to as *Mycosphaerella chrysanthemi*, with *Didymella ligulicola* as one of its synonyms (see Section 3.1.1). Red circles and crosses represent the presence of the pathogen as national and sub-national records, respectively

Table 1: The status of *Stagonosporopsis chrysanthemi* (as *Didymella ligulicola*) outside Europe, according to EPPO PQR (2012) (version 5.0, accessed on 26 May 2013)

Continent	Country	Pest status (EPPO PQR, 2012)
Africa	Kenya	Present, no details
	Malawi	Present, no details
	Tanzania	Present, no details
	Tunisia	Present, restricted distribution
	Zimbabwe	Present, no details
America	Canada	Present, no details

Continent	Country	Pest status (EPPO PQR, 2012)
	Mexico	Present, no details
	United States of America	Present, no details
Asia	Israel	Present, widespread
	Japan	Present, no details
Oceania	Australia	Present, restricted distribution
	New Zealand	Present, few occurrences
	Papua New Guinea	Present, no details

3.1.2.2. Occurrence in the risk assessment area

The pathogen is present in some EU MS, though with a restricted distribution (Figure 3 and Table 2).

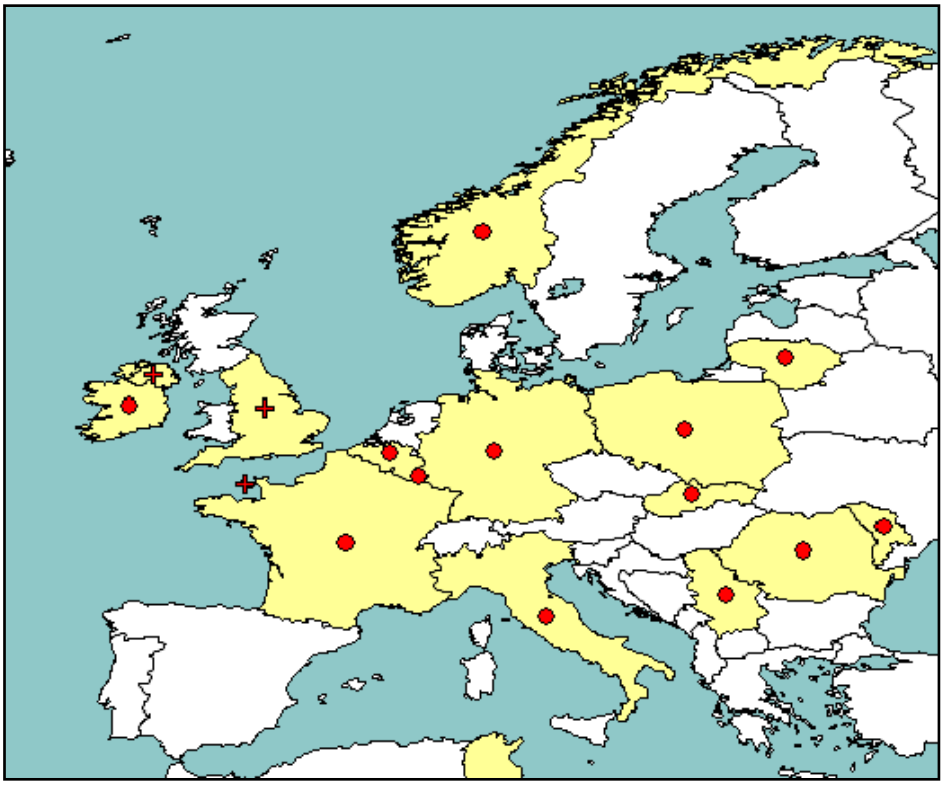

Figure 3: Distribution of *Stagonosporopsis chrysanthemi* in Europe, as extracted from EPPO PQR (2012) (version 5.0, accessed on 26 May 2013). In the EPPO PQR (2012), the preferred name of the pathogen is erroneously referred to as *Mycosphaerella chrysanthemi*, with *Didymella ligulicola* as one of its synonyms (see Section 3.1.1). Red circles and crosses represent the presence of the pathogen as national and sub-national records, respectively

Table 2: The current distribution of *Stagonosporopsis chrysanthemi* (as *Didymella ligulicola*) in the risk assessment area, as gathered from EPPO PQR (2012) (version 5.0, accessed on 26 May 2013) and the answers received via e-mail from the NPPOs of the EU MS

Member State	Pest status (according to EPPO PQR)	Pest status (according to the e-mails received from the NPPOs in 2013)
Austria	Absent, pest no longer present	Absent, pest no longer present
Belgium	Present, restricted distribution	Pest status left unchanged. No recent survey data are available to specify status at that time or for the moment
Bulgaria	Absent, intercepted only	Absent, intercepted only
Croatia	–	Probably present with few occurrences. Never confirmed in the laboratory
Cyprus	–	Absent, no records
Czech Republic	Absent, intercepted only	Absent, intercepted only
Denmark	Absent, pest eradicated	Absent, pest eradicated
Estonia	–	Absent, no pest record
Finland	Absent, no pest record	Absent, no pest record
France	Present, restricted distribution	Present, restricted distribution
Germany	Present, restricted distribution	Present, few occurrences
Greece	–	Absent (not known to occur) No systematic survey data are available
Hungary	–	Detected in 1975. Since that time no data on the distribution of the pathogen is available. Not detected again since 1975
Ireland	Present, restricted distribution	Present, restricted distribution
Italy	Present, no details	Confirmed. Detected on *Chrysanthemum* cultivation in greenhouse in 2000
Latvia	–	–
Lithuania	Present, few occurrences	Absent, pest eradicated
Luxembourg	Present, no details	
Malta	–	Not known to occur
Netherlands	Absent, pest no longer present	Absent, confirmed by survey
Poland	Present, few occurrences	Absent, pest no longer present (confirmed by surveys)
Portugal	–	Absent, never detected
Romania	Present, no details	Present, no details
Slovakia	Present, restricted distribution	Present, restricted distribution
Slovenia	–	Present, only in protected cultivation
Spain	–	–
Sweden	Absent, pest no longer present	Absent, pest no longer present
United Kingdom	Present, few occurrences	England, Wales and Northern Ireland: present, few occurrences Scotland, Channel Islands and Isle of Man: absent, pest no longer present

3.1.3. Regulatory status

S. chrysanthemi is a regulated harmful organism in the EU and is listed as *D. ligulicola* in Council Directive 2000/29/EC in the following Annexes:

Annex II, ***Part A*** – Harmful organisms whose introduction into, and spread within, all Member States shall be banned if they are present on certain plants or plant products

Section II—Harmful organisms known to occur in the EU and whose introduction into and spread within the EU is banned if they are present on certain plants or plant products

(c) Fungi

Species	Subject of contamination
4. *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx	Plants of *Dendranthema* (DC) Des Moul., intended for planting, other than seeds

Annex IV, **Part A**—Special requirements which must be laid down by all Member States for the introduction and movement of plants, plant products and other objects into and within all Member States

Section I—Plants, plant products and other objects originating outside the Community

Plant products and other objects	Special requirements
28. Plants of *Dendranthema* (DC) Des Moul., intended for planting, other than seeds	Without prejudice to the requirements applicable to the plants listed in Annex IV(A)(I)(27.1) and (27.2), official statement that: (c) in the case of unrooted cuttings, no symptoms of *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx were observed either on the cuttings or on the plants from which the cuttings were derived, or that, in case of rooted cuttings, no symptoms of *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx were observed either on the cuttings or on the rooting bed

Section II—Plants, plant products and other objects originating in the Community

Plant products and other objects	Special requirements
21.1. Plants of *Dendranthema* (DC) Des Moul., intended for planting, other than seeds	Without prejudice to the requirements applicable to the plants listed in Annex IV(A) (II)(20), official statement that: (c) in the case of unrooted cuttings, no symptoms of *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx were observed either on the cuttings or on the plants from which the cuttings were derived, or that, in case of rooted cuttings, no symptoms of *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx were observed either on the cuttings or on the rooting bed

Annex V – Plants, plant products and other objects which must be subject to a plant health inspection (at the place of production if originating in the Community, before being moved within the

Community – in the country of origin or the consignor country, if originating outside the Community) before being permitted to enter the Community

Part A – Plants, plant products and other objects originating in the Community

Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community and which must be accompanied by a plant passport.

2. Plants, plant products and other objects produced by producers whose production and sale is authorised to persons professionally engaged in plant production, other than those plants, plant products and other objects which are prepared and ready for sale to the final consumer, and for which it is ensured by the responsible official bodies of the Member States, that the production thereof is clearly separate from that of other products.

2.1 Plants intended for planting other than seeds of the genera *Abies* Mill., *Apium graveolens* L., *Argyranthemum* spp., *Aster* spp., *Brassica* spp., *Castanea* Mill., *Cucumis* spp., ***Dendranthema*** (DC) Des Moul., *Dianthus* L. and hybrids *Exacum* spp., *Fragaria* L., *Gerbera* Cass., *Gypsophila* L., all varieties of New Guinea hybrids of *Impatiens* L., *Lactuca* spp., *Larix* Mill., *Leucanthemum* L., *Lupinus* L., *Pelargonium* l'Hérit. ex Ait., *Picea* A. Dietr., *Pinus* L., *Platanus* L., *Populus* L., *Prunus laurocerasus* L., *Prunus lusitanica* L., *Pseudotsuga* Carr., *Quercus* L., *Rubus* L., *Spinacia* L., *Tanacetum* L., *Tsuga* Carr., *Verbena* L. and other plants of herbaceous species, other than plants of the family Gramineae, intended for planting, and other than bulbs, corms, rhizomes, seeds and tubers.

Part B—Plants, plant products and other objects originating in territories, other than those territories referred to in part A.

Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community.

2. Parts of plants, other than fruits and seeds: of *Castanea* Mill., ***Dendranthema*** (DC) Des. Moul., *Dianthus* L., *Gypsophila* L., *Pelargonium* l'Herit. ex Ait, *Phoenix* spp., *Populus* L., *Quercus* L., *Solidago* L. and cut flowers of Orchidaceae.

Hosts of *S. chrysanthemi*, i.e. *Chrysanthemum* spp. (as *Dendranthema* (DC) Des Moul.) are further regulated in Council Directive 98/56/EC of 20 July 1998 on the marketing of propagating material of ornamental plants (See Section 4).

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

3.1.4.1. Host range

Hosts of *S. chrysanthemi* are the commercially important cultivars of *Chrysanthemum* × *morifolium* (syn. *D. grandiflorum*; common name florist's chrysanthemum) (Van der Aa et al., 1990; de Gruyter et al., 2002; Vaghefi et al., 2012).

In the past, the genus *Chrysanthemum* was split up into several genera and the economically important florist's chrysanthemum was placed in the genus *Dendranthema*. However, in 1999, the Commission on International Code of Botanical Nomenclature restored the florist's chrysanthemum to the genus *Chrysanthemum* (Greuter et al., 1999).

Cultivars of *Chrysanthemum* × *morifolium* are frequently divided into three groups, based on the type of end-product they are cultivated for. There are cultivars for cut flowers, cultivars for pot chrysanthemum, and cultivars for multiflora plants. Commercial multiflora plants are large ball-shaped plants with many relatively small flowers. When grown in private gardens multiflora cultivars are often referred to as garden mums or garden chrysanthemum. Cultivars for cut flowers and pot chrysanthemum are mostly grown in protected cultivation, while multiflora plants are mainly grown outdoors (EFSA PLH Panel, 2012).

Prior to the recent taxonomic developments, *S. chrysanthemi*, under the name *D. ligulicola*, was reported to infect plants of *Chrysanthemum carinatum* (annual chrysanthemum), *Cicorium endivia* var. *latifolia* (endives), *Dahlia variabilis* (dahlia), *Cynara scolymus* (globe artichoke), *Lactuca sativa* (lettuce), *Rudbeckia hirta* (rudbeckia), *Helianthus annuus* (sunflower) and *Zinnia elegans* (zinnia) grown in artificially infested non-sterile compost (Chesters and Blakeman, 1967). Based on Chesters and Blakeman (1967) pathogenicity studies, lettuce (cv. Sugar Cos) was the most severely infected plant species tested. However, the European literature probably refers to *S. inoxydabilis* (see also Punithalingam (1980), who mentions under "physiologic specialisation" the different characteristics of the British isolates). Nevertheless, there is only one report of the fungus being detected on symptomatic lettuce plants *(L. sativa)* originating in China and imported into Korea (Hyun et al., 2005). However, the taxonomic information provided in this paper does not unambiguously describe *S. chrysanthemi*, but could also refer to *Boeremia exigua* var. *exigua* (syn. *Phoma exigua* var. *exigua*), also producing aseptate and septate conidia and occurring on lettuce (Koike et al., 2006).

The record on wild chrysanthemum, *C. boreale*, (Kim et al., 2001) is unlikely to refer to *S. chrysanthemi* because the authors report on *in vitro* formation of pseudothecia by the pathogen. The paper probably refers to *S. inoxydabilis*, as this species easily produces pseudothecia *in vitro*.

Host plants of *S. chrysanthemi*, i.e. cultivars of *Chrysanthemum* × *morifolium*, are widely grown in open fields and greenhouses as well as in private and public gardens in both rural and urban regions of the risk assessment area (see Section 3.3.1 and Table 4). However, data on the area grown commercially with host plants are not available for all MS (AIPH, 2011). The main EU producers of chrysanthemum cut flowers are the Netherlands and Italy, while pot chrysanthemum and multiflora are produced in the entire EU territory (EFSA, in press).

It should be also noted that, because of the confusion in the taxonomy of the pathogen in the past, studies on host range of the ray blight pathogen of chrysanthemum, such as those of Peregrine and Watson (1964), Chesters and Blakeman (1967) and Neergaard (1979) have to be interpreted with caution. Those studies were performed before the separation of the species into different varieties and, as a result, it is not clear which fungus was tested for pathogenicity (Vaghefi et al., 2012).

Based on the above, it may be concluded that the potential hosts of *S. chrysanthemi* in the risk assessment area would be cultivars of *Chrysanthemum* × *morifolium* grown outdoors and under protection.

3.1.4.2. Climatic conditions

S. chrysanthemi can infect its hosts over a wide range of temperatures (6–30 °C), given there is sufficient moisture (Baker et al., 1949). Nevertheless, germinating *S. chrysanthemi* conidia are able to withstand dry periods as long as five days and resume growth when rewetted (Baker et al., 1949). The pathogen survives over a wide range of temperatures (–23 to 30 °C) and relative humidity (6–85 %) (Baker et al., 1949). The primary inocula are ascospores which, in the presence of moisture, are discharged from the pseudothecia produced on infected plant debris and are disseminated by air currents to infect susceptible hosts (Baker et al., 1949). Ascospores have been shown to be produced throughout the whole growing season, causing scattered infections. Pycnidia with conidia of the asexual stage are readily and abundantly produced on infected plant tissues under variable conditions of moisture and temperature (Baker et al., 1949). Conidia exude in a gelatinous mass and are dispersed by water (rain, irrigation, heavy mist, etc.) over relatively short distances.

S. chrysanthemi is present (or had been present in the past) in some parts of the risk assessment area, though with a restricted distribution (see Table 2). This indicates that the climatic conditions prevailing, at least in some areas of the EU territory where the hosts (i.e. cultivars of *Chrysanthemum* × *morifolium*) are grown, are favourable for infection, sporulation, spread and survival of *S. chrysanthemi* (see Section 3.3.2).

3.1.5. Potential for consequences in the risk assessment area

Ray blight disease of chrysanthemum was first recorded in North Carolina (USA) in the early 1900s on *Chrysanthemum* × *morifolium* plants (Stevens, 1907; Baker et al., 1949), and remained localised and of little importance until the late 1940s when it began to cause serious losses. At that time, in Florida, ray blight was considered the most serious disease of chrysanthemum (Engelhard, 1969). Afterwards, the disease spread to many areas of the USA (Baker et al., 1961) and worldwide (CABI, 2012).

The following factors have been considered the main drivers of disease spread locally and worldwide: (i) increasing intensification of chrysanthemum production, with cultivars growing all year round; (ii) shipment of infected cuttings; (iii) irrigation of chrysanthemum crops by misting; and (iv) use of dark cloth covers to regulate chrysanthemum flowering (Alfieri, 1966). Once the disease is present, eradication of the pathogen is difficult and is achieved only with considerable effort (Alfieri, 1966).

The disease occurs on pot plants, stock beds, and cuttings grown both in the open field and in protected cultivation (Engelhard, 1972). Losses are caused by the development of the disease symptoms on all plant parts, particularly on flowers and cuttings, which are highly susceptible (Baker et al., 1949).

Symptoms on flowers consist of reddish to brownish spots, initially on one side of the blossom only, which spread rapidly and cause the complete rot of the flower. The symptoms then develop down the peduncle, blackening and weakening the tissue resulting in drooping and wilting of the flower head. As a result, the affected plants and/or plant parts are not marketable. Flowers, asymptomatic at harvest, may develop symptoms during transit to the market (Baker et al., 1949). On adult plants, stem lesions may girdle the stem and cause the wilting of the above organs. The disease can develop with dramatic rapidity under favourable weather conditions in the field, causing complete loss of entire blocks of susceptible varieties (Baker et al., 1949). In the absence of control measures, losses up to 100 % may occur on highly susceptible cultivars (Engelhard, 1984).

The disease is currently distributed worldwide, under a wide range of climates (see Section 3.1.2), because of the ability of *S. chrysanthemi* to adapt to different environmental conditions (see Section 3.1.1.4). The pathogen is also present (or had been present in the past) in some parts of the risk assessment area (see Section 3.1.2.2). In the EU territory, host plants of *S. chrysanthemi* (i.e. cultivars of *Chrysanthemum* × *morifolium*) are extensively grown commercially outdoors and under protection for the production of cut flowers and pot plants (see Table 3), as well as in private and public gardens.

Based on the above, it may be concluded that *S. chrysanthemi* has the potential for consequences in the risk assessment area.

3.1.6. Conclusion on the pest categorisation

S. chrysanthemi could present a risk to the EU territory as:

- Susceptible hosts (cultivars of *Chrysanthemum* × *morifolium*) are extensively grown in open fields, greenhouses, as well as in private and public gardens in all MS.

- It is present (or had been present in the past) in the risk assessment area and is under official control on *Dendranthema* spp. (i.e. cultivars of *Chrysanthemum* × *morifolium)*. Nevertheless, the PLH Panel considers that the information on the presence of the organism in the risk assessment area should be treated with caution because of the uncertainty about the correspondence between the organism isolated in the past from *Chrysanthemum* × *morifolium* plants showing ray blight-like symptoms and the causal agent of ray blight under its current taxonomic status (i.e. *S. chrysanthemi*)

- It has the potential for further establishment and spread and for causing consequences in the risk assessment area.

3.2. Probability of entry

S. chrysanthemi is present in some EU MS though with restricted distribution or few occurrences (Table 2). The assessment of the probability of entry considers the potential for further entry of the organism from third countries into the EU territory.

3.2.1. Identification of pathways

The PLH Panel identified the following six pathways as relevant for further entry of *S. chrysanthemi* from infested third countries into the risk assessment area:

1. host plants for planting, excluding pot plants and seeds (i.e. rooted and unrooted cuttings)
2. cut flowers of host plants
3. seeds of host plants
4. soil and other growing media
5. pot plants (not necessarily host plants), including associated soil and other growing media
6. natural means.

3.2.1.1. Selection of the most important pathways

The selection of the most important pathways from those listed above for further assessment was based on the EFSA "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), which states that the most relevant pathways should be selected using expert judgement and, where there are different origins and end-uses, it is sufficient to consider only realistic worst-case pathways.

The Panel considers that the most important pathways of entry to be further assessed are:

- host plants for planting, excluding pot plants and seeds (i.e. rooted and un-rooted cuttings); and
- cut flowers of host plants.

The last four of the pathways listed in Section 3.2.1 are considered by the Panel to be secondary pathways for the entry of *S. chrysanthemi* into the EU territory for the reasons explained in Section 3.2.4.

3.2.2. Pathway 1. Host plants for planting, excluding pot plants and seeds (i.e. rooted and unrooted cuttings)

3.2.2.1. Probability of association with the pathway at origin

S. chrysanthemi affects all plant parts of *Chrysanthemum* × *morifolium* (including roots), with cuttings being particularly susceptible to infection (Baker et al., 1949). Disease symptoms on cuttings are variable and include girdling lesions at the stem base or nodes, stem cankers, abnormal appearance of shoots, drooping of terminal shoot growth, lesions or irregular necrotic areas on leaves, root discoloration and rotting, etc. (see Section 3.1.1.2). Provided there is sufficient moisture, *S. chrysanthemi* can infect its hosts over a wide range of temperatures (6–30 °C) with an optimum at

24 °C (Baker et al., 1949). The pathogen can effectively survive adverse environmental conditions (see Section 3.1.1.4). On infected rooted and unrooted cuttings of host plants, *S. chrysanthemi* may be present as mycelium, pycnidia with conidia, pseudothecia with ascospores and, possibly (in the case of rooted cuttings) as epiphytic mycelium on the root surface and/or "loose sclerotia" in the soil substrate attached to the roots (see Section 3.2.4, Pathway 4). Moreover, infected cuttings, asymptomatic at harvest, may develop symptoms during transport or storage (Baker et al., 1949).

The pathogen has a wide geographic distribution being reported from several countries in North, Central and South America, the Caribbean region, Asia, Africa, Oceania and Europe (EPPO PQR, 2012, referred to as *M. chrysanthemi*).

There are no specific statistical data in Eurostat (2013) on imports of plant material of host plants for planting excluding pot plants and seeds (i.e. rooted/unrooted cuttings) from third countries into the EU. The data available are aggregated as "live outdoor plants" or "perennial outdoor plants" from which it is impossible to separate chrysanthemum. Cuttings represent by far the largest amount of plants for planting (EFSA, in press). Most of the host plant propagation material used in the risk assessment area is bred in the EU and propagated in non-European countries to produce cuttings, which are then imported into the EU (EFSA, in press). Major non-European production regions are Africa (countries: Uganda, Kenya, Tanzania, South Africa), South America (countries: Bolivia, Brazil) and Central America (country: Guatemala) (EFSA, in press). Of the above-mentioned countries, Kenya and Tanzania have been reported to be infested by *S. chrysanthemi* (as *M. chrysanthemi*) (EPPO PQR, 2012). However, there is no information on the prevalence of the pathogen in those countries.

Import of chrysanthemum cuttings from third countries into the EU is mainly via the Netherlands (EFSA, in press). The annual number of imported cuttings amounted for the period 2010–2012 to approximately two billion cuttings (NPPO of the Netherlands, personal communication, 2012, see Appendix B). During the same period, the annual number of consignments of chrysanthemum cuttings entering the Netherlands varied between 2 000 and 2 500, with an average number of 804 368 to 953 376 cuttings per consignment. An average of 35.5 % of the consignments contained over one million cuttings, representing 74.5 % of the number of cuttings. All consignments are visually inspected either by Naktuinbouw (Inspection Service for Horticulture, the Netherlands; 1.1–1.5 billion cuttings per year inspected upon opening of consignments at registered companies) or by KCB (Dutch Quality Control Bureau for Vegetables and Fruits—direct inspection at the airport) at a rate of 100 cuttings inspected per 10 000 cuttings, with a maximum of 1 000 cuttings inspected per consignment. Samples are taken and analysed in cases of cuttings showing suspect symptoms (EFSA, in press).

Although most chrysanthemum cuttings used in the EU are produced and imported from third countries, several companies still remain in the risk assessment area and locally produce cuttings for pot plants and multiflora, usually less than 15 million cuttings per company (EFSA, in press).

According to current practice, the cycle of production of chrysanthemum cuttings is subject to certification schemes by major breeding and propagation companies in the EU. These certification schemes are based on the EPPO scheme (EPPO, 2002). For example the elite protocol for chrysanthemum adopted by Naktuinbouw, which applies at present to the greatest amount (60–70 %) of cuttings used, includes production of cuttings in a direct line from individually tested candidate plants (pyramiding system) and a quality management system audited by Naktuinbouw (EFSA, in press). Requirements and norms are updated yearly and mother plants of chrysanthemum are renewed every three to four months. Some companies have not officially joined the elite certification scheme but operate independently under the same principles.

Unrooted cuttings can be imported into the EU year round, rooted in EU greenhouses year round and subsequently sold to growers for production of cut flowers or pot plants. A large proportion of unrooted cuttings for pot mums and multiflora plants are sold directly to growers (at present 95 %).

For cut flower production, a smaller proportion (15 %) of cuttings is rooted by growers (EFSA, in press).

It is believed that the pathogen spread between the states of North America on infected chrysanthemum cuttings (Baker et al., 1961). There are also indications that *S. chrysanthemi* was first introduced into Europe via infected chrysanthemum cuttings, as the disease was first found in 1959 in southern England in nurseries that imported cuttings from the USA (Baker et al., 1961).

Based on the above and given that the current EU legislation is in place, the PLH Panel considers that *S. chrysanthemi* is **unlikely** to be associated with host plants for planting excluding pot plants and seeds (i.e. rooted/unrooted cuttings) originating in infested third countries. This assessment is further supported by the lack of interceptions of the organism in the EU (EUROPHYT, 2013). The rating is associated with a **medium uncertainty,** mainly because of lack of precise information on the prevalence of the pathogen in infested third countries.

3.2.2.2. Probability of survival during transport or storage

According to Rudnicki et al. (1991), cuttings of many temperate zone plant species are better preserved at low temperatures. Chrysanthemum cuttings can be stored for a period of up to six weeks at temperatures between –0.5 and 1.6 °C. *S. chrysanthemi* has been reported to survive over a wide range of temperatures (–23 to 30 °C) and relative humidity (6–85 %) (Baker et al., 1949). However, the pathogen is very unlikely to multiply at the low temperatures used for the transport and storage of chrysanthemum cuttings.

Based on the above, the PLH Panel considers that the pathogen is **very likely** to survive the transport and storage conditions that ensure the viability of host plants for planting excluding pot plants and seeds (i.e. rooted/unrooted cuttings). There is **no uncertainty** associated with this rating. Furthermore, *S. chrysanthemi* is **very unlikely** with a **low uncertainty** to increase in prevalence during transport and storage of infected chrysanthemum cuttings.

3.2.2.3. Probability of surviving existing pest management procedures

Cultural practices, such as use of pathogen-free propagation material, monitoring of the crop, avoiding overhead irrigation, proper management of waste plant material, soil disinfestation with steam, use of clean irrigation water, general hygiene measures, etc., are usually applied in a certification scheme for the production of chrysanthemum cuttings (EFSA, in press).

In the past, *S. chrysanthemi* was controlled by the application of fungicide sprays, with benomyl and thiophanate-methyl being the most effective ones (Baker et al., 1949; Crane et al., 1970; Grouet, 1974; Punithalingam, 1980). Several fungicides provide good control of ray blight disease of Asteraceae (Appendix C). Crane et al. (1970) reported that the most consistent control, in tests on three chrysanthemum cultivars, was by weekly sprays of benomyl and thiabendazole under moderate and severe disease pressure, and that an adequate or marginal control was achieved by daconil sprays under moderate or severe disease pressure. Engelhard (1984) reported that, on two cultivars, weekly sprays of propiconazole reduced the disease incidence by 94–100 %. Vinclozolin and iprodione produced similar results. Propiconazole and iprodione provided the same level of control when sprayed at two-week intervals (Engelhard, 1984). In the 1980s, dicarboximide derivatives were used successfully for the control of the pathogen (as *D. ligulicola*) (Engelhard, 1984). However, the repeated use of fungicides, such as benomyl and thiophanate-methyl, over a number of years has led to the development of *S. chrysanthemi* resistant strains (Grouet, 1974; Punithalingam, 1980).

Information on the effects of more recent fungicides on *S. chrysantemi* is poor. The most recent active substances (a.s.) available have mostly been tested against *S. tanaceti*, phyllogenetically closely related to *S. chrysanthemum* species (Vaghefi et al., 2012), which causes ray blight of pyrethrum (*T. cinerarifolium*) in Australia. Assuming that the a.s. that are effective against *S. tanaceti* may be similarly effective against *S. chrysanthemum*, it is worth mentioning that fungicides belonging to the

demethylation inhibitor group (DMI), including prochloraz, tebuconazole, difenoconazole and cyproconazole, reduced mycelial growth of *S. tanaceti in vitro* (Pethybridge et al., 2005). According to the same studies, low concentrations of azoxystrobin reduced conidial germination. In field trials, azoxystrobin significantly decreased disease intensity and increased pyrethrin yield in all seasons. Applications of either azoxystrobin or difenoconazole in early spring were the most effective, whereas no significant benefit was demonstrated from applications in autumn. Application of azoxystrobin and chlorothalonil resulted in a 45–48 % increase in flowers, reduced defoliation, and increased stem diameter (Pethybridge et al., 2005). However, the assumption made above is associated with a medium level of uncertainty about the efficacy of the more recent a.s. against *S. chrysanthemi*. Uncertainty also concerns the potential of the pathogen to develop resistance against new or older a.s. because of either lack of recent studies on fungicide efficacy against the pathogen or the possible confusion about the species identity in older studies.

According to Green and Engelhard's (1974) studies, an integrated production system based on a minimum fungicide spray programme in combination with viaflo irrigation under mulch and 50 % ammonium nitrogen fertiliser gave maximum production and disease control.

So far, no biological control methods are available (CABI, 2012).

Based on the above, and although there is lack of precise information on the chemical control measures applied at the place of origin, it may be assumed that, when a certification scheme is used for the production of chrysanthemum cuttings and in addition to the cultural practices applied, some broad-spectrum fungicides are also used for the control of other chrysanthemum fungal pathogens (e.g. *Botryotinia fuckeliana*, *Puccinia horiana*, etc.), which may also be effective against *S. chrysanthemi* (EFSA, in press). This is further supported by Fides (2006) statement that ray blight of chrysanthemum occurs only sporadically on chrysanthemum crops nowadays as a result of the intensive measures taken for the control of *P. horiana*.

With respect to the preparation of chrysanthemum cuttings consignments, unrooted cuttings are usually dipped into rooting powder (e.g. indolyl butyric acid) immediately after picking and packed in quantities of 25–50 in plastic bags, which in turn are packed in boxes, crates or other containers (Fides, 2006). Rooted cuttings, which are usually delivered as bare root cuttings, are pulled up from the rooting medium and packed in boxes or crates. Grading of cuttings may be applied but it is not always necessary. Although there is no information on any other procedures applied to consignments during their preparation, the PLH Panel assumes that culling of cuttings before shipment may also be a common practice. Nevertheless, although culling may remove symptomatic plant material, it cannot eliminate the pathogen present on latently infected chrysanthemum cuttings.

Chrysanthemum cuttings (rooted and unrooted) are regulated in the EU, and special requirements, exclusively based on visual inspection of plant material, including mother plants, are laid down in Annex IV of Council Directive 2000/29/EC. However, the symptoms caused by *S. chrysanthemi* on leaves and stems of host plants are similar to those caused by other pathogens, such as *Botryotinia fuckeliana*, *Stemphylium lycopersici*, *Stemphylium floridanum*, *Septoria* spp., *Pythium* spp. and *Erwinia chrysanthemi* (Baker et al., 1949; Nishi et al., 2009; CABI, 2012). In addition, infected chrysanthemum cuttings, asymptomatic at harvest, may develop symptoms during transport or storage (Baker et al., 1949; Engelhard, 1972). Reliable detection and identification of *S. chrysanthemi* is only possible by laboratory testing based on the cultural and morphological characters and the positive reaction to NaOH, as well as on molecular sequencing of the pathogen (see Section 3.1.1.2).

Provided that (i) standard certification schemes (EPPO, 2002; EFSA, in press) and sanitation measures are in place for the production of chrysanthemum cuttings, and (ii) the EU requirements are fulfilled (Council Directive 2000/29/EC), the PLH Panel considers it **unlikely** that *S. chrysanthemi* will survive the current pest management procedures, including phytosanitary measures. This rating is further supported by the lack of interceptions of the pest in the EUROPHYT database. The uncertainty

associated with the above rating is **medium**, as it is not known if all chrysanthemum cuttings imported into the risk assessment area are produced under a certification scheme.

3.2.2.4. Probability of transfer to a suitable host

Host plants are widely grown in open fields and greenhouses, as well as in private and public gardens, in both rural and urban regions of the risk assessment area. Therefore, it is expected that, following their import, rooted and unrooted cuttings of *Chrysanthemum* × *morifolium* will be widely distributed within the EU territory. Cuttings of host plants are imported into the EU all year round (EFSA, in press). In the case of unrooted cuttings, in general one consignment is expected to go to a single destination for rooting; following rooting, the cuttings are further distributed to growers for the production of cut flowers or pot plants. A large proportion of unrooted cuttings for pot mums and multiflora plants is sold directly to growers (at present 95 %). For cut flower production a smaller proportion (15 %) of cuttings is rooted by growers. Nevertheless, rooted cuttings will most probably be distributed to growers immediately following their import into the EU territory (EFSA, in press).

On infected host plants for planting excluding pot plants and seeds (i.e. rooted or unrooted *Chrysanthemum* × *morifolium* cuttings) the pathogen may be present as pycnidia, pseudothecia and latent/epiphytic mycelium (see Section 3.1.1.4). Because of their intended use (i.e. planting), cuttings infected by *S. chrysanthemi* most probably will be planted mainly in greenhouses or open fields in the risk assessment area. From this plant material, the pathogen is **very likely** to be transferred by natural means (wind, rain, wind-driven rain, irrigation water, etc.) to susceptible host plants grown in close proximity (Baker et al., 1961) (see Section 3.2.4, Pathway 6) within the risk assessment area. There is **no uncertainty** associated with this rating.

3.2.3. Pathway 2. Cut flowers of host plants

3.2.3.1. Probability of association with the pathway at origin

S. chrysanthemi affects all parts of *Chrysanthemum* × *morifolium* plants, with flowers being particularly susceptible (Baker et al., 1949). Flowers may become infected when still at the bud stage (Baker et al., 1949). Disease symptoms on cut flowers include lesions on petals, distortion and blight of flower heads, girdling lesions at the nodes, stem cankers, lesions or irregular necrotic areas on leaves, etc. (see Section 3.1.1.2). The pathogen may be present on infected chrysanthemum petals, peduncles, leaves and stems of cut flowers as mycelium, pycnidia and/or pseudothecia (Baker et al., 1949). Provided there is sufficient moisture, *S. chrysanthemi* can infect its hosts over a wide range of temperatures (6–30 °C) with an optimum at 24 °C (Baker et al., 1949). The pathogen can also effectively survive adverse environmental conditions (see Section 3.1.1.4). Moreover, infected flowers, asymptomatic at harvest, may develop symptoms during transport or storage (Baker et al., 1949; Engelhard, 1972).

The PLH Panel assumes that, in the infested third countries, cultural practices and chemical control measures are applied to chrysanthemum crops for the control of other fungal pathogens (e.g. *B. fuckeliana*, *P. horiana*, etc.) and that those measures may also be effective against *S. chrysanthemi*. This is further supported by Fides's (2006) statement that ray blight of chrysanthemum occurs only sporadically nowadays as a result of the intensive measures taken for the control of *P. horiana*.

According to Eurostat (2012), 4 000–5 000 tons of chrysanthemum cut flowers are imported annually into the EU from Third countries, even from countries infested with *S. chrysanthemi*, such as Kenya and Tanzania (see Section 3.1.2.1). During the period 2008–2013, a total of 1 068 600 kg and 8 400 kg of chrysanthemum cut flowers and buds were imported into the EU from Kenya and Tanzania, respectively (Eurostat, 2012). Imports of chrysanthemum cut flowers into the EU take place all year round with peaks mainly in spring (March) and autumn (October–November) (Eurostat, 2013). Host plants are grown in the risk assessment area throughout the whole year, particularly in greenhouses, and are susceptible to the infection by the pathogen, even under extreme temperature and humidity conditions (Baker et al., 1949) (see Section 3.1.1.4).

According to the current EU legislation (Council Directive 2000/29/EC, Annex V, Part B I, point 2), chrysanthemum (as *Dendranthema*) cut flowers originating in third countries should be submitted to a plant health inspection in the country of origin or the consignor country before being permitted to enter the EU territory. However, based on the information provided in Section 3.1.1.2, the PLH Panel considers that infected cut flowers, particularly latently infected, originating in infested third countries may escape the plant health inspection procedure.

Based on the above, the PLH Panel considers that *S. chrysanthemi* is **likely** to be associated with chrysanthemum cut flowers originating in infested areas. The uncertainty is estimated as **medium** owing to lack of information on the prevalence of the pathogen in infested third countries and to the possible escape of cut flowers with mild symptoms or latent infections during plant health inspection at the place of origin.

3.2.3.2. Probability of survival during transport or storage

Cut flowers may be preserved by wet or dry storage/shipment methods (Rudnicki et al., 1991). Chrysanthemum cut flowers are among the species that keep better and for longer when stored dry at the tight bud stage than when stored wet. The optimum temperature for storing cut flowers originating in the temperate climatic zones is slightly above the freezing point of tissues (i.e. –1 to –2 °C), although in practice a temperature range between 0 and +1 °C is mostly used. High relative humidity in the storage room (90–95 % RH) is necessary to minimise moisture losses and prevent wilting, particularly when moisture-proof packaging is not used (Rudnicki et al., 1991). *S. chrysanthemi* has been reported to survive over a wide range of temperatures (–23 to 30 °C) and relative humidity (6–85 %) (Baker et al., 1949), and thus its survival will not be affected by the conditions prevailing during the transport or storage of infected chrysanthemum cut flowers.

Given that there are no major differences between the transport and storage conditions of cut flowers and those of cuttings (see Section 3.2.2.2), the PLH Panel considers that the pathogen is **very likely** with **no uncertainty** to survive the transport and storage conditions that ensure the viability of chrysanthemum cut flowers. In addition, *S. chrysanthemi* is **very unlikely** with **low uncertainty** to increase in prevalence during transport and storage of infected chrysanthemum cut flowers.

3.2.3.3. Probability of surviving existing pest management procedures

Cultural practices and chemical control measures applied at the place of origin for the control of other chrysanthemum fungal diseases, as described in the previous pathway (see Section 3.2.2), may reduce the incidence of ray blight of chrysanthemum and even control to some extent the disease, particularly when an integrated approach is applied. This is further supported by Fides's (2006) statement that *S. chrysanthemi* occurs only sporadically nowadays on chrysanthemum crops as a result of the intensive measures taken for the control of *P. horiana*.

The symptoms caused by *S. chrysanthemi* on *Chrysanthemum* × *morifolium* flowers are similar to those caused by other pathogens (*B. fuckeliana*, *E. chrysanthemi*, *Septoria* spp., etc.) (Baker et al., 1949; CABI, 2012). In addition, infected cut flowers, asymptomatic at harvest, may develop symptoms during transport or storage (Baker et al., 1949; Engelhard, 1972). Therefore, reliable detection and identification of the pathogen is possible only by laboratory testing based on the cultural and morphological characters and the positive reaction to NaOH, as well as on molecular sequencing of the pathogen (see Section 3.1.1.2).

Cut flowers are usually graded during harvest, prepared in bunches and left for 20 hours in water to which bactericides, sugars and wetting agents may be added (Fides, 2006). Following bunching, the flowers should be cooled (7–8 °C) as quickly as possible. Although there is no information on any other procedures applied to consignments during their preparation, the PLH Panel assumes that culling of cut flowers may also be a common practice. Nevertheless, although culling may remove symptomatic cut flowers, it cannot eliminate the pathogen present on latently infected flowers.

Chrysanthemum cut flowers originating in third countries and imported into the EU territory should have undergone a plant health inspection in the country of origin or the consignor country (Council Directive 2000/29/EC, Annex V, Part B I, point 2). However, based on the information provided in Section 3.1.1.2, the PLH Panel considers that infected cut flowers, particularly those latently infected, originating in infested third countries may escape the plant health inspection procedure.

Based on the above, the PLH Panel considers that *S. chrysanthemi* is **moderately likely** to survive existing pest management procedures applied to chrysanthemum cut flowers imported into the EU from infested third countries. This is further supported by the lack of interceptions of the pathogen in the EUROPHYT database. The uncertainty associated with this rating is **medium**, owing to lack of (i) information on whether cut flowers imported into the EU territory originate from cuttings produced under a certification scheme, and (ii) precise information on the cultural practices and chemical control measures applied at the place of origin during the production of cut flowers.

3.2.3.4. Probability of transfer to a suitable host

Cut flowers of *Chrysanthemum* × *morifolium* are mainly used indoors as ornamentals. Therefore, once imported into the risk assessment area, they will be widely distributed within and among all EU MS. According to Eurostat (2012), 4 000–5 000 tons of chrysanthemum cut flowers are imported annually into the EU from third countries (see Section 3.1.2). Imports of cut chrysanthemum flowers into the EU take place all year round with peaks mainly in spring (March) and autumn (October–November) (Eurostat, 2013). Once wilted, cut flowers will be discarded through either regular waste disposal or home composting. The pathogen is not expected to survive such waste management procedures. Nevertheless, some cut flowers may be placed outdoors as for example at cemeteries, as in several EU MS chrysanthemum cut flowers are widely used to ornament graveyards. Although the pathogen may be transferred by natural means (wind, rain, wind-blown rain, etc.) (Baker et al., 1961) from infected host plant material to susceptible hosts grown in close proximity in the risk assessment area (see Section 3.2.4., Pathway 6), the PLH Panel assumes that the pathogen present on fresh cut flowers placed in graveyards has relatively limited potential to initiate plant infection in nearby commercial growing areas, even under favourable environmental conditions, as (i) the wind-disseminated ascospores of the pathogen cannot possibly travel distances further than 400 m from the inoculum source (see Section 3.2.4, Pathway 6), and (ii) graveyards are usually surrounded by hedges, walls or fences which will most probably limit the spore dispersal of the pathogen beyond the graveyard either by physical interception or through reduction of wind speed.

The PLH Panel considers that the transfer of *S. chrysanthemi* from imported infected chrysanthemum cut flowers to host plants grown in close proximity in the risk assessment area is **unlikely**. The uncertainty associated with this rating is considered by the PLH Panel to be **medium**, as there is lack of information about the volume of infected cut flowers that are placed (or discarded) outdoors and in proximity to susceptible crops.

3.2.4. Secondary pathways of entry

Of the six pathways listed in Section 3.2.1, the last four are considered by the PLH Panel of minor importance for the entry of the pathogen into the risk assessment area for the reasons explained below.

<u>Pathway 3. Seeds of host plants</u>

No reports of seed infection of *Chrysanthemum* × *morifolium* by *S. chrysanthemi* have been found during the systematic literature search performed by the PLH Panel. Nevertheless, based on the biology of related pathogens, it cannot be ruled out that seed contamination may occur in infested seed production areas.

The report of *D. ligulicola* as a seed-borne pathogen of *Chrysanthemum carinatum* (current name *Glebionis carinatum*) (Neergaard, 1979) should be considered with caution because of the recent taxonomic changes within the *D. ligulicola* complex. In addition, pycnidia of other *Phoma*-like species

can be generally found on seeds (Boerema et al., 2004). The most recent studies on seed-borne infection caused by species included in the former *D. ligulicola* complex concern *S. tanaceti* (as *P. ligulicola*) (Pethybridge et al., 2006) and are limited to *T. cinerariifolium* (pyrethrum). According to Pethybridge et al. (2006), pyrethrum seed is the most likely source of primary *S. tanaceti* inoculum. The same authors found that all pyrethrum seed lots tested in Tasmania were infested with the pathogen, with an incidence of up to 28 % of seeds per lot.

In contrast to commercial pyrethrum crops, which are propagated by seed (Pethybridge et al., 2006), in commercial chrysanthemum production, the current propagation practice is by cuttings (EFSA, in press). In the case of commercial production of chrysanthemum, seed is used only in breeding for new cultivars, which are then multiplied and distributed as unrooted/rooted cuttings (EFSA, in press). Therefore, the seed is employed in breeding departments where seeds are germinated and plants are grown and selected with the attention needed in this delicate phase. Chrysanthemum hybridising protocols have been improved as optimal conditions for light, temperature, nutrition, and pest control have been determined (Anderson, 1990). Therefore, appropriate plant disease management measures, including fungicide treatments of seed, seedlings and/or plants, aiming at preventing damping-off and other plant diseases (Fides, 2006; Anonymous, 2011; Hagan, 2011; Warfield, 2012) are likely to be applied during chrysanthemum breeding programmes. Should *S. chrysanthemi* be present in seed, the above measures may also provide protection against this pathogen and minimise the risk of its transmission to subsequent commercial cuttings.

Besides the use of chrysanthemum seeds in breeding programmes, the PLH Panel found indications of chrysanthemum seed trade, including e-commerce. According to a recent study (FAO IPPC, 2012), packets with a small number of chrysanthemum seeds (fewer than 50) are generally offered for sale via the Internet. No further information or specific statistical data on chrysanthemum seed trade, either via e-commerce or other means, has been found by the PLH Panel. Therefore, there is uncertainty about the volume of host seed that is traded via the Internet, although such seed trade is likely to concern mostly private gardeners.

The PLH Panel assumes that the pathogen present on host plants grown from infected seed sown in gardens has relatively limited possibilities to initiate plant infection in commercially grown areas, even under favourable environmental conditions, as (i) the wind-disseminated ascospores of the pathogen cannot possibly travel distances more than 400 m from the inoculum source (see below, Pathway 6), (ii) gardens are usually surrounded by hedges, walls or fences, which will most probably limit the spore dispersal either by physical interception or through reduction of wind speed, and (iii) it may be assumed that chrysanthemum plants originating from seeds are planted in a small number in each single garden, thus limiting the amount of inoculum available.

In addition, the possibility that *S. chrysanthemi* conidia or ascospores originating in private/public gardens will land on host plants grown commercially under protection (greenhouses, etc.) is even more limited because of the relative isolation provided to host plants by the sheltering structures.

Taking into account all the above, the PLH Panel considers that the pathway “seed of host plants” is of **minor** importance for the entry of *S. chrysanthemi* into the risk assessment area.

<u>Pathway 4. Soil and other growing media</u>

Chrysanthemum plants are grown outdoors and also indoors, mainly in natural soil or other organic substances, such as peat or compost. According to Blakeman and Hornby (1966), *S. chrysanthemi* (as *Mycosphaerella ligulicola*) can survive in soil even without being associated with host plant debris. In a trial conducted by the same authors, the “loose sclerotia” of the pathogen were buried in various types of soil and then their survival was assessed over a period of 30 weeks. The results of that study showed that in dry garden soil, 94 % of the buried “loose sclerotia” were still viable even after 30 weeks. However, in moist garden soil, the biological activity of other microorganisms inhibited the survival of the “loose sclerotia”, but still 4 % of them were viable even after 22 weeks. In sterile

garden soil, 100 % and 79 % of the "loose sclerotia" were viable after 30 weeks under moist and dry conditions, respectively (Blakeman and Hornby, 1966). According to the same study, 12 % of the sclerotia remained viable for 30 weeks even in non-nutritious moist silver sand. Blakemen and Hornby (1966) found that "loose sclerotia" and associated mycelium of the pathogen buried in non-sterile compost ceased to be infective after eight weeks.

According to Blakemen and Hornby (1966), the conidia of *M. ligulicola* do not survive in non-sterile compost; however, in sterile compost conidia have been found to remain viable for up to 46 days. Without sterilisation of the media, subsequent infection of the host plants could occur by the surviving conidia.

The PLH Panel considers that high uncertainty is associated with the information provided by Blakeman and Hornby (1966) on the presence of "loose sclerotia" and their survival potential and infectivity. The isolates of the pathogen (referred to as *M. ligulicola*) used in the above study were not specified and, therefore, the identity of the fungus involved is uncertain. It is not possible to check whether those isolates belonged to *S. chrysanthemi*. The presence of mycelial structures, called by the authors "loose sclerotia", could not be confirmed by other publications and, therefore, it seems that those structures are not characteristic of *S. chrysanthemi*. However, it cannot be ruled out that the "loose sclerotia" described by Blakeman and Hornby (1966) might refer either to the initial developmental stages of fruiting bodies of the pathogen or even to another *Phoma*-like species.

Baker at al. (1961) showed that *S. chrysanthemi* (as *D. ligulicola*) can survive in dry host plant debris under laboratory conditions. The fungus was able to develop pycnidia and pseudothecia on artificially inoculated chrysanthemum stems that had been kept at a relative humidity of 6 % and temperatures of 10 and 21 °C for 18 weeks at normal day length. At a relative humidity of 2 %, no pseudothecia were formed but pycnidia were produced abundantly on the dry stem debris. This indicates that the fungus is able to survive in dry plant debris. However, no pycnidia or pseudothecia were produced at 10 and 21 °C when the relative humidity was high (above 85 % and 100 %, respectively). When the authors conducted the same experiment in the dark using dry plant debris of a different chrysanthemum variety, (i) no pseudothecia were produced at any of the relative humidity tested, and (ii) pycnidia were not produced at high relative humidity or at 2 % relative humidity (Baker et al., 1961). Nevertheless, the results of those studies cannot be extrapolated to the survival potential of the organism in host plant debris in the soil.

According to Directive 2000/29 EC Annex III, Part A, point 14, the importation of soil and growing media as such, which consist completely or in part of soil or solid organic substances, such as parts of plants, humus including peat or bark, other than that composed entirely of peat, is prohibited in all MS if originating from Turkey, Belarus, Moldova, Russia, Ukraine and third countries not belonging to continental Europe, other than Egypt, Israel, Libya, Morocco and Tunisia. This means that soil and other growing media can be imported only from the last five third countries, among which Israel and Tunisia are reported to be infested with *S. chrysanthemi* (as *D. ligulicola)* (EPPO PQR, 2012). No data are available regarding the volume of imports of soil or other growing media from Israel and Tunisia into the risk assessment area. However, it may be assumed that the imported volume is unlikely to be high, particularly given the availability of soil and other organic growing media in the MS as well as the high cost of the transport of such material from areas outside the EU.

Therefore, the PLH Panel considers soil and other growing media as a **minor** pathway for the entry of the pathogen into the risk assessment area.

<u>Pathway 5. Pot plants (not necessarily host plants), including associated soil and other growing media</u>

In case *Chrysanthemum* × *morifolium* pot plants (including associated soil and growing media) were to be imported into the risk assessment area from infested third countries, the PLH Panel considers that they could support the entry of the pathogen into the EU territory as (i) the pathogen infects all plant parts, and (ii) even not intended for propagation purposes, pot plants could still be planted in

gardens, parks or cemeteries in the risk assessment area. Nevertheless, there is lack of data on the volume of *Chrysanthemum* × *morifolium* pot plants which are planted in rural areas and in proximity to susceptible chrysanthemum crops grown outdoors (crops in greenhouses are far less exposed to inoculum).

The PLH Panel considers that the pathogen is unlikely to enter the EU territory on soil and other growing media associated with commercially produced non-host pot plants originating in infested third countries, because of the disinfestation procedure that is usually applied to the soil and other growing media used for the growth of those plants.

In addition, based on the information provided in the technical report (EFSA, in press), under the current situation, pot plants in general are mainly produced within the risk assessment area because of the high cost of shipping of such plant material. Therefore, the PLH Panel considers that pot plants (not necessarily host plants), including the associated soil and other growing media pathway is of **minor** importance for the entry of the pathogen into the risk assessment area.

Pathway 6. Natural means

S. chrysanthemi produces pycnidia from which conidia exude in saffron-coloured gelatinous masses forming short columns (see Section 3.1.1.3). There are no specific studies on the distance over which conidia of *S. chysanthemi* are dispersed by rain, but based on general knowledge about splash dispersal of spores, it can be stated that they cannot travel over long distances (Fitt et al., 1989). Droplets formed from rain splashes comprise two types: large ballistic splashed droplets and smaller aerosol droplets (Fitt and McCartney, 1986). In general, large ballistic splash droplets (> 200 µm in diameter) tend to travel relatively short distances in wind, which can be measured in metres, while strong winds combined with rain in storms can carry small aerosol droplets (< 100 µm) greater distances, which usually can be measured in a few hundreds of metres (Fitt and McCartney, 1986; Fitt et al., 1989).

Pseudothecia of the pathogen produce ascospores, which, in contrast to conidia, are airborne and, therefore, they can potentially travel over longer distances. There are no specific studies available on the distance over which ascospores of *S. chysanthemi* can be disseminated by wind. According to Pethybridge et al. (2008b), ascospores of *S. chrysanthemi* (as *P. ligulicola* var. *ligulicola*) are believed to be responsible for long-distance dispersal of this pathogen within fields (and possibly among fields). In field trials on *D. pinodes*, the ascospores of which are similar in size and shape (12–18 × 4–8 µm) (Chilvers et al., 2009) to those of *S. chrysanthemi* (12–16 × 4–6 µm) (Baker et al., 1949), deposition of ascospores on pea "trap plants" was studied at six distances (0, 10, 50, 100, 200 and 400 m) downwind from an infested field pea stubble bearing pseudothecia for a 21-week period in Western Australia (Salam et al., 2011). Most ascospores were trapped within a distance of 10 m from the inoculum source. At 400 m, ascospores were found in only 14 % of samples and in low numbers (only 0.3 % of total ascospores trapped). The physical model developed by Salam et al. (2011) showed that deposition of *D. pinoides* ascospores tends to zero after 200 m from the inoculum source.

In another *Didymella* species, *D. rabiei* (*Ascochyta* blight of chickpea), the ascospores of which are similar in size and shape (5–16 × 4.5–7 µm) (Trapero-Casas and Kaiser, 1992) to those of *S. chrysanthemi*, there is evidence that its ascospores do not travel over long distances either. According to Trapero-Casas et al. (1996) studies, the disease spread extensively in plots located at sites where there was considerable production of *D. rabiei* ascospores by pseudothecia present in nearby infested chickpea debris; however, no disease symptoms were found where there were no infected chickpea debris in close proximity to the chickpea crop.

In the case of *S. chrysanthemi* and taking into account that (i) both pycnidia and pseudothecia are produced on infected host plants; (ii) conidia are splash dispersed and do not travel over long distances; (iii) ascospores are airborne and, although there are no studies on the maximum distance they can travel by air currents, it has been shown that ascospores of similar *Didymella* species do not

travel in relevant high numbers longer than 200–400 m; and (iv) there are no other known natural means (i.e. insects or other animals) by which the pathogen can spread over longer distances, the PLH Panel considers the entry of the pathogen via natural means from infested non-European countries into the risk assessment area as a **minor pathway**.

In addition to the above and considering that (v) the pathogen is present in two European non-EU countries, namely Serbia (with restricted distribution) and Moldova (no details on its distribution); (vi) the above records are dated in 1992 and 1994, respectively, and since then no other evidence of the presence of the pathogen in those countries has been published; and (vii) it is unlikely that host plants are cropped in close vicinity to the borders of adjoining EU and non-EU infested countries, the PLH Panel considers the entry of the pathogen via natural means from infested European non-EU countries into the risk assessment area as a **minor pathway**, too.

3.2.5. Conclusions on the probability of entry

Rating	Justification
Unlikely	• *S. chrysanthemi* may be associated (as mycelium, pycnidia, pdeudothecia and possibly "loose sclerotia") with host plants for planting, excluding pot plants and seeds (i.e. rooted and unrooted cuttings of *Chrysanthemum* × *morifolium*) originating in infested third countries. The pathogen can survive transport and storage conditions and can be transferred from the pathway to susceptible hosts grown in close proximity in the risk assessment area by natural and human-assisted means. Nevertheless, the standard certification schemes currently used for the production of chrysanthemum cuttings and the EU legislation, have considerably reduced the risk of entry of the pathogen into the EU territory on host plant cuttings originating in infested third countries. • *S. chrysanthemi* may be associated with *Chrysanthemum* × *morifolium* cut flowers originating in infested third countries and can survive transport and storage conditions and, to some extent existing pest management procedures. However, because of the end-use of cut flowers (i.e. placed indoors for decorative purposes), the pathogen is unlikely to be transferred from the pathway to susceptible hosts grown within the vicinity in the risk assessment area, provided that cut flower waste is properly managed. In the event that fresh cut flowers of host plants are used to ornament graveyards, the pathogen is unlikely to be transferred from the pathway to susceptible hosts grown in close proximity in the risk assessment area, as the hedges, wall or fences that usually surround the graveyards will most probably limit the spore dispersal of the pathogen beyond those places either by physical interception or through reduction of wind speed.

3.2.6. Uncertainties on the probability of entry

Rating	Justification
Medium	• There is a lack of data on whether all chrysanthemum cuttings imported into the risk assessment area have been produced under an appropriate certification scheme. • There is a lack of data on the probability of infected cut flowers or their waste coming into contact with susceptible hosts grown in close proximity in the risk assessment area.

3.3. Probability of establishment

3.3.1. Availability of suitable hosts, alternative hosts and vectors in the risk assessment area

Hosts of *S. chrysanthemi* (i.e. cultivars of *Chrysanthemum* × *morifolium*; common name florist's chrysanthemum) (Van der Aa et al., 1990; de Gruyter et al., 2002; Vaghefi et al., 2012) are widely grown in open fields and greenhouses as well as in private and public gardens in both rural and urban regions of the risk assessment area. However, detailed data on the area grown with host plants in the risk assessment area are not available for all EU MS (AIPH, 2011; Table 4). The main EU producers of cut chrysanthemum are the Netherlands and Italy, while pot chrysanthemum and multiflora plants are produced in the entire EU territory (EFSA, in press).

Table 3: Area (ha) and production (1 000 pieces) per EU Member State of chrysanthemum (mainly cultivars of *Chrysanthemum* × *morifolium*) crops commercially grown for cut flowers and pot plants (International Statistics Flowers and Plants, 2011)

	Cut flower production (ha)		**Pot plants production (ha)**		**Cut flower production (1 000 pieces)**		**Pot plants production (1 000 pieces)**	
Country	**In the open**	**Under protection**	**In the open**	**Under protection**	**In the open**	**Under protection**	**In the open**	**Under protection**
Austria								
Belgium (2010)			343				11 500	
Bulgaria								
Cyprus								
Czech Republic								
Denmark								
Estonia								
Finland (2010)		0.4						1 049
France								
Germany (2008)	69	59					29.5	
Greece (1995)	54							
Hungary (2006)		15						
Iceland								
Ireland (2007)				2.6				
Italy (2007)					437.16		9.7	
Latvia								
Lithuania								
Luxembourg								
Malta								
Netherlands (2010)		504						
Poland								
Portugal								
Romania								
Slovakia								
Slovenia								
Spain								
Sweden (2010)					5		3.7	
United Kingdom (2007/2008)	16						3 500	

3.3.2. Suitability of the environment

S. chrysanthemi can infect its hosts over a wide range of temperatures (6–30 °C), given there is sufficient moisture (Baker et al., 1949). Germinated *S. chrysanthemi* conidia are able to withstand dry periods as long as five days and resume growth when rewetted (Baker et al., 1949). The pathogen can also survive over a wide range of temperatures (–23 to 30 °C) and relative humidity (6–85 %) (Baker et al., 1949) (see Section 3.1.1.4).

The current geographic distribution of *S. chrysanthemi* is shown in Figures 2 and 3 (see Section 3.1.2). *S. chrysanthemi* is also present (or had been present in the past) in some parts of the risk assessment area, albeit with a restricted distribution (Figure 3 and Table 1). Comparison of the world distribution map of *S. chrysanthemi* (Figure 2) with the Köppen–Geiger climate map (Figure 4) shows that the pathogen has established in areas with different climates and that all the climates present in the risk assessment area are favourable for the establishment of the pathogen. The Köppen–Geiger climate map shows that four main climate types are found in Europe. The dominant climate type by land area is cold D (44.4 %), followed by arid B (36.3 %), temperate C (17.0 %) and polar E (2.3 %). The same climates occur in North America, where the pathogen is also present (EPPO PQR, 2012) (Figure 2). More specifically, the dominant climate type by land area in North America is cold D (54.5 %), followed by arid B (15.3 %), temperate C (13.4 %), polar E (11.0 %) and tropical A (5.9 %). The Cfb type, which is largely present in central and northern Europe, is not widespread in North America. *S. chrysanthemi* is present in Germany and the Netherlands (Vaghefi et al., 2012), which belong to the Cfb climate (Fig. 4D). However, it is very likely that these records are based on findings in greenhouses. In addition, this climate type is present in south-east Australia and Tasmania (Figure 4), where a phylogenetically closely related species, *S. tanaceti*, causing ray blight of pyrethrum (*T. cinerariifolium*), is present (Vaghefi et al., 2012).

Although there is uncertainty because of lack of information on the exact geographical distribution of the pathogen within each of the infested countries, since climates in the non-European countries, where the pest is currently present (or had been present in the past), cover almost the majority of the climates prevailing in the risk assessment area, the Panel considers that the environmental conditions, at least in some parts of the EU territory where the hosts (cultivars of *Chrysanthemum* × *morifolium*) are grown, are favourable for the establishment of *S. chrysanthemi*. Environmental conditions are also suitable in protected cultivation of host plants, since the environmental conditions favouring plant growth are also suitable for the pathogen.

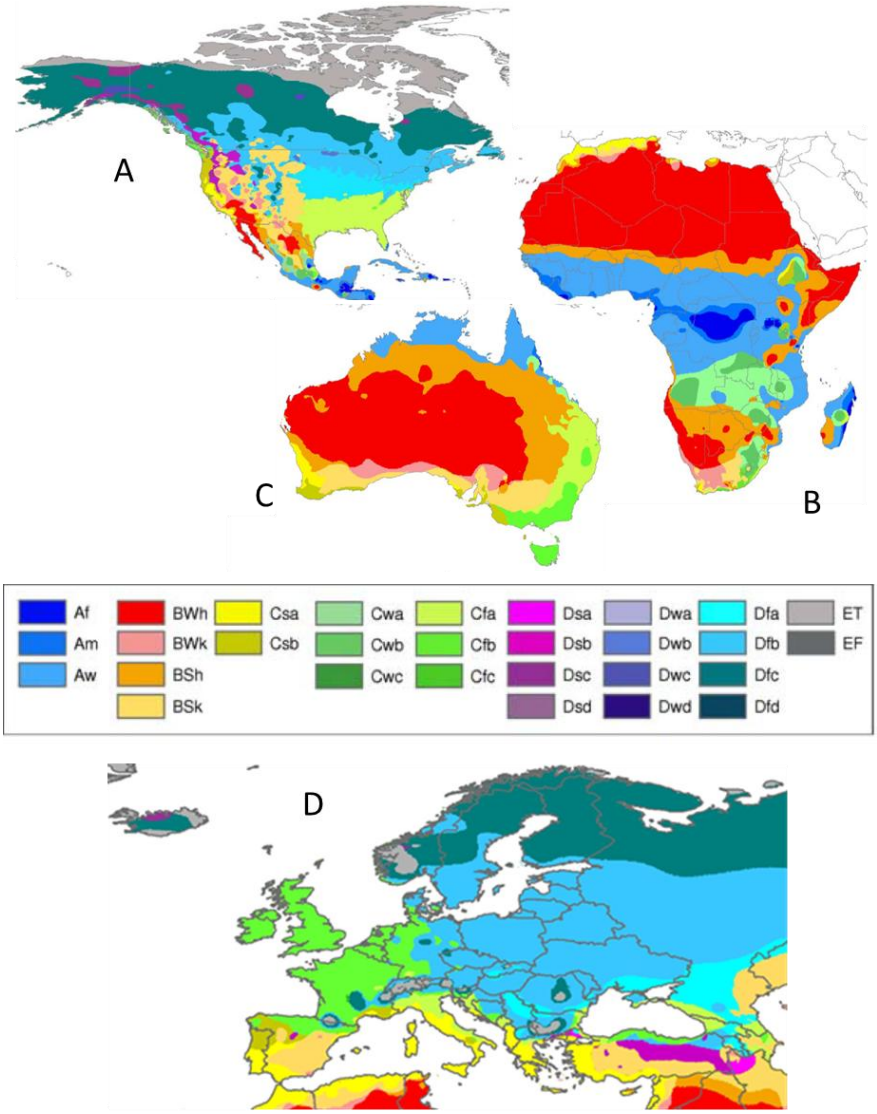

Figure 4: Köppen–Geiger climate map of Europe (Peel et al., 2007)

3.3.3. Cultural practices and control measures

According to the current practice followed in the EU, the production of chrysanthemum propagation material (i.e. rooted and unrooted cuttings) is subject to a certification scheme (see Section 3.2.2). Although there is no detailed information available in the literature, it is assumed that cultural practices, such as use of pathogen-free propagation material, monitoring of the crop, avoiding overhead irrigation, proper management of plant debris, soil disinfestation, use of clean irrigation water, etc., are usually included in a certification scheme for the production of chrysanthemum cuttings by the major breeding and propagation companies in the risk assessment area (EFSA, in press).

In addition to the cultural practices applied, some broad-spectrum fungicides used for the control of other fungal pathogens of chrysanthemum, such as *B. fuckeliana*, *P. horiana*, etc., may be also effective against *S. chrysanthemi*. This is further supported by (i) the report of ray blight disease occurring only sporadically nowadays on chrysanthemum crops as a result of the intensive measures taken for the control of *P. horiana* (Fides, 2006), and (ii) the restricted distribution or the few occurrences of *S. chrysanthemi* in some EU MS (see Table 2). Several fungicides are effective in controlling ray blight of chrysanthemum (Appendix C), although the pathogen has developed

resistance to some of them (see Section 3.2.2.3) and there is concern about the possibility that some of the effective active substances might be withdrawn in future.

Resistance of *Chrysanthemum* × *morifolium* cultivars to ray blight has been reported in the past (Engelhard, 1969, 1984; Green and Engelhard, 1974). Nevertheless, because of the lack of recent studies on this aspect, there is uncertainty about the level of resistance present in the cultivars currently grown in the risk assessment area and worldwide. No biological control methods are available (EPPO PQR, 2012).

As mentioned above, there is uncertainty about the resistance of current commercial *Chrysanthemum* × *morifolium* cultivars to the infection by the pathogen, although it is known from the literature that in the past the disease was severe on relatively few cultivars and most cultivars showed diverse levels of resistance. Nevertheless, in the absence of fungicide treatments, some resistant cultivars have been reported to show symptoms.

It should be also noted that, in the risk assessment area, host plants of *S. chrysanthemi* are also grown in private and public gardens, where the application of chemical sprays is either not feasible or not a common practice. Therefore, such semi-managed environments are particularly favourable for the establishment of the pathogen.

Based on the above, the PLH Panel considers that the cultural practices and chemical control measures currently applied in the risk assessment area for the control of other chrysanthemum pathogens can reduce the severity of the disease caused by *S. chrysanthemi*, but they are unlikely to prevent the establishment of the pathogen in the risk assessment area. This is further supported by the fact that the pathogen is present with restricted distribution (or had been present in the past) in the risk assessment area and despite the control measures applied.

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

S. chrysanthemi is a highly adaptable pathogen with wide ecological tolerance (see Section 3.1.1.4). The pathogen can infect its hosts over a wide range of temperatures (6–30 °C), given sufficient moisture (Baker et al., 1949). Under optimum environmental conditions, *S. chrysanthemi* conidia germinate within 3.5–4 hours and can infect the host in slightly more than 6 hours. Germinated conidia of the pathogen can withstand dry periods as long as five days and resume growth when re-wetted. *S. chrysanthemi* can also survive over a wide range of temperatures (–23 to 30 °C) and relative humidity (6–85 %) (Baker et al., 1949). In addition, the pathogen has the ability to produce both the asexual and the sexual stages abundantly on infected host plants, even under less conducive environmental conditions (low temperatures and relative humidity) (Baker et al., 1949).

The ability of the pathogen to develop resistance to fungicides (Grouet, 1974; Punithalingam, 1980) and reproduce sexually may increase its evolutionary potential and thus its virulence and adaptability.

3.3.5. Conclusions on the probability of establishment

Rating	Justification
Very likely	• *S. chrysanthemi* is present (or had been present in the past) in some parts of the risk assessment area, albeit with a restricted distribution. • Host plants (i.e. cultivars of *Chrysanthemum* × *morifolium*) are widely distributed in the risk assessment area, in open fields, greenhouses, private and public gardens, etc. and are susceptible to infection by the pathogen throughout the whole growing period. • The environmental conditions prevailing in parts of the risk assessment area, where susceptible hosts are grown, are suitable for infection, inoculum production and survival of *S. chrysanthemi*.

Rating	Justification
	• Cultural practices and chemical control measures applied in the risk assessment area for the control of other chrysanthemum fungal pathogens may reduce the disease severity, but they cannot prevent the establishment of *S. chrysanthemi*. • *S. chrysanthemi* is a highly adaptable pathogen with wide ecological tolerance. The occurrence of sexual reproduction may further increase its evolutionary potential resulting in increase in virulence and adaptability.

3.3.6. Uncertainties on the probability of establishment

Rating	Justification
Low	• Information and data are overall sufficient, consistent and not conflicting. However, there is lack of precise information on the cultural practices and chemical control measures applied in the risk assessment area for the management of other chrysanthemum fungal pathogens.

3.4. Probability of spread

Once introduced into the risk assessment area, *S. chrysanthemi* can spread by both natural means and human assistance.

3.4.1. Spread by natural means

Host plants are extensively grown in the risk assessment area in open fields and greenhouses as well as in private and public gardens, and are susceptible to infection by *S. chrysanthemi* for the whole growing period. The main *Chrysanthemum* × *morifolium*-producing MS (mostly for cut flowers) are the Netherlands, Italy, Germany, Belgium, France and Poland (EFSA, in press).

Climatic conditions in the EU territory, where host plants are grown, are considered favourable for infection as well as for sporulation and survival of the pathogen (see Sections 3.1.4.2 and 3.3.2). Once established in an area, the pathogen can survive long periods of drying and low temperatures (Baker et al., 1949). *S. chrysanthemi* is able to form pseudothecia and pycnidia readily and abundantly on infected plant parts even under less conducive environmental conditions (i.e. low temperatures and dry conditions). Ascospores of *S. chrysanthemi* are airborne and, based on studies on spore dispersal of other *Ascochyta* species with spores of similar size, they can possibly travel up to a distance of 400 m from the inoculum source, whereas conidia are dispersed over relatively short distances through rain splash or irrigation (see Section 3.2.4, Pathway 6). No other natural means (i.e. insects or other animals) are known to be involved in the spread of the pathogen.

Based on the above, it may be concluded that, following its establishment in the risk assessment area, *S. chrysanthemi* can spread by natural means (wind, rain, wind-blown rain) from infected plants to infect susceptible hosts grown in close proximity.

Large areas free of susceptible hosts may be a barrier to the spread of *S. chrysanthemi* by natural means because of the relatively short distance (possibly up to 400 m; see Section 3.2.4, Pathway 6) to which the ascospores of the pathogen may be transported by air currents. Although such barriers have not been identified in the risk assessment area, if present, they may be overcome by human-assisted spread of the pathogen.

3.4.2. Spread by human assistance

Long-distance spread of *S. chrysanthemi* in the risk assessment area may occur by human assistance through the movement of infected propagation material (rooted/unrooted cuttings) and pot plants of

Chrysanthemum × *morifolium*. Within the EU territory there is an important movement of chrysanthemum commodities (rooted/unrooted cuttings, cut flowers, pot plants), which may carry the pathogen both between the MS and within a single MS. According to Eurostat (2012), the intra-EU movement of fresh cut chrysanthemum and buds was 52 135 700 kg in 2010 and 48 560 800 kg in 2011. However, no statistical data are available to quantify the intra-EU movement of chrysanthemum cuttings and pot plants, since such data is aggregated in the Eurostat database.

The production and movement of chrysanthemum (as *Dendranthema*) cuttings (rooted/unrooted) within the EU is subject to special requirements for *S. chrysanthemi* (as *D. ligulicola*) detailed in Annex IV, Part A, Section II, of Council Directive 2000/29/EC. In addition, according to Annex V, Part A, point 2.1, of the same Directive, the movement within the MS of chrysanthemum plants for planting other than seeds originating in the Community should be accompanied by a plant health passport. Those requirements may limit the spread potential of the pathogen within the EU territory on cuttings and pot plants but they cannot prevent it, particularly on latently infected plant material. However, chrysanthemum cut flowers can be produced and marketed in the EU territory without any restrictions, thus facilitating the spread of *S. chrysanthemi* within the risk assessment area by human assistance.

3.4.3. Containment of the pest within the risk assessment area

The PLH Panel considers that the pathogen is most likely not to be contained in the risk assessment area, as:

- Host plants (*Chrysanthemum* × *morifolium*) are extensively grown in open fields and greenhouses as well as in private and public gardens, both in rural and urban regions of the risk assessment area.
- Host plants are susceptible to infection by *S. chrysanthemi* for the whole growing period.
- Ascospores of the pathogen are airborne and can possibly travel up to a distance of 400 m from the inoculum source, while conidia are dispersed over relatively short distances through rain splash or irrigation.
- *S. chrysanthemi* can overcome natural barriers in the risk assessment area (e.g. areas where susceptible hosts are not grown) via the high volume of chrysanthemum commodities being traded within and among the EU MS.
- Although the existence of resistant cultivars is reported in old literature, no updated information on this subject is available.
- Fungicides currently available in the risk assessment area for the control of other chrysanthemum fungal pathogens, which may also be effective against *S. chrysanthemi*, might be withdrawn in future. Moreover, there might be limitations in the efficacy of chemical control measures because of the possibility of the appearance of fungicide-resistant populations.
- Certification schemes and the current EU regulations are likely to reduce further spread of the pathogen via propagation material that is still produced within the risk assessment area.

3.4.4. Conclusions on the probability of spread

Rating	Justification
Very likely	• Environmental conditions prevailing in parts of the EU territory, where the hosts are grown, are suitable for sporulation and dispersal of *S. chrysanthemi*. • Once introduced into the EU territory, *S. chrysanthemi* can spread (i) over relatively short distances by natural means (e.g. rain, irrigation, wind), and (ii) over longer distances by human assistance (movement of infected chrysanthemum plant material). • Host plants are widely grown in the EU territory in open fields, greenhouses, private and public gardens, both in rural and in urban regions.

3.4.5. Uncertainties on the probability of spread

Rating	Justification
Low	• There is no uncertainty concerning the spread of the pathogen in the risk assessment area by natural means and human assistance. However, there are no studies on the distance over which the ascospores of *S. chrysanthemi* can be disseminated by weather-related events (e.g. wind, wind-driven rain, etc.).

3.5. Conclusion regarding endangered areas

Given (i) the presence of host plants (i.e. cultivars of C*hrysanthemum* × *morifolium)* in commercial fields and greenhouses, as well as in private and public gardens (in both rural and urban regions) in the risk assessment area, and (ii) the wide range of temperature and humidity under which *S. chrysanthemi* can infect, reproduce and survive, the PLH Panel considers the whole EU territory as an endangered area.

3.5.1. Present distribution of the organism in the EU territory in comparison with the endangered area

According to the information provided in Section 3.1.2.2, the pathogen is present with a restricted distribution in 12 MS (i.e. Belgium, Croatia, France, Germany, Hungary, Ireland, Italy, Luxemburg, Romania, Slovakia, Slovenia and UK).

Given that the hosts (i.e. cultivars of *Chrysanthemum* × *morifolium*) are grown in the entire risk assessment area and the pathogen can complete its life cycle over a wide range of climatic conditions, the PLH Panel considers that the area of the pathogen's present distribution in the EU territory is limited compared with the endangered area. However, there are uncertainties associated with the real distribution of *S. chrysanthemi* in the risk assessment area because of the taxonomic confusion that occurred in the past over the causal agent of ray blight of chrysanthemum.

3.6. Assessment of consequences

3.6.1. Pest effects

Cut flowers and pot plants of *Chrysanthemum* spp. (mainly *Chrysanthemum* × *morifolium)* are usually produced in protected cultivation, while multiflora plants are grown outdoors. In the EU, the annual production of *Chrysanthemum* × *morifolium* cut flowers, pot plants, and multiflora plants is estimated at 1 600 million stems, 210 million cuttings (100 million pots) and 50 million cuttings, respectively (EFSA, in press).

No recent reports on the effects of *S. chrysanthemi* on chrysanthemum crops have been found by the PLH Panel in the published literature. The ray blight disease of chrysanthemum has been described as "destructive" in 1946–47 in North Carolina (USA), where it caused severe losses in crops grown outdoors and under cloth (a type of protected cultivation). The disease developed with dramatic rapidity under favourable weather conditions in the field, causing complete loss of entire blocks of susceptible varieties (Baker et al., 1949). In experiments conducted in the past in Florida (artificial inoculation, no fungicide treatments) on 52 cultivars of chrysanthemum belonging to spray, standard and pot types, in beds under cloth, the disease was severe on relatively few cultivars (Engelhard, 1969). Most cultivars showed diverse level of resistance and some were rated no more than 3 (i.e. infection limited to the lower part of the plants) in a 0–10 scale. Losses up to 100 % have been reported on highly susceptible cultivars in the absence of fungicide treatments (Engelhard, 1984). When no fungicides are applied, some resistant cultivars may show symptoms (Engelhard, 1972).

Infected chrysanthemum cuttings and cut flowers, asymptomatic at harvest, may develop symptoms during their storage or transit to the market making them unfit for sale (Baker et al., 1949).

S. chrysanthemi is present in the risk assessment area sporadically (Table 2). However, there are no reports of the pathogen causing damage on chrysanthemum crops in the EU territory. Therefore, the PLH Panel considers that under the current host plant production system and the EU legislation, the overall impact of *S. chrysanthemi* in the risk assessment area is **minor**.

Nevertheless, given the wide ecological tolerance of the pathogen and the wide distribution of the host in the risk assessment area, the PLH Panel considers that, in the absence of the EU legislation and of a certification scheme for the production of host plant propagation material, the potential impacts of *S. chrysanthemi* would increase.

3.6.2. Environmental consequences

S. chrysanthemi affects only *Chrysanthemum* × *morifolium* plants causing ray blight disease of chrysanthemum. The hosts are not considered rare species, and thus they do not play an important environmental role in the risk assessment area. Fungicide sprays, additional to those currently used for the control of other fungal diseases of chrysanthemum crops, are not required for the control of ray blight of chrysanthemum. Therefore, the PLH Panel considers that the establishment and further spread of the pathogen in the risk assessment area is not expected to have any environmental consequences.

3.6.3. Conclusion on the assessment of consequences

Rating	Justification
Minor	• The damage caused by *S. chrysanthemi* in the risk assessment area is currently minor and it is unlikely to increase in future because of the existing agricultural practices applied to chrysanthemum crops, including use of certified plant propagation material and fungicide sprays against other fungal diseases of chrysanthemum. • *S. chrysanthemi* at the moment seems to be absent in some EU MS and present with a restricted distribution (or a few occurrences) in other MS. • No negative environmental consequences are foreseen.

3.6.4. Uncertainties on the assessment of consequences

Rating	Justification
Medium	• There is lack of information on (i) the level of resistance of the *Chrysanthemum* × *morifolium* cultivars currently grown in the EU territory to the infection by the pathogen, (ii) the efficacy of recent fungicides against the pathogen, and (iii) the resistance of *S. chrysanthemi* population to fungicides. • In addition there is uncertainty with respect to the availability of effective fungicides in future. Were the effective fungicides to be withdrawn because of legislative restraints, the impact rating would be higher.

3.7. Conclusions and uncertainties of the pest risk assessment

Under the current EU legislation, the conclusions of the pest risk assessment conducted by the PLH Panel are as follows:

Entry

The probability of entry of *S. chrysanthemi* into the EU territory is:

- Unlikely for the *Chrysanthemum* × *morifolium* plants for planting excluding pot plants and seeds (i.e. rooted and unrooted cuttings) pathway. The pathogen (i) may be present on such material originating in infested third countries, (ii) can survive transport and storage conditions and (iii) can be transferred from the pathway to *Chrysanthemum* × *morifolium* plants grown in close proximity in the risk assessment area by natural and human-assisted means. Nevertheless the standard certification schemes currently used for the production of chrysanthemum cuttings and the EU legislation have considerably reduced the risk of entry of the pathogen into the EU territory on such plant material. However, the above rating is associated with a **medium uncertainty** because of lack of data on whether all chrysanthemum cuttings imported into the risk assessment area have been produced under an appropriate certification scheme.

- **Unlikely** for the *Chrysanthemum* × *morifolium* cut flowers pathway. Although the pathogen (i) may be present on such plant material, (ii) can survive transport and storage conditions and (iii) can survive to some extent existing pest management procedures, it is unlikely to be transferred from the pathway to *Chrysanthemum* × *morifolium* grown within the vicinity in the risk assessment area, provided that cut flower waste is properly managed. However, the above rating is associated with a **medium uncertainty** because of lack of data on the probability of infected cut flowers or their waste coming into contact with hosts grown in close proximity in the risk assessment area.

Establishment

The probability of establishment of *S. chrysanthemi* in the EU territory is **very likely** because:

- The pathogen is present in some parts of the risk assessment area, albeit with restricted distribution.

- *Chrysanthemum* × *morifolium* plants are widely distributed in the risk assessment area and are susceptible to infection by the pathogen throughout the whole growing period.

- The environmental conditions are suitable for infection, inoculum production and survival of the pathogen.

- Existing cultural practices and chemical control measures may reduce the disease severity, but they cannot prevent the establishment of the pathogen.

The overall uncertainty for the probability of establishment is rated as **low**, although there is lack of precise information on the cultural practices and chemical control measures applied in the risk assessment area for the management of other chrysanthemum fungal pathogens.

Spread

The probability of spread of *S. chrysanthemi* following its establishment in the EU territory is **very likely**, as:

- The environmental conditions prevailing in parts of the EU territory are suitable for sporulation and dispersal of the pathogen.
- The pathogen can spread by both natural means and human assistance.
- Chrysanthemum × morifolium plants are widely grown in the EU territory.

The **uncertainty** associated with the above rating is **low**, although there are no studies on the distance over which the pathogen can be spread by weather-related events.

Consequences

The damage caused by the pathogen in the risk assessment area is currently **minor** and it is unlikely to increase in future because of the existing agricultural practices applied to chrysanthemum crops. No negative environmental consequences are foreseen.

The uncertainty associated with the above rating is **medium** because there is lack of information on (i) the level of resistance of the *Chrysanthemum* × *morifolium* cultivars currently grown in the EU territory, (ii) the efficacy of recent fungicides against the pathogen, and (iii) the potential development of resistance of the pathogen to fungicides.

Endangered area

The PLH Panel considers the whole EU territory as an endangered area, given that (i) *Chrysanthemum* × *morifolium* plants are extensively grown in open fields, greenhouses, private and public gardens, and (ii) *S. chrysanthemi* can infect, reproduce and survive over a wide range of temperature and humidity.

4. Identification and evaluation of risk reduction options

In this Section, the Panel (i) identified and evaluated the possible options for reducing the risk of entry, establishment and further spread of *S. chrysanthemi* in the EU territory, based on the EFSA's guidance document (EFSA PLH Panel, 2012), and (ii) evaluated the effectiveness of the current EU measures listed in Council Directive 2000/29/EC against the introduction and spread of *S. chrysanthemi* and explored the possible consequences if these measures were to be removed.

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

Plants for planting, excluding pot plants and seeds (i.e. rooted and unrooted cuttings) and cut flowers of *Chrysanthemum* × *morifolium* represent the two major pathways for the entry of *S. chrysanthemi* into the risk assessment area (see Section 3.2.1). The options to reduce the probability of entry of *S. chrysanthemi* through these two major pathways are in most cases similar and therefore, in this Section, each option is evaluated considering the two pathways of entry at the same time. In cases in

which an option changes with the pathway of entry, then it is evaluated separately for each of the two pathways.

For each risk reduction option, the PLH Panel evaluated its effectiveness and technical feasibility and assessed the level of uncertainty associated with the ratings given.

4.1.1. Options for consignments

4.1.1.1. Prohibition

Identification

Prohibition of the import of *Chrysanthemum* × *morifolium* plant material into the EU would prevent the entry of the pathogen into the risk assessment area. According to International Standards for Phytosanitary Measures (ISPM) No 11 (FAO, 2004), prohibition of a commodity should be viewed as a measure of last resort and should be considered in the light of the principles of minimal impact and non-discrimination (unless the same measures were also deployed for intra-EU trade).

Effectiveness

The effectiveness of prohibition to reduce the probability of entry of *S. chrysanthemi* into the risk assessment area is considered **very high**.

Technical feasibility

The technical feasibility is considered by the Panel to be **very high**.

Uncertainty

The uncertainty for the above ratings is **low**.

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

Identification

S. chrysanthemi affects all parts of the host, and genotypes of *Chrysanthemum* × *morifolium* resistant to *S. chrysanthemi* are not known. Therefore, the PLH Panel considers that this option is **not applicable** in the case of *S. chrysanthemi*.

4.1.1.3. Pest freedom of consignments: inspection and testing

Identification

The detection of a fungal harmful organism in consignments is based on (i) visual inspection, (ii) sampling of symptomatic plant material, and (iii) laboratory testing. Methods for inspection and sampling of consignments have been described in the ISPM No 23 (FAO, 2005) and ISPM No 31, respectively (FAO, 2008).

Inspection and testing of consignments for the detection of *S. chrysanthemi* may be applied at the place of export and/or the place of import. However, for the reasons mentioned in Section 3.1.1.2, visual inspection of consignments applied alone cannot reliably detect *S. chrysanthemi*, as (i) infection might be at a latent stage (asymptomatic plant material), and (ii) symptoms of ray blight disease of chrysanthemum might be missed (e.g. in cases of low disease severity or early stages of the disease or because of the sampling method) or confused with those of other diseases. Therefore, laboratory testing, based on the cultural and morphological characters of *S. chrysanthemi* is also required for the detection and identification of the pathogen. Nevertheless, identification based on morphology requires special expertise. Molecular sequencing would be necessary for correct identification. There are no specific molecular detection methods available for the detection and identification of *S. chrysanthemi* (see Section 3.1.1.2).

Effectiveness

The effectiveness of the visual inspection is considered by the PLH Panel as **low**, whereas that of laboratory testing is **high**. The overall effectiveness of visual inspection and laboratory testing is **low**.

Technical feasibility

The technical feasibility of visual inspection is **high**, as it is already in place. The technical feasibility of laboratory testing is **moderate to high**, depending on the laboratory facilities.

Uncertainty

The uncertainty associated with the above ratings is **low**.

4.1.1.4. Pre- or post-entry quarantine system

Identification

Under a pre- or post-entry quarantine system, the commodities of chrysanthemum plant propagation material (rooted/unrooted cuttings) or cut flowers should be kept under strict segregation in the exporting or importing country, respectively, under favourable environmental conditions and for a period of time sufficient for the development of symptoms in the potentially infected material.

Effectiveness

Although a pre- or post-entry quarantine system is considered very effective in reducing the probability of entry of *S. chrysanthemi* into the EU territory, this option is **not applicable**, as the host plant material (i.e. chrysanthemum cuttings and cut flowers) is sensitive and it cannot be stored in conditions favourable for disease development.

4.1.1.5. Preparation of the consignment

Identification

Preparation of the consignment of chrysanthemum cuttings or cut flowers includes several stages from the production site to export, such as picking of cuttings/harvest of flowers, transport of plant material to packinghouses, packing/wrapping, storing under cool conditions, etc. Culling may also be applied during the preparation of the consignments to reduce the prevalence of *S. chrysanthemi* on infected chrysanthemum cuttings or cut flowers. However, culling cannot eliminate the pathogen present on latently infected (asymptomatic) plant material or on plant material with low disease severity. In addition, the symptoms of ray blight are similar to those caused by other chrysanthemum pathogens (see Section 3.1.1.2).

Effectiveness

The effectiveness of this option is considered by the PLH Panel as **low**.

Technical feasibility

The technical feasibility is **very high**, as preparation of consignments is already in place.

Uncertainty

The uncertainty for the above ratings is **low**.

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

Identification

During the preparation of plant or plant product consignments, specific treatments (e.g. fungicides) may be applied for reducing or delaying the post-harvest development of fungal diseases. However, in the case of chrysanthemum cuttings and cut flowers, post-harvest fungicide treatments are not

common practice owing to possible phytotoxicity, especially on flowers (Fides, 2006). Therefore, **this option is not applicable** in the case of chrysanthemum cuttings and cut flowers.

4.1.1.7. Restriction on end-use, distribution and periods of entry

Identification

This option aims to reduce the probability that the pest will be transferred from the imported infected consignments to a suitable host in the importing country. Restriction in the periods of imports of chrysanthemum cuttings and cut flowers in the EU territory is not effective in the case of *S. chrysanthemi*, as chrysanthemum is grown in the risk assessment area all year round and plants are susceptible to infection during the whole growing period. In the case of chrysanthemum cuttings (rooted/unrooted), limiting their distribution to cut flower producers may reduce the probability of entry of *S. chrysanthemi* into the EU territory but it cannot prevent it. For chrysanthemum cut flower consignments, restricting their end-use or limiting their distribution is **not applicable**, as cut flower end-use is for decorative purposes only.

Effectiveness

The effectiveness of this option for the chrysanthemum propagation material (rooted/unrooted cuttings) is **low**.

Technical feasibility

The technical feasibility of this option for the chrysanthemum propagation material (rooted/unrooted cuttings) is **high**.

Uncertainty

The uncertainty associated with the above ratings is **low**.

4.1.2. Options preventing or reducing infestation in the crop

4.1.2.1. Cultural practices and sanitation measures

The cultural practices and sanitation measures aim to control the environmental conditions that are favourable for the pathogen and to reduce/prevent infestation or re-infestation of the crop, respectively. In the case of *S. chrysanthemi*, cultural practices and sanitation measures (e.g. avoiding overhead irrigation, reducing humidity by maintaining good spacing between plants, using ventilation in greenhouse crops and/or removing weeds, removing infected and dead plants, soil/growing substrate disinfestations, etc.), although an important part of an integrated control programme, may only partially reduce the disease incidence and severity, as the pathogen can infect and complete its life cycle over a wide range of temperatures and relative humidity (see Sections 3.1.1.4 and 3.1.4.2).

Effectiveness

The effectiveness of the cultural practices and sanitation measures used alone as a risk reduction option to prevent/reduce the infestation of chrysanthemum crops by *S. chrysanthemi* at the place of origin is considered **low**. Nevertheless, the effectiveness of this option as part of a systems approach, and particularly in combination with chemical control measures, is assessed as **high**.

Technical feasibility

The technical feasibility is considered **high**, as cultural practices and sanitation measures for the control of chrysanthemum diseases are already in place.

Uncertainty

The uncertainty for the above ratings is **low**.

4.1.2.2. Fungicide treatment of the crop at the place of production to reduce disease incidence/severity

Identification

Based on the information provided in Section 3.2.2.3, fungicide treatments applied to chrysanthemum crops at the place of origin for the control of other fungal pathogens (*B. cinerea*, *P. horiana*, etc.) may also reduce ray blight disease incidence and severity, but they cannot eliminate the pathogen.

Effectiveness

The effectiveness of fungicide treatments applied to the chrysanthemum crops used alone as a risk reduction option to prevent/reduce the infestation of chrysanthemum crops by *S. chrysanthemi* at the place of origin is considered **moderate**. Nevertheless, the effectiveness of this option, when used in combination with cultural practices and sanitation measures, is assessed as **high**.

Technical feasibility

The technical feasibility is **high**, as fungicides are regularly applied to chrysanthemum crops for the control of other fungal diseases.

Uncertainty

The uncertainty for the above ratings is **low**.

4.1.2.3. Resistant or less susceptible varieties

Identification

There is no information available on the reaction of the currently commercially grown chrysanthemum cultivars to infection by *S. chrysanthemi*. Therefore, this option is **not applicable**.

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

Identification

Growing chrysanthemum plants (cuttings, plants for cut flower production) far from infected host crops can prevent infection by *S. chrysanthemi* spores. Although there are no specific studies on the dispersal of *S. chrysanthemi* ascospores by wind, based on data on other *Ascochyta* species having ascospores of a similar size to those of *S. chrysanthemi*, the maximum distance over which ascospores are disseminated by air currents is approximately 400 m (see Section 3.2.4). At shorter distances, growing chrysanthemum plants under protection (e.g. in greenhouses, plastic tunnels, etc.) can reduce the infection of the crop by airborne *S. chrysanthemi* ascospores from outside but it cannot fully prevent it, because these installations are frequently opened for ventilation.

Effectiveness

The effectiveness of growing chrysanthemum plants at great distances from inoculum sources is **high**. The effectiveness of growing plants under protection in proximity to inoculum sources is **low**.

Technical feasibility

The technical feasibility is **high**.

Uncertainty

The uncertainty associated with the rating given for the effectiveness is **medium**, as there are no specific studies on the distance over which ascospores of *S. chrysanthemi* can be disseminated by air currents. The uncertainty associated with the rating for the technical feasibility is **low**.

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

Identification

Chrysanthemum plants are susceptible to infection by *S. chrysanthemi* during the whole growing period and the pathogen infects all plant parts. Therefore, this option is **not applicable**.

4.1.2.6. Certification scheme

Identification

Production of chrysanthemum cuttings under a certification scheme (EPPO, 2002; EFSA, in press) could reduce or even eliminate the infection of the crop by *S. chrysanthemi* (see Section 3.2.2.1). So far, there are no certification schemes for the production of cut flowers. However, the PLH Panel considers that a certification scheme used for the production of chrysanthemum cuttings could also reduce the risk for cut flowers.

Effectiveness

The effectiveness of this option is **very high**

Technical feasibility

The technical feasibility is considered to be **very high**, as voluntary certification schemes are already in place for the production of chrysanthemum plants for planting.

Uncertainty

The uncertainty associated with the above ratings is **low**.

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

4.1.3.1. Pest-free area

Identification

According to ISPM No 4 (FAO, 1995), a pest-free area is 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. According to ISPM 4 (FAO, 1995), the three main components required to establish and maintain a pest-free area are: systems to establish pest freedom (general surveillance or specific surveys), phytosanitary measures to maintain freedom (regulatory actions (e.g. listing of the pest on a quarantine pest list, specification of import requirements into a country or area, restriction of the movement of certain products within areas of a country or countries including buffer zones), routine monitoring and extension advice to producers) and checks to verify freedom has been maintained (*ad hoc* inspection of exported consignments, requirement that researchers, advisers or inspectors notify the NPPO of any occurrences of the pest and monitoring surveys).

In the case of *S. chrysanthemi*, to ensure that a pest-free area remains free, regular systematic surveys are needed because the disease is polycyclic and many infection cycles can occur during the growing period. Nevertheless, because of the pathogen's potential to disperse by air currents, the *S. chrysanthemi*-free status of an area might be difficult to maintain when infected host plants are grown in close proximity.

Effectiveness

The effectiveness of the option is **very high**.

Technical feasibility

The technical feasibility of this option is **moderate**.

Uncertainty

The level of uncertainty for the above ratings is **low**.

4.1.3.2. Pest-free place of production, pest-free production site

Identification

According to ISPM No 4 (FAO, 1995), a pest-free place of production is a place of production in which a specific pest does not occur, as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period. A pest-free production site is a defined portion of a place of production in which a specific pest does not occur, as demonstrated by scientific evidence, and in which, where appropriate, this condition is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest-free place of production.

In the case of *S. chrysanthemi*, to ensure that a pest-free place of production/production site remains free, regular systematic surveys are needed because the disease is polycyclic and many infection cycles can occur during the growing season. Nevertheless, because of the pathogen's potential to disperse by air currents, the *S. chrysanthemi*-free status of a place of production/production site might be difficult to maintain when infected host plants are grown in close proximity.

Effectiveness

The effectiveness of the option is **very high**.

Technical feasibility

The technical feasibility of this option is **high**.

Uncertainty

The level of uncertainty for the above ratings is **low**.

4.2. Systematic identification and evaluation of options to reduce the probability of establishment of *S. chrysanthemi* in the EU territory

4.2.1. Surveillance

Identification

According to ISPM No 5 (FAO, 2010), surveillance is an official process that collects and records data on pest occurrence or absence by survey, monitoring or other procedures. Guidelines for conducting surveillance (general surveillance and specific surveys) are provided in ISPM No 6 (FAO, 1997).

In the case of *S. chrysanthemi* regular systematic surveys are needed because several infection cycles can occur during the growing season. In addition to visual inspection, laboratory testing for correct identification of the organism is necessary because of the similarity of symptoms with those of other chrysanthemum diseases.

Effectiveness

The effectiveness of this option is **high**.

Technical feasibility

The technical feasibility is **moderate**, as chrysanthemum plants are extensively grown in the risk assessment area in the open fields and greenhouses as well as in private and public gardens, in both rural and urban areas.

Uncertainty

The uncertainty for the above ratings is **low**.

4.2.2. Eradication

Identification

According to ISPM No 5 (FAO, 2010), eradication is the application of phytosanitary measures to eliminate a pest from an area. Elimination of all potential inoculum sources (infected host plants and residues) in an area is a very effective measure in reducing the probability of establishment and spread of a pest.

Eradication may reduce the probability of establishment of *S. chrysanthemi* in areas where it is not yet present. Eradication may be less effective in areas where the pathogen is already present and widespread, because chrysanthemum plants are grown in the entire EU territory, the pathogen is airborne and there are repeated infection cycles during the growing season.

Effectiveness

Based on the information provided in Section 3.1.2.2, eradication of *S. chrysanthemi* in some EU MS has been reported to be successful in the past. Therefore, the effectiveness of eradication as a risk reduction option is considered **high**. However the PLH Panels considers that if the pathogen becomes established and widespread in an area the effectiveness of this option is **low**.

Technical feasibility

The technical feasibility of eradication is **high**.

Uncertainty

The uncertainty associated with the above ratings is **low**.

4.3. Systematic identification and evaluation of options to reduce the probability of further spread and the magnitude of impact

The options discussed under section 4.1.2 (Options preventing or reducing infestation in the crop) are applicable also to reduce the probability of further spread and the magnitude of impact, but are not repeated in this section.

4.3.1. Containment

Identification

According to ISPM No 5 (FAO, 2010), containment is the application of phytosanitary measures in and around an infested area to prevent spread of a pest. For the reasons listed in Section 3.4.3, containment as an option for reducing the further spread of *S. chrysanthemi* in the risk assessment area has rather limited effectiveness.

Effectiveness

The effectiveness of this option is assessed as **low**.

Technical feasibility

The technical feasibility is **high**.

Uncertainty

The uncertainty for the ratings given is **low**.

4.3.2. Waste management

Identification

Waste management (e.g. composting) as an option to reduce the further spread of *S. chrysanthemi* in the risk assessment area is especially important for cut flowers, which are discarded when they are no longer fresh. There are no published data on the effect of composting in eliminating *S chrysanthemi* present in plant material. However, the EPPO Standard PM 3/66(2) refers to specific requirements for bio-waste containing quarantine pests or heat-tolerant pests, which could be applied (EPPO, 2008).

Effectiveness

The effectiveness of this option is considered **high**.

Technical feasibility

The technical feasibility is **moderate**, because proper management of such waste is applied only to some extent in the risk assessment area.

Uncertainty

The uncertainty for the above ratings is considered **low**.

Additional options to reduce further spread of *S. chrysanthemi* within the EU territory are: cultural practices and sanitation measures (see Section 4.1.2.1); chemical treatments at the places of production (see Section 4.1.2.2); growing host plants under exclusion conditions (see Section 4.1.2.4); a certification scheme for source planting material (see Section 4.1.2.6.); and eradication (see Section 4.2.2). The evaluation of these options with respect to their effectiveness and technical feasibility (see Sections 4.1 and 4.2) is also valid for the reduction of the probability of further spread of *S. chrysanthemi* within the EU territory.

4.4. Evaluation of the current EU phytosanitary measures to prevent the introduction and spread of *S. chrysanthemi*

The current EU regulation (Directive 2000/29/EC, Annex II, Part A, Section II) prohibits the introduction into and spread within the MS of *S. chrysanthemi* (listed as *D. ligulicola*), on *Chrysanthemum* × *morifolium* plants (listed as *Dendranthema*) intended for planting, other than seeds (i.e. rooted and unrooted cuttings). In addition, specific requirements are laid down in Council Directive (Annex IV, Part A, Section I, point 28(c) and Section II, point 21.1(c)) for the introduction into and movement within the MS of chrysanthemum cuttings and cut flowers, which include official inspection of plant material (unrooted/rooted cuttings, mother plants, cut flowers) at the place of origin/production. Host plants (as *Dendranthema*) are further subjected to plant health inspection according to Annex V (see Section 3.1.3).

The PLH Panel identified some weaknesses associated with the above regulation:

- Visual inspection of infected host plant material applied alone is not reliable for detecting *S. chrysanthemi*, as (i) infection might be at a latent stage (asymptomatic plant material), and (ii) symptoms of ray blight disease might be missed (e.g. because of low disease incidence/severity, early stages of the disease, sampling method) or confused with those of other diseases.

- The frequency and/or exact timing of performing the official inspection are not specified and, therefore, late infections may escape in the event that inspection is performed some time before harvest; inspection soon before harvest would reduce the risk of undetected infections. However, plant health inspection at the place of entry, according to Annex V, could reduce the risk of late infections remaining undetected.

- No measures alternative or complementary to visual inspection measures (e.g. laboratory testing, chemical treatments at the production sites or places of production) that could further reduce the risk of entry of S. chrysanthemi into the EU territory are envisaged in the current regulations.

Based on the EUROPHYT database, there is a lack of interceptions of the organism in the risk assessment area. The Panel considers that, under the current situation, it is not possible to distinguish the effect of the current legislation from that of the voluntary certification schemes used for the production of chrysanthemum cuttings (see Section 3.2.2) on the reduction of the risk of introduction into and spread within the EU territory of *S. chrysanthemi*.

Effectiveness

The effectiveness of the EU phytosanitary measures (i.e. visual inspection) is considered by the PLH Panel to be **low**.

Technical feasibility

The technical feasibility of the EU phytosanitary measures is **high**, as they are already in place.

Uncertainty

The uncertainty for the above ratings is considered **high**.

4.5. Consequences of removing the current EU legislation

In the event that the current EU regulations regarding the pest were to be removed and the voluntary certification schemes remained in place, there would be no great effect on the risk of introduction and spread or on the impact of *S. chrysanthemi* in the EU territory. However, if the current EU legislation was to be removed and at the same time the chrysanthemum industry stopped the application of its certification scheme for the production of chrysanthemum plants for planting, the risk of introduction and spread, as well as the impact of *S. chrysanthemi* in the risk assessment area, would increase.

4.6. Summary of evaluation of risk reduction options

The Panel evaluated the phytosanitary measures listed in Council Directive 2000/29/EC against the introduction into and spread within the EU MS of *S. chrysanthemi*, explored the possible consequences if these measures were to be removed and identified additional risk reduction options to enhance the current measures.

This Section contains the summary table (Table 4) of the applicable risk reduction options identified and evaluated for the major pathways of entry of *S. chrysanthemi* into the EU territory, i.e. host plants for planting, excluding pot plants and seeds (rooted/unrooted cuttings) and cut flowers of host plants.

Table 4: Summary of the most effective risk reduction options (RROs) identified and evaluated in Section 4

Risk element affected by the RRO (entry, establishment, spread, impact)	Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Effectiveness	Technical feasibility	Uncertainty
Entry	**Options for consignments**	Prohibition	**Very high**	**Very high**	**Low**
		Pest freedom of consignments: inspection and testing	**Low** for inspection **High** for laboratory testing **Low** overall for inspection + laboratory testing	**High** for visual inspection **Moderate to high** for laboratory testing	**Low**
	Options preventing or reducing infestation in the crop	Cultural practices and sanitation measures	**Low** alone **High** in systems approach	**High**	**Low**
		Fungicide treatment of the crop, at the place of production to reduce disease incidence/severity	**Moderate** alone **High** in systems approach	**High**	**Low**
		Growing plants under exclusion conditions (greenhouse, screen, isolation)	**High** for chrysanthemum plant material grown at great distance from infected host plants	**High**	**Medium** for the rating given for effectiveness
			Low for chrysanthemum plants grown under protection in close proximity to infected host plants		**Low** for the rating given for technical feasibility
		Certification scheme	**Very high**	**Very high**	**Low**
	Options ensuring that the area, place or site of production remains free from the pest	Pest-free area	**Very high**	**Moderate**	**Low**
		Pest-free place of production, pest-free production site	**Very high**	**High**	**Low**
Establishment		Surveillance	**High**	**Moderate**	**Low**
		Eradication	**High** in areas where the pathogen is not present **Low** in areas where the	**High**	**Low**

Risk element affected by the RRO (entry, establishment, spread, impact)	Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Effectiveness	Technical feasibility	Uncertainty
			pathogen is established and widespread		
Spread/impact		Waste management	**High**	**Moderate**	**Low**
		Cultural practices and sanitation measures	**Low** alone **High** in systems approach	**High**	**Low**
		Fungicide treatment of the crop, at the place of production to reduce disease incidence/severity	**Moderate** alone **High** in systems approach	**High**	**Low**
		Growing plants under exclusion conditions (greenhouse, screen, isolation)	**High** for chrysanthemum plant material grown at great distance from infected host plants	**High**	**Medium** for the rating given for effectiveness
			Low for chrysanthemum plants grown under protection in close proximity to infected host plants		**Low** for the rating given for technical feasibility
		Certification scheme	**Very high**	**Very high**	**Low**
		Eradication	**High** in areas where the pathogen is not present **Low** in areas where the pathogen is established and widespread	**High**	**Low**

4.7. Conclusions on the analyses of risk reduction options and of the current phytosanitary measures

The Panel evaluated the effectiveness of the current EU requirements (Council Directive 2000/29/EC) against *S. chrysanthemi*, explored the possible consequences if these measures were to be removed and identified additional risk reduction options to enhance the current measures.

The PLH Panel considered that the current EU requirement of visual inspection of host plant material is not reliable for detecting *S. chrysanthemi*, as infection might be latent and ray blight symptoms might be missed or confused with those of other diseases. The frequency and the exact timing for visual inspection are not specified and no alternative or complementary measures are envisaged in the current regulations. The **effectiveness** of visual inspection in reducing the risk of introduction into, and spread within, the EU territory of the pathogen is considered by the PLH Panel to be **low**. The **uncertainty** associated with this rating is **high** as, in the current situation, it is not possible to distinguish the effect of the current legislation from that of the voluntary certification schemes used for the production of chrysanthemum cuttings.

In the event that the current EU regulations regarding the pest were to be removed and the voluntary certification schemes remained in place, there would be no great effect on the risk of introduction into and spread within or on the impact of *S. chrysanthemi* in the EU territory. However, if the current EU legislation were to be removed and at the same time the chrysanthemum industry stopped the application of its certification schemes for the production of chrysanthemum plants for planting, the risk of introduction and spread, as well as the impact of *S. chrysanthemi* in the risk assessment area, would increase.

The PLH Panel identified the following additional risk reduction options that could enhance the current EU phytosanitary measures against the introduction into and spread within the EU of *S. chrysanthemi*.

Of the risk reduction options that could reduce the probability of entry of *S. chrysanthemi* into the risk assessment area, prohibition is a very highly effective measure, with very high technical feasibility and low uncertainty. Pest freedom of the consignment can be detected by visual inspection and laboratory testing. The effectiveness of visual inspection is low, whereas that of laboratory testing is high, with high or moderate to high technical feasibility, respectively, and low uncertainty.

The effectiveness of cultural practices combined with sanitation measures and fungicide treatments of the crop applied at the place of origin is high with a high technical feasibility and low uncertainty. Growing chrysanthemum plants far from infected host crops can prevent infection with high effectiveness. At shorter distances exclusion conditions can reduce but cannot fully prevent the infection, therefore the effectiveness is low. The technical feasibility in both cases is high. The level of uncertainty for effectiveness is medium and for technical feasibility is low. The effectiveness of a certification scheme for the production of host plant propagation material is considered very high, with high technical feasibility and low uncertainty.

The effectiveness of a pest-free area of production is very high, with moderate technical feasibility and low uncertainty. The effectiveness of a pest-free place of production or production site is very high, with a high technical feasibility and low uncertainty.

In terms of preventing establishment, the effectiveness of systematic surveillance as a risk reduction option is high with moderate technical feasibility and a low uncertainty. Eradication is a highly effective option, with high technical feasibility and low uncertainty but only in cases where the pathogen was not present in the area in the past.

For reduction of the probability of further spread of S. *chrysanthemi* within the EU territory, waste management of chrysanthemum cut flowers, which are discarded when they are no longer fresh, is highly effective with moderate technical feasibility and low uncertainty.

The above-identified options for reducing the risk of entry, establishment and further spread of the pathogen in the EU territory are also appropriate for reducing its impact.

CONCLUSIONS

After consideration of the evidence, the PLH Panel reached the following conclusions.

Following a request from the European Commission, the EFSA PLH Panel was asked to deliver a scientific opinion on the pest risk of *D. ligulicola* for the EU territory, to identify risk management options and to evaluate their effectiveness in reducing the risk to plant health posed by the organism. In particular, the Panel was asked to provide an opinion on the effectiveness of the current EU requirements against this organism, which are laid down in Council Directive 2000/29/EC, in reducing the risk of introduction of this pest into, and its spread within, the EU territory. EFSA was also requested to concentrate in particular on the analysis of the present spread of the organism in comparison with the endangered area, the analysis of the observed and potential impacts of the organism and the availability of effective and sustainable control methods.

In conducting the pest risk assessment, the PLH Panel took into consideration the recent developments in the taxonomy of *D. ligulicola* (current name *S. chrysanthemi*), the causal agent of ray blight of chrysanthemum (i.e. *Chrysanthemum* × *morifolium* referred to as *Dendranthema* in the EU legislation). 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 PLH Panel, 2012). Given the fact that *S. chyrsanthemi* is already present in some EU MS and has been regulated by the EU for many years under the name *D. ligulicola*, the Panel conducted the risk assessment considering the scenario of the current EU plant health legislation being in place.

"The PLH Panel also considers that the information on the presence of the organism in the risk assessment area should be treated with caution due to the uncertainty about the correspondence between the organism isolated in the past from *Chrysanthemum* × *morifolium* plants showing ray blight-like symptoms and the causal agent of ray blight under its current taxonomic status (i.e. *S. chrysanthemi*).

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

With regard to the assessment of the risk to plant health posed by *S. chrysanthemi* for the EU territory:

<u>Entry</u>

The probability of entry of *S. chrysanthemi* into the EU territory is **unlikely** for the *Chrysanthemum* × *morifolium* plants for planting excluding pot plants and seeds (i.e. rooted and unrooted cuttings) pathway. The pathogen (i) may be present on such material originating in infested third countries, (ii) can survive transport and storage conditions, and (iii) can be transferred from the pathway to *Chrysanthemum* × *morifolium* plants grown in close proximity in the risk assessment area by natural and human-assisted means. Nevertheless, the standard certification schemes currently used for the production of chrysanthemum cuttings and the EU legislation have considerably reduced the risk of entry of the pathogen into the EU territory on such plant material. However, the above rating is associated with a **medium uncertainty** because of lack of data on whether all chrysanthemum cuttings

imported into the risk assessment area have been produced under an appropriate certification scheme. The probability of entry of *S. chrysanthemi* into the EU territory is **unlikely** for the *Chrysanthemum* × *morifolium* cut flowers pathway. Although the pathogen (i) may be present on such plant material, (ii) can survive transport and storage conditions, and (iii) can survive to some extent existing pest management procedures, it is unlikely to be transferred from the pathway to *Chrysanthemum* × *morifolium* grown within the vicinity in the risk assessment area, provided that cut flower waste is properly managed. The above rating is associated with a **medium uncertainty** because of lack of data on the probability of infected cut flowers or their waste coming into contact with hosts grown in close proximity in the risk assessment area.

Establishment

The probability of establishment of *S. chrysanthemi* in the EU territory is **very likely**. The pathogen is present in some parts of the risk assessment area, albeit with restricted distribution. *Chrysanthemum* × *morifolium* plants are widely distributed in the risk assessment area and are susceptible to infection by the pathogen throughout the whole growing period. The environmental conditions are suitable for infection, inoculum production and survival of the pathogen. Existing cultural practices and chemical control measures may reduce the disease severity, but they cannot prevent the establishment of the pathogen. The **uncertainty** for the probability of establishment is rated as **low**, although there is lack of precise information on the cultural practices and chemical control measures applied in the risk assessment area for the management of other chrysanthemum fungal pathogens.

Spread

The probability of spread of *S. chrysanthemi* following its establishment in the EU territory is **very likely**. The environmental conditions prevailing in parts of the EU territory are suitable for sporulation and dispersal of the pathogen. The pathogen can spread by both natural means and human assistance. *Chrysanthemum* × *morifolium* plants are widely grown in the EU territory. The **uncertainty** associated with the above rating is **low**, although there are no studies on the distance over which the pathogen can be spread by weather-related events.

With regard to the risk reduction options, the Panel evaluated the effectiveness of the current EU requirements (Council Directive 2000/29/EC) against *S. chrysanthemi*, explored the possible consequences if these measures were to be removed and identified additional risk reduction options to enhance the current measures.

The PLH Panel considered that the current EU requirement for visual inspection of host plant material is not reliable for detecting *S. chrysanthemi*, as infection might be latent and ray blight symptoms might be missed or confused with those of other diseases. The frequency and the exact timing for visual inspection are not specified and no alternative or complementary measures are envisaged in the current regulations. The **effectiveness** of visual inspection in reducing the risk of introduction into and spread within the EU territory of the pathogen is considered by the PLH Panel to be **low**. The **uncertainty** associated with this rating is **high** as, in the current situation, it is not possible to distinguish the effect of the current legislation from that of the voluntary certification schemes used for the production of chrysanthemum cuttings.

In the event that the current EU regulations regarding the pest were removed and the voluntary certification schemes remained in place, there would be no great effect on the risk of introduction into and spread within as well as on the impact of *S. chrysanthemi* in the EU territory. However, if the current EU legislation was to be removed and at the same time the chrysanthemum industry stopped the application of its certification schemes for the production of chrysanthemum plants for planting, the risk of introduction and spread and the impact of *S. chrysanthemi* in the risk assessment area would increase.

The PLH Panel identified the following additional risk reduction options that could enhance the current EU phytosanitary measures against the introduction into and spread within the EU of *S. chrysanthemi*:

Of the risk reduction options that could reduce the probability of entry of *S. chrysanthemi* into the risk assessment area, prohibition is a very highly effective measure, with very high technical feasibility and low uncertainty. Pest freedom of the consignment can be detected by visual inspection and laboratory testing. The effectiveness of visual inspection is low, whereas that of laboratory testing is high, with high or moderate to high technical feasibility, respectively, and low uncertainty.

The effectiveness of cultural practices combined with sanitation measures and fungicide treatment of the crop applied at the place of origin is high, with a high technical feasibility and low uncertainty. Growing chrysanthemum plants far from infected host crops can prevent infection with high effectiveness. Over shorter distances exclusion conditions can reduce but cannot fully prevent the infection, therefore the effectiveness is low. The technical feasibility in both cases is high. The level of uncertainty for effectiveness is medium and for technical feasibility is low. The effectiveness of a certification scheme for the production of host plant propagation material is considered very high, with high technical feasibility and low uncertainty.

The effectiveness of a pest-free area of production is very high, with moderate technical feasibility and low uncertainty. The effectiveness of a pest-free place of production or production site is very high, with a high technical feasibility and low uncertainty.

In terms of preventing establishment, the effectiveness of systematic surveillance as a risk reduction option is high with moderate technical feasibility and a low uncertainty. Eradication is a highly effective option, with high technical feasibility and low uncertainty but only in cases in which the pathogen was not present in the area in the past.

To reduce of the probability of further spread of S. *chrysanthemi* within the EU territory, waste management of chrysanthemum cut flowers, which are discarded when they are no longer fresh, is highly effective with moderate technical feasibility and low uncertainty.

The above-identified options for reducing the risk of entry, establishment and further spread of the pathogen in the EU territory are also appropriate for reducing the impact.

Analysis of present spread of the organism in comparison with the endangered area

The PLH Panel considers the whole EU as an endangered area, as *Chrysanthemum* × *morifolium* plants are extensively grown in the territory and the pathogen can infect, reproduce and survive over a wide range of temperature and humidity. The area of the pathogen's present distribution in the EU territory is limited compared with the endangered area. Nevertheless, there are uncertainties with respect to the real distribution of *S. chrysanthemi* in the risk assessment area because of the taxonomic confusion over the pathogen that occurred in the past.

Analysis of the observed and potential impacts of the organism

The damage caused by the pathogen in the risk assessment area is currently **minor** because of the existing agricultural practices applied to chrysanthemum crops, and no negative environmental impacts are foreseen. The **uncertainty** is **medium** because of lack of information on the level of resistance of the chrysanthemum cultivars grown in the EU, the efficacy of recent fungicides against the pathogen and the potential development of resistance of the pathogen to fungicides.

Availability of effective and sustainable control methods

The PLH Panel considers that the cultural practices and sanitation measures (e.g. use of pathogen-free propagation material, monitoring of the crop, avoiding overhead irrigation, proper management of waste plant material, soil disinfestation with steam, use of clean irrigation water, general hygiene

measures, etc.) currently applied to chrysanthemum crops in the risk assessment area for the control of *S. chrysanthemi* and other chrysanthemum pathogens are effective in reducing the severity of ray blight disease. Resistance of *Chrysanthemum* × *morifolium* cultivars to ray blight has been reported in the past. However, because of the lack of recent studies on this aspect, there is uncertainty about the level of resistance present in the cultivars currently grown in the risk assessment area and worldwide. No biological control methods are available.

DOCUMENTATION PROVIDED TO EFSA

Request to provide a scientific opinion on the risks to plant health of a pest risk assessment of *Arabic mosaic virus*, *Tomato black ring virus*, *Raspberry ringspot virus*, *Strawberry latent ringspot virus*, *Strawberry crinkle virus*, *Strawberry mild yellow edge virus*, *Daktulosphaira vitifoliae* (Fitch), *Eutetranychus orientalis* (Klein), *Parasaissetia nigra* (Nietner), *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis et al., *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, ***Didymella ligulicola*** (Baker, Dimock and Davis) v. Arx, and *Phytophthora fragariae* Hickmann var. *fragariae*, for the EU territory, 19 July 2012. Submitted by the European Commission, DG SANCO (Directorate General for Health and Consumers).

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APPENDICES

Appendix A. RATINGS AND DESCRIPTORS

In order to follow the principle of transparency as described under Paragraph 3.1 of the Guidance document on the harmonised framework for risk assessment (EFSA Panel on Plant Health (PLH), 2010) —"… Transparency requires that the scoring system to be used is described in advance. This includes the number of ratings, the description of each rating … the Panel recognises the need for further development …"— the PLH 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 PLH Panel, for the risk assessment of *S. chrysanthemi* 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 for *S. chrysanthemi*
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, 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, 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, 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

Rating for entry	Descriptors for *S. chrysanthemi*
	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, and/or • has no limitations for transfer to a suitable host in the risk assessment area.

1.2. Rating of probability of establishment

Very unlikely	The likelihood of establishment would be very low because of the absence or very limited availability of host plants; the unsuitable environmental conditions; and the occurrence of other considerable obstacles preventing establishment
Unlikely	The likelihood of establishment would be low because of the limited availability of host plants; the unsuitable environmental conditions over the majority of the risk assessment area; and the occurrence of other obstacles preventing establishment.
Moderately likely	The likelihood of establishment would be moderate because hosts plants are abundant in few areas of the risk assessment area; environmental conditions are suitable in few areas of the risk assessment area; and no obstacles to establishment occur.
Likely	The likelihood of establishment would be high because hosts plants are widely distributed in some areas of the risk assessment area; environmental conditions are suitable in some areas of the risk assessment area; and no obstacles to establishment occur. Alternatively, the pest has already established in some areas of the risk assessment area.
Very likely	The likelihood of establishment would be very high because hosts plants are widely distributed; environmental conditions are suitable over the majority of the risk assessment area; and no obstacles to establishment occur. Alternatively, the pest has already established in the risk assessment area.

1.3. Rating of probability of spread

Rating for spread	Descriptors for *S. chrysanthemi*
Very unlikely	The likelihood of spread would be very low because: • the pest has only one specific way to spread that is not available/possible 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 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 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: • 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: • 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 impact	Descriptors for *S. chrysanthemi*
Minimal	Differences in crop production (saleable fruits and leaves, cut branches with foliage, plants for planting) are within normal day-to-day variation; no additional control measures are required.
Minor	Crop production (saleable fruits and leaves, cut branches with foliage, plants for planting) is rarely reduced or at a limited level; additional control measures are rarely necessary.
Moderate	Crop production (saleable fruits and leaves, cut branches with foliage, plants for planting) is occasionally reduced to a limited extent; additional control measures are occasionally necessary.
Major	Crop production (saleable fruits and leaves, cut branches with foliage, plants for planting) is frequently reduced to a significant extent; additional control measures are frequently necessary.
Massive	Crop production (saleable fruits and leaves, cut branches with foliage, plants for planting) 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.

2.1. Rating of the effectiveness of risk reduction options

Rating	Descriptors for *S. chrysanthemi*
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, to a large extent, the probability of entry or establishment or spread or the potential consequences.
Very high	The risk reduction option essentially eliminates the probability of entry or establishment or spread or any potential consequences.

2.2. Rating of the technical feasibility of risk reduction options

Rating	Descriptors for *S. chrysanthemi*
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

Rating	Descriptors for *S. chrysanthemi*
	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, implementing 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 management options, the level of uncertainty has been rated separately for consistency with the descriptors that have been defined specifically by the Panel in this opinion.

Rating	Descriptors for *S. chrysanthemi*
Low	No or little information or no or few data are 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. Import of chrysanthemum cuttings from third countries into the EU via the Netherlands, over the period 2010–2012 (the Netherlands NPPO, personal communication, 2012)

	2010	**2011**	**2012 (up to 7 November)**
Number of consignments	2 457	2 156	1 907
Number of cuttings	1 976 330 970	2 003 053 714	1 818 088 912
Average number of cuttings/consignment	804 368	929 060	953 376
Number of cuttings/consignment	**Number of consignments**		
< 10 000/consignment	90	143	94
10 000 to 99 999	255	150	206
100 000 to 499 999	582	541	476
500 000 to 999 999	782	540	374
1 000 000 to 1 999 999	586	569	546
2 000 000 to 2 999 999	128	113	121
3 000 000 to 3 999 999	32	71	72
4 000 000 to 4 999 999	1	22	17
5 000 000 to 5 999 999	0	6	0
6 814 800	1	0	0
9 911 000	0	1	0
10 804 506	0	0	1

Appendix C. Active substances (a.s.) mentioned in the literature for the control of ray blight disease of Asteraceae

Active substance	Country	Effects[(a)]	Reference
Benomyl[(b)]	USA (Florida)	Adequate disease control under moderate disease pressure, consistent under severe pressure	Crane et al. (1970)
		Good disease control	Engelhard (1972)
Thiabendazole	USA (Florida)	Adequate disease control under moderate disease pressure, consistent under severe pressure	Crane et al. (1970)
Chlorothalonil	USA (Florida)	Adequate disease control under moderate disease pressure, marginal under severe pressure	Crane et al. (1970)
		Variation in efficacy	Engelhard (1972)
Captan	USA (Florida)	Good disease control	Engelhard (1972)
		Good disease control	McFadden (1960)
Phaltan	USA (Florida)	Relatively ineffective (better control than check, worse than benomyl, thiabendazole or chlorothalonil)	Crane et al. (1970)
Mancozeb	USA (Florida)	Good disease control	Engelhard (1972)
Propiconazole	USA (Florida)	Good disease control	Engelhard (1984)
Vinclozolin	USA (Florida)	Good disease control	Engelhard (1984)
Iprodione	USA (Florida)	Good disease control	Engelhard (1984)
Zineb	USA (North Carolina)	Complete protection (heavy infection on checks	Baker et al. (1949)

(a): Some a.s. are reported as phytotoxic to certain cultivars or under some environmental conditions. Of those mentioned in the table, thiabendazole seems to cause more concern with respect to this.

(b): Engelhard (1984) reported that, in his trials, benomyl + mancozeb, routinely applied and known to give good control, showed a trend towards reduced control compared with the best treatments, so suggesting the possibility that the fungal isolate used in the experiment had developed a low level of resistance to benomyl.