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Pest categorisation of *Stenocarpella maydis*

EFSA Panel on Plant Health (PLH),
Claude Bragard, Paula Baptista, Elisavet Chatzivassiliou, Francesco Di Serio, Paolo Gonthier, Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod, Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell, Roel Potting, Emilio Stefani, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen, Lucia Zappalà, Quirico Migheli, Irene Vloutoglou, Andrea Maiorano, Franz Streissl and Philippe Lucien Reignault

Abstract

The EFSA Plant Health Panel performed a pest categorisation of *Stenocarpella maydis,* a clearly defined fungus causing seedling blight, stalk and ear rot in maize, its only confirmed main host. The pathogen occurs in many countries of North, Central and South America, Africa, Asia and Oceania where maize is grown commercially. It is present in the EU with restricted distribution (Czech Republic and Spain). *Stenocarpella maydis* is not included in Commission Implementing Regulation (EU) 2019/2072. Plants for planting (maize seeds) is the main pathway of entry and spread in the EU. Host availability and climate are favourable for the establishment of the pathogen in maize-growing areas of the EU. The pathogen has a direct impact on yield and quality of maize production. Phytosanitary measures are available to mitigate further introduction and spread of the pathogen into the EU. The Panel concludes that *S. maydis* satisfies all the criteria to be regarded as a potential Union quarantine pest.

Keywords: pest risk, plant health, plant pest, quarantine, maize, stalk rot, white ear rot

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Correspondence: plants@efsa.europa.eu

Panel members: Claude Bragard, Paula Baptista, Elisavet Chatzivassiliou, Francesco Di Serio, Paolo Gonthier, Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod, Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell, Roel Potting, Philippe L Reignault, Emilio Stefani, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen and Lucia Zappalà

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1. Introduction

1.1. Background and terms of reference as provided by the requestor

1.1.1. Background

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

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

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

1.1.2. Terms of Reference

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

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

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

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

1.2. Interpretation of the terms of reference

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

1.3. Additional information

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

2. Data and methodologies

2.1. Data

2.1.1. Information on pest status from NPPOs

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

2.1.2. Literature search

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

2.1.3. Database search

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

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

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

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

2.2. Methodologies

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

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

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

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest (article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest clearly defined, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways for entry and spread.
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent pest entry, establishment, spread or impacts?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the identity of *Stenocarpella maydis* is clearly defined, it has been shown to produce consistent symptoms and to be transmissible.

EPPO Global Database (EPPO, 2022) provides the following taxonomic identification for *S. maydis*:

Preferred scientific name: *Stenocarpella maydis* (Berkeley) Sutton Order: Diaporthales.
Family: Diaporthaceae.
Genus: Stenocarpella.
Species: *Stenocarpella maydis*.

The following synonyms (anamorphic state) are listed in the EPPO Global Database:

Diplodia maydis (Berkeley) Saccardo.
Diplodia zeae (Schweinitz) Léveillé.
Sphaeria maydis Berkeley.
Sphaeria (Hendersonia) zeae Schweinitz.
Macrodiplodia zeae (Schweinitz) Petrak & Sydow.
Dothiora zeae (Schweinitz) Bennett.

In addition, other synonyms are listed either in the USDA fungal database (Farr and Rossman, 2002) or in the CABI datasheet:

Diplodia maydicola Spegazzini.
Diplodia zeae-maydis Mekht.
Hendersonia zeae (Schweinitz) Hazsl.
Phaeostagonosporopsis zeae (Schweinitz) Woron.

The nomenclature of the anamorphic state of the fungus was a controversial issue for many years, moving for example from the *Sphaeria* to the *Diplodia* genera before being placed into the *Stenocarpella* genus, which was described by Sutton (1980) based largely on conidiation (CABI, 2022).

Common names: Stalk rot, white ear rot, Diplodia ear rot and seedling blight of maize.

Nucleotide sequences of *S. maydis* are available in Genbank (accessed on 20/07/2022 https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Undef&name=Stenocarpella%20maydis).

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

3.1.2. Biology of the pest

Stenocarpella maydis survives as mycelium in maize stubble throughout the winter. Pycnidia begin to develop from late winter to early summer (Flett et al., 1992). The pathogen may also overwinter as mycelia in seed which may infect mesocotyls of seedlings and later crowns and stalks of maize plants (McNew, 1937). *Stenocarpella maydis* was recovered from field soil planted with maize the previous season which implies that *S. maydis* can survive in soil (McNew, 1937) via maize debris. Although survival in the soil is considered minimal (Flett et al., 1992), *S. maydis* could be more easily isolated from residues in either monoculture or consecutive culture conditions (Flett et al. 2001). Luna et al. (2017) reported a survival ability reaching from 11 up to 17 months, depending on the residue nature and the soil depth. Under warm, moist conditions, the fungus produces asexual spores, i.e. conidia (pycnidiospores), since they are extruded from pycnidia in long cirri, that are disseminated by rain, and therefore also by sprinklers during irrigation, and a possible contribution of wind. They can also be transmitted by infected seed and debris (Sutton and Waterston, 1966a, 1966b) and by insects, similar to other conidia-producing fungal pathogens.

Pycnidia that contain the conidia are the principal dissemination source. A sexual stage for this ascomycete that could provide other types of spores such as ascospores has not been described. Bensch and Van Staden (1992a,b) showed that *S. maydis* conidia germinate *in vitro*, on shank, ear, leaf sheath and stalk (at ear attachment) tissues after 5 h incubation at 30°C. After 72 h, appressoria were formed at hyphal tips.

Stalk rot infections occur primarily through the crown, mesocotyl, roots and stalk nodes where the leaf sheath is attached (Shurtleff, 1980) (see also Figure 1). Infections at the leaf sheath attachments to maize stalks followed by water and heat stress result in stalk infections and rot development (Dodd, 1980).

Maize was most susceptible to stalk rot when inoculated just before and after pollen production (Michaelson, 1957). According to Alvarez-Cervantes et al. (2016), natural infection is greater between 1 and 2 weeks after pollination, in the presence of rain and temperatures ranging 28–30°C.

In addition to primary infection by conidia, infected maize seed is an important inoculum source (McGee, 1988). McNew (1937) demonstrated pathogen transmission from infected maize seeds to the mesocotyl of maize seedlings. Hoppe (1942) showed levels of *S. maydis* infection in various seed lots to vary from 18.4% to 66.7% in the USA. In Nigeria, levels from 4.86% to 38.89% were reported (Nwigwe, 1974).

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

The development of the stalk rot phase is favoured by dry weather early in the growing season, followed by extended periods of rainfall shortly after silking stage. In stalk infections, colonisation of the tissues in charge of sap transportation disrupts nutrients translocation and, consequently, reduces grain size. Unbalanced fertilisation, low potassium availability, poor drainage, mechanical and insect damage, variety or hybrid and sowing density, all influence disease severity. The ear and grain rotting phases are similarly favoured by excessive rainfall during silking to harvest with ears being most susceptible during the weeks after silking. Infection of the ear usually occurs through the shank. Hybrids with poor husk coverage or thin pericarps are often very susceptible. Race specialisation has not been reported (Koehler, 1960; Dhanraj, 1966; Sutton and Waterston, 1966a,b; Christensen and Wilcoxson, 1967; Walker, 1969; Shurtleff, 1980; CABI, 2022; EPPO, 2022).

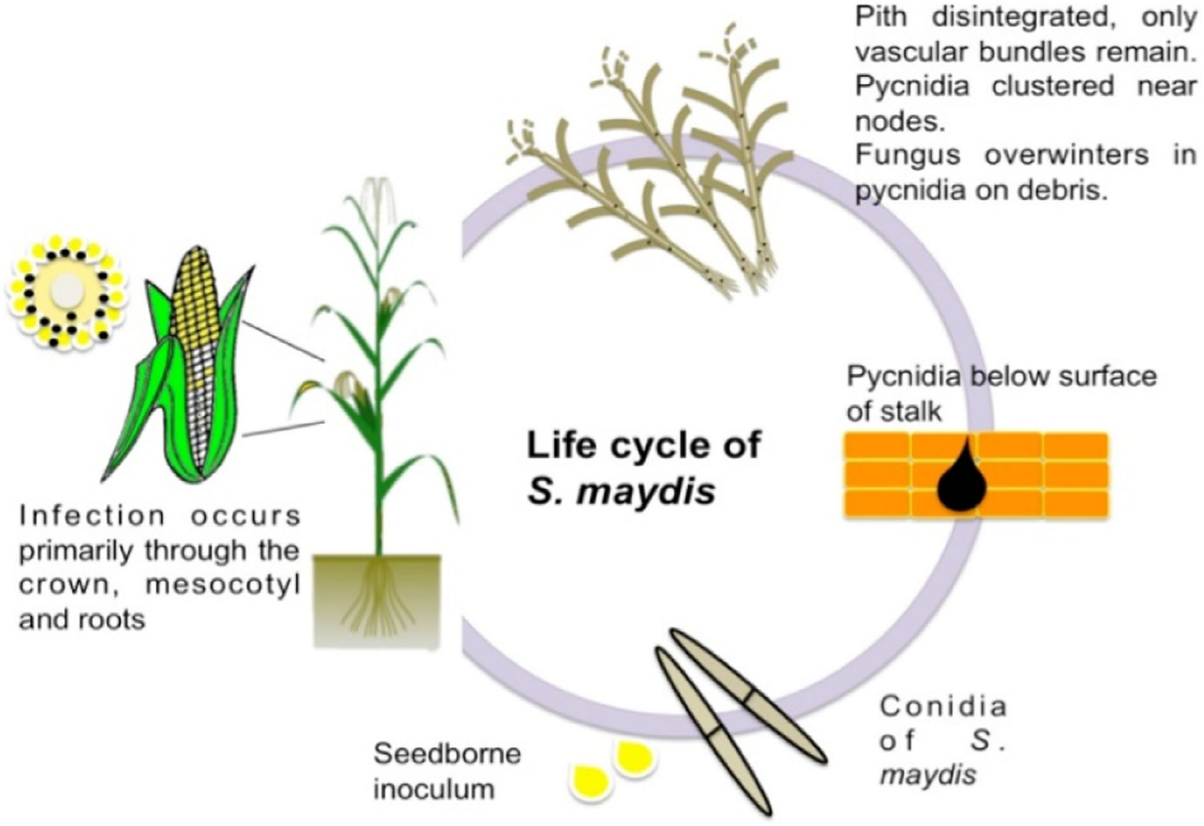

Figure 1: Life cycle of *Stenocarpella maydis* (From Alvarez-Cervantes et al., 2016)

It must be emphasised that *S. maydis* shares many biological and pathological features with the closely related species *S. macrospora* (Earle) Sutton (EPPO code: DIPDMC) which also causes Diplodia ear rot of maize. However, *S. maydis* generally occurs in cooler regions than *S. macrospora* (EPPO, online).

3.1.3. Host range/species affected

Stenocarpella maydis has a narrow host range (Flett, 1991). Reported host plants are all from the Poaceae family (from CABI):

- *Zea mays* is the only host crop, i.e. both *Zea mays* (maize) and *Zea mays* subsp. *mays* (sweetcorn)
- *Arundinaria sp*. (bamboo cane) (Sutton and Waterston, 1966a) and *Bambusa* sp. (Farr and Rossman, 2022)
- *Zea diploperennis*, the diploperennial teosinte, which is a perennial wild relative of maize. It is endemic to Mexico where it exists in an area of only a few square miles (Rossouw et al., 2009).

Because of the very few and old references mentioning them as hosts, there is uncertainty on the host status of *Zea diploperennis* and of the genera *Arundinaria* and *Bambusa*. However, this uncertainty does not affect the overall conclusion of the present pest categorisation. For the present pest categorisation, only *Zea mays* is considered as a host.

3.1.4. Intraspecific diversity

Few studies have addressed *S. maydis* diversity. Dorrance et al. (1999) studied variation within *S. maydis* using 46 isolates: very low levels of isoenzyme (α-esterase, hexose kinase and malate dehydrogenase) polymorphisms were detected. Although colony colour and pycnidiospores production were variable, these phenotypes were very poor diversity markers.

The genetic relationship of 34 isolates of *S. maydis* from different geographic regions in South Africa was analysed by random amplified polymorphic DNA (RAPD) and ribosomal DNA markers. Two genetic groups were differentiated by using three RAPD primers and correlated to the cultural morphology of the isolates (Xia et al., 2001). There is no information if those two groups differed in virulence, pathogenicity or fitness.

Inter-simple sequence repeat (ISSR) primers were also evaluated for analysis of genetic variability. For DNA analysis, six isolates of *S. maydis* were amplified using 42 ISSR primers. Considerable genetic variation was observed in *S. maydis*, with a core set of 10 primers (Fedrigo et al., 2016). In addition, it is hypothesised by Romero et al. (2017) that although *S. maydis* is only reported as an asexual fungus, sporadic cryptic recombination may occur, which could contribute to the observed genetic diversity.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, detection and identification methods are available for *S. maydis*

Symptomatology

Seedling blight. The pathogen reduces seed germination and causes seedling blight (Nwigwe, 1974). Seed germination was negatively correlated with *S. maydis*-infected kernels (Rheeder et al., 1990). Infected seeds give rise to pre-emergence death in cold soils or blighted seedlings in warmer soils. Infected seeds show discoloration and are shrivelled, mouldy and may be rotten when heavily infected. Seedlings develop brown-cortical lesions on the internode between the scutellum and coleoptile, and the seminal roots are frequently destroyed (EPPO, 2022).

Stalk rot. Symptoms do not usually appear until several weeks after silking, and generally arise following root infection. Oval, irregular or elongate, single or confluent lesions, 1–10 cm long, with pale cream-brown centres and indeterminate darker borders are frequently associated with stalk rot infection. Leaves wilt, become dry and appear greyish-green, the symptoms resembling frost damage. Affected plants may die suddenly. The green colour of the internodes fades and they become brown to straw-coloured, spongy and easily crushed. The pith disintegrates and becomes discoloured, with only the vascular bundles remaining intact. Dark, sub-epidermal pycnidia may be seen clustered near the nodes, and white fungal growth may also be present on the surface (Sutton and Waterston, 1966a,b; Christensen and Wilcoxson, 1967; Walker, 1969; Shurtleff, 1980).

Ear rot. Infection usually begins at the ear base, moving up from the shank. If infection occurs within 2 weeks after silking, the entire ear turns greyish-brown, shrunken and completely rotted and light. Alternatively, early infections result in bleached or straw-coloured husks. Lightweight ears usually stand upright with inner husks adhering tightly to one another or to the ear because of mycelial growth between them. Black pycnidia may be scattered on husks, floral bracts and the sides of kernels. Late-infected ears show no external symptoms, but when ears are broken and grains removed, a white mould is commonly found growing between the grains whose tips are discoloured (Sutton and Waterston, 1966a,b; Christensen and Wilcoxson, 1967; Walker, 1969; Shurtleff, 1980).

Overall, the pathogen cannot be identified based on symptomatology as similar symptoms are caused by *S. macrospora* and other pathogens of maize.

Morphology

Cultures vary in colour from white to sandy-brown woolly mycelial growth on potato dextrose or malt extract agar. Mycelia are brown, branched and septate. Pycnidia are immersed, spherical to subglobose, 150–300 μm in diameter, with multicellular walls and a circular protruding papillate ostiole, 30–40 μm in diameter (see Figure 2). Conidia are straight, curved or irregular, 1 (0–2) septate, smooth-walled and pale brown with rounded or truncated ends, 5–8 × 15–34 μm (Sutton, 1964, 1980) (see Figure 3).

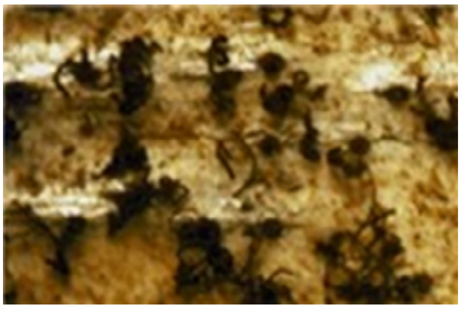

Figure 2: Pycnidia of *Stenocarpella maydis* on maize stubble, releasing spores (conidia or pycnidiospores) from the cirri (From CABI, Copyright: Bradley Flett, Agricultural Research Council – Grain Crops)

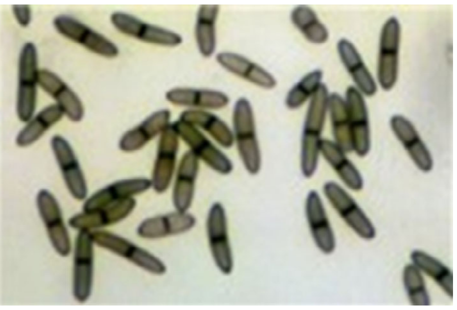

Figure 3: Double-celled conidia of *Stenocarpella maydis* (From CABI, Copyright: Bradley Flett, Agricultural Research Council – Grain Crops)

Stenocarpella maydis may be isolated from infected kernels, cob and stalk rind or pith and root tissues (Flett and Wehner, 1991; Flett et al., 1992). *S. maydis* can be positively identified based on morphological characters of its conidia as described above. *Stenocarpella macrospora*, a closely related *Stenocarpella* species also affecting maize, is readily distinguishable from *S. maydis* by its large (44–82 × 7.5–11.5 μm), 0- to 3-septate conidia and its requirement for biotin when cultured on synthetic media (Sutton, 1964; Sutton and Waterston, 1966a). The detection and inspection method of *S. maydis* (as well as for *S. macrospora*) is outlined in EPPO's standard PM3/078 (2) about consignment inspection of seed and grain of cereals. The Japanese Plant Protection Service proposed a procedure which required less time for seed testing by removing the outer layers of the seeds halfway through the incubation period, with subsequent microscopic examination for the detection and determination of *S. maydis* (Dai et al., 1987).

DNA-based identification

Real-time quantitative PCR assay has been developed using primer sets designed from unique RAPD fragments for the rapid detection and quantification of *S. maydis* in maize kernels (Barros et al., 2008).

Species-specific primers were designed, targeting a portion of the internal transcribed spacer (ITS) region of the fungal genome for conventional and real-time PCR assays. The conventional PCR method successfully amplified a single 1.7-kb fragment for each *S. maydis* isolate. A corresponding real-time method was also established (Romero and Wise, 2015).

The morphological identification of *S. maydis* on maize seeds from various varieties and geographical origins can be confirmed by amplification and sequencing of ITS barcodes and/or PCR as described by Romero and Wise (2015).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

Stenocarpella maydis occurs in many countries on several continents where maize is grown commercially, such as North America, Central America, South America, Africa, Asia, Oceania and Europe (see Figure 4 and Appendix A).

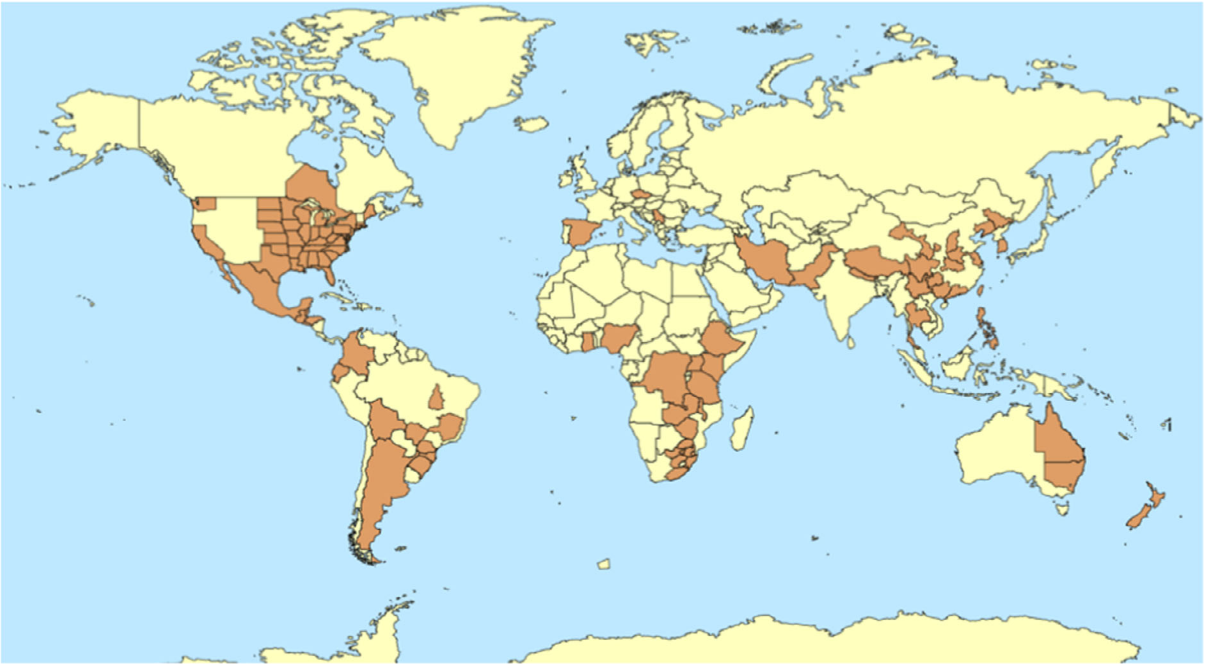

Figure 4: Global distribution of *Stenocarpella maydis*

3.2.2. Pest distribution in the EU

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

Yes, *S. maydis* is reported to be present in the EU (Czech Republic, and Spain), with restricted distribution.

Stenocarpella maydis is locally established with restricted distribution in Czech Republic. It has also been reported from Spain (de la Riva et al., 2019) and Italy (Picco et al., 1994). It is confirmed by the Spanish NPPO to be present, but not widely distributed. No positive cases are reported by the Italian NPPO, and hence, the pest is considered absent from Italy.

3.3. Regulatory status

3.3.1. Commission implementing regulation 2019/2072

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

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

The Poaceae family, other than plants for ornamental purpose are included in Annex VI (see Table 2). Maize (*Zea mays*) is not listed in Commission Regulation (EU) 2018/2019.

Table 2: List of plants, plant products and other objects that are *Stenocarpella maydis* hosts whose introduction into the Union from certain third countries is prohibited (Source: Commission Implementing Regulation (EU) 2019/2072, Annex VI)

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	**CN Code**	**Third country, group of third countries or specific area of third country**
14.	Plants for planting of the family *Poaceae*, other than plants of ornamental perennial grasses of the subfamilies *Bambusoideae* and *Panicoideae* and of the genera *Buchloe*, *Bouteloua* Lag., *Calamagrostis*, *Cortaderia* Stapf., *Glyceria* R. Br., *Hakonechloa* Mak. ex Honda, *Hystrix*, *Molinia*, *Phalaris* L., *Shibataea*, *Spartina* Schreb., *Stipa* L. and *Uniola* L., other than seeds	ex 0602 90 50 ex 0602 90 91 ex 0602 90 99	Third countries other than Albania, Algeria, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo- Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Turkey, Ukraine and the United Kingdom

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

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

Yes, *S. maydis* is able to enter the EU territory via host plants for planting as seeds for sowing.

Comment on plants for planting as a pathway.

Host plants for planting is a main pathway of entry, as hosts are traded as seeds.

Since infected maize seeds are an important inoculum source (McNew, 1937; McGee, 1988) with levels of *S. maydis* in seed lots reaching up to 66.7% (Hoppe, 1942) and the fungus being present in the endosperm and embryo of maize seeds (Zad and Ale Agha, 1985), the PLH Panel identified the following main pathway for the further entry of *S. maydis* into the EU territory:

- Host plants for planting, as hosts are traded as seeds for sowing.

An overview on potential pathways of entry is provided in Table 3.

The quantity of imported maize from infested third countries into the EU quantities of imported maize is presented in Table 4 and Appendix B.

Stenocarpella maydis is transmitted by seed and can survive in host plant debris in soil (Sutton and Waterston, 1966) (see Section 3.1.2) Therefore, besides seeds of host plants, soil and other growing media carrying infected debris associated or not with host and non-host plants may represent a potential pathway of further entry of *S. maydis* into the EU territory.

Fresh sweetcorn and maize and fresh vegetable maize are also potential entry pathways.

Maize seeds are imported for animal feed uses. Spills could occur and it cannot be ruled out that some maize seeds intended for animal feed are sown (e.g. small farms or private gardens).

Although there are no quantitative data available, different types of propagules (mycelium, pycinidia and conidia) of *S. maydis* may be also present as contaminants on other substrates (e.g. non-host plants for planting or seed, straw and husks, plant debris and contaminated machinery and equipment) imported into the EU from infested third countries.

Table 3: Potential pathways for *Stenocarpella maydis* entry into the EU 27

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Description (e.g. host/intended use/source)		
Seeds of *Zea mays* and *Zea mays* ssp. *mays* for sowing	Mycelium and conidia	Annex XI A (8) requires a Phytosanitary certificate for the introduction into the EU territory of seed of maize originating from Argentina, Australia, Bolivia, Brazil, Chile, New Zealand and Uruguay
		Annex XI A (8) requires a Phytosanitary certificate for the introduction into the EU territory for seed of sweetcorn for sowing (ex 07099960) and maize (corn) seeds for sowing (10051013, 10051015) originating from third countries other than Switzerland
Fresh sweetcorn and maize and fresh vegetable maize.	Mycelium and conidia	Annex XI A (3) requires a Phytosanitary certificate for the introduction into the EU territory of fresh or chilled sweetcorn (ex 07099960), maize (corn) (10059000), fresh vegetable products of maize not elsewhere specified or included (ex 14049000) from third countries other than Switzerland.
Seeds of *Zea mays* and *Zea mays* ssp. *mays* imported for animal feed	Mycelium and conidia	
Soil and growing media containing debris from infected maize plants.	Mycelium and conidia	
Machinery and equipment with debris from infected maize plants.	Mycelium and conidia	

Table 4: EU 27 annual imports of maize from countries where *Stenocarpella maydis* is present, 2017–2021 (in 1000 kg) Source: Eurostat accessed on 22/07/2022

Commodity	HS code	2017	2018	2019	2020	2021
Maize	1,005	6,114,330	8,550,048	7,171,885	6,296,401	5,883,368
Maize seed for sowing	100,510	18,756	14,568	16,071	13,734	13,309

It is unlikely for the pathogen to enter the EU by natural means (wind, water splash) or insects because of the long distance between the infested third countries and the EU Member States.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 5 July 2022, there were no records of interception of *Stenocarpella maydis* in the Europhyt and TRACES databases. According to the EPPO GD, the pathogen was intercepted in Bulgaria in 1993.

3.4.2. Establishment

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

Yes, this pest is already established in parts of the EU (see Section 3.2.2). Both the biotic (host availability) and abiotic (climate suitability) factors occurring in the EU suggest that *S. maydis* could further establish additional parts of EU territory.

Stenocarpella maydis could potentially be transferred from the seed pathway to the host plants grown in the EU via splash-dispersed conidia produced on the plants emerging from the infected seeds. The frequency of this transfer will depend on the volume and frequency of imported commodities. After a successful transfer, establishment is possible in large areas of the EU where maize is cultivated. The transfer from the soil/growing media pathway to the host grown in the EU is very unlikely because of negligible probability of soil/growing media to be used in maize fields.

3.4.2.1. EU distribution of main host plants

Maize, the main host of *S. maydis*, is widely cultivated in the EU. The harvested area of maize cultivated in the EU 27 in recent years is shown in Table 4. Appendix C provides production statistics for individual Member States (Table 5).

Table 5: Harvested area of *Stenocarpella maydis* main host (maize) in EU 27, 2017–2021 (1,000 ha). Source EUROSTAT (accessed 7 June 2022) (for individual Member States see Appendix C) https://ec.europa.eu/eurostat/databrowser/view/APRO_CPSH1__custom_3085921/default/table?lang=en

Crop	2017	2018	2019	2020	2021
Maize	8,266.64	8,252.47	8,910.74	9,354.73	9,231.62

3.4.2.2. Climatic conditions affecting establishment

The global Köppen-Geiger climate zones (Kottek et al., 2006) describe terrestrial climate in terms of average minimum winter temperatures and summer maxima, amount of precipitation and seasonality (rainfall pattern). Based on the data available in the literature on the geographic coordinates of the locations where the fungus has been reported, *S. maydis* has been reported from areas with BSh, BSk, Cfa, Cfb, Csa, Csb, Dfb and Dfc Köppen-Geiger climate zones. These climate zones also occur in the EU territory, where maize, the main host of *S. maydis* is grown (see Figure 5).

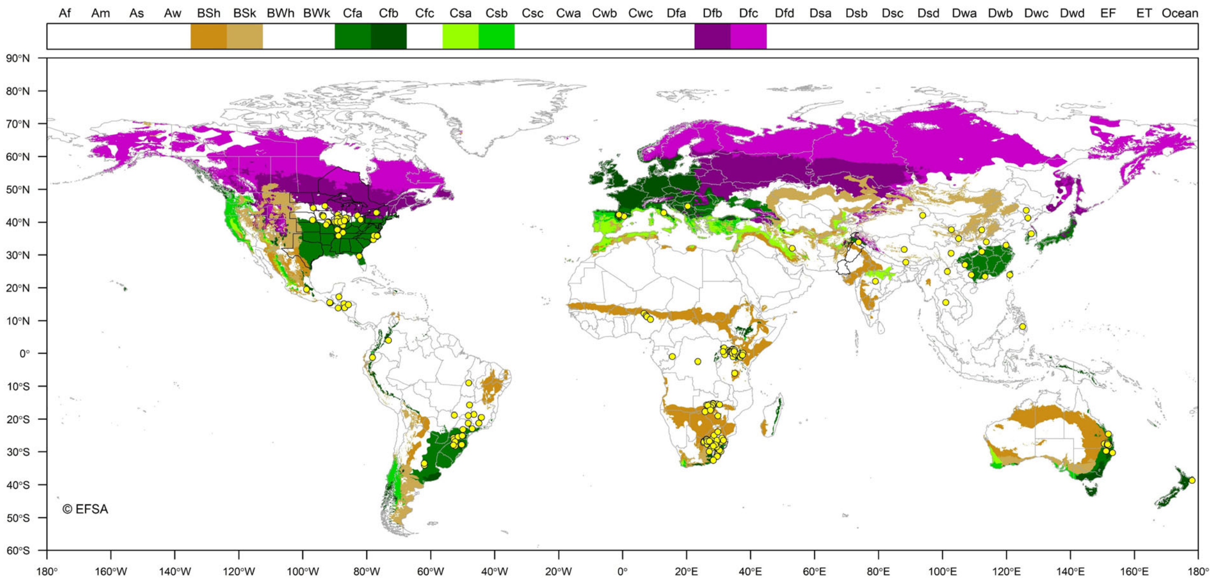

Figure 5: Distribution of eight Köppen–Geiger climate types, i.e. BSh, BSk, Cfa, Cfb, Csa, Csb, Dfb and Dfc that occur in the EU and in countries where *Stenocarpella maydis* has been reported. The legend shows the list of Köppen–Geiger climates. Yellow dots indicate point locations where *S. maydis* was reported (Appendix A).

3.4.3. Spread

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

S. maydis could potentially spread within the EU by both natural and human-assisted means.

Comment on plants for planting as a mechanism of spread.

Spread via plants for planting as seeds for sowing would be the main mechanism of spread.

Spread by natural means

CABI (CPC online) reports '*Observations by* Ullstrup *(*1964*) indicated that most of the conidia do not travel great distances from the inoculum source*' and that '*similar results were obtained by Flett (BC Flett, ARC-Grain Crops Institute, South Africa) where ear rot incidence was high for the first 10 m from the inocoum focal point*'.

Spread by human-assisted means. The pathogen could potentially spread over long distances via the movement of infected seeds, plant debris (e.g. stubble), fresh sweetcorn and maize, fresh vegetable maize and maize seeds intended for animal feed, soil and other growing media and contaminated agricultural machinery and equipment.

3.5. Impacts

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

Yes. The introduction of *S. maydis* is likely to have yield and quality impacts on the EU territory.

Stenocarpella maydis is considered as one of the most important diseases of maize, that significantly affects its yield performance with yield loss in maize fields varying from 1–2% to as high as 80% (Baer et al., 2021). It also has a significant impact as a toxin-producing pathogen. More specifically:

Seedling blight. *S. maydis* has been shown to cause between 5% and 37% loss in seed germination (Nwigwe, 1974). Seed germination was negatively correlated with *S. maydis*-infected kernels (Rheeder et al., 1990).

Stalk rot. In the USA, Christenson and Wilcoxsen (1966) estimated annual yield losses of 5–20% due to stalk rot and lodging. Differences in grain weight between stalk-rotted and healthy plants in a naturally infected field ranged from 0 to 26.2%. Relating these data to disease incidence in Illinois, state-wide losses were estimated to be 8.6% (Hooker and Britton, 1962).

In artificial conditions, Chambers (1988) found yield losses (grain weight per plant) as high as 97% from Diplodia ear rot inoculations made 10 days after silking.

Ear rot. Koehler et al. (1925) reported stand decrease of 36.3% and yield losses of 32.4% due to sowing *S. maydis*-infected seed.

Mycotoxic Effects. *S. maydis*-infected maize grain can be detrimental to both humans and animals due to the toxins produced by the pathogen. Diplodiosis, a nervous disorder of cattle and sheep results from ingestion of mouldy ears, kernels and maize stubble infected by *S. maydis*. Although this disease is most common in southern Africa, it has also been reported in Australia, Argentina, Brazil and the USA. In addition to diplodiatoxin, other metabolites such as dipmatol, diplonine and chaetoglobosins K and L have been isolated from *S. maydis*-infected maize crops. (Wicklow et al., 2011; Masango et al., 2015). Poisoning of cattle fed on *S. maydis*-infected maize stover was first reported by Mitchell (1919) in South Africa. Of four oxen force-fed infected maize ears, three developed typical diplodiosis symptoms. Isolates able to induce corresponding diplodiosis disorder under experimental conditions were obtained from maize grown in the USA, Argentina and South Africa, although isolates toxic to ducklings and rats were not always able to induce diplodiosis in cattle or sheep. This neuromycotoxicosis has been reported only under natural field conditions in South Africa (Rabie et al., 1985). Sheep were reported to have perinatal mortalities when exposed to diplodiosis in the second and third trimesters of pregnancy (Kellerman et al., 1991). Fincham et al. (1991) reported mycotoxic peripheral myelinopathy, myopathy and hepatitis in vervet monkeys (*Chlorocebus pygerythrus*) as caused by mycotoxins produced by *S. maydis*.

Based on the above, *S. maydis* is expected to have a significant impact in the EU.

3.6. Available measures and their limitations

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

Yes. Although not specifically targeted against *S. maydis*, existing phytosanitary measures (see Sections 3.3.2 and 3.4.1) mitigate the likelihood of the pathogen's entry on host plants, plant products and other objects into the EU territory. Potential additional measures are also available to further mitigate the risk of entry and spread of the pathogen in the EU (see Section 3.6.1).

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants for planting (see Sections 3.3.2 and 3.4.1).

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

3.6.1.1. Additional potential risk reduction options

Potential additional control measures are listed in Table 6.

Table 6: Selected control measures (a full list is available in EFSA PLH Panel et al., 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Control measure/ Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Require pest freedom	Plants, plant products and other objects come from a pest-free country or a pest-free area or a pest-free place of production.	Entry/Spread
Crop rotation, associations and density, weed/ volunteer control	Crop rotation, associations and density, weed/volunteer control are used to prevent problems related to pests and are usually applied in various combinations to make the habitat less favourable for pests. The measures deal with (1) allocation of crops to field (over time and space) (multicrop, diversity cropping) and (2) to control weeds and volunteers as hosts of pests/vectors. Based on the biology of the pathogen, crop rotation of at least 2 years and control of volunteer plants could be an effective measure to reduce inoculum sources and potential survival of the pathogen	Establishment/Spread/Impact
Use of resistant and tolerant plant species/varieties	Resistant plants are used to restrict the growth and development of a specified pest and/or the damage they cause when compared to susceptible plant varieties under similar environmental conditions and pest pressure. • It is important to distinguish resistant from tolerant species/varieties. The use of resistant/tolerant maize hybrids to *S. maydis* could mitigate the risk of introduction and spread as well as the impacts. Moreover, use of maize hybrids with good stalk strength could reduce lodging associated with *S. maydis* infection	Entry/Establishment/Spread/ Impact
Biological control and behavioural manipulation	Pest control such as: a) Biological control b) Sterile Insect Technique (SIT) c) Mating disruption d) Mass trapping Biological control methods are available against this fungus (Bressan and Figureiredo 2005), but their effectiveness has not been tested under field conditions.	Spread/Impact
Chemical treatments on crops including reproductive material	Treatment with fungicides may not be an efficient mitigation measure.	Entry/Spread/Establishment/ Impact

Control measure/ Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Chemical treatments on consignments or during processing	Use of chemical compounds that may be applied to plants or to plant products after harvest, during process or packaging operations and storage. The treatments addressed in this information sheet are: a) fumigation; b) spraying/dipping pesticides; c) surface disinfectants; d) process additives; e) protective compounds Fungicides could be used as a mitigation measure for seeds for sowing. However, their effectiveness against *S. maydis* is questionable	Entry/Spread
Cleaning and disinfection of facilities, tools and machinery	The physical and chemical cleaning and disinfection of facilities, tools, machinery, transport means, facilities and other accessories (e.g. boxes, pots, pallets, palox, supports, hand tools). The measures addressed in this information sheet are: washing, sweeping and fumigation. Cleaning, disinfection and disinfestation (sanitation) of equipment and facilities (including premises, storage areas) are good cultural and handling practices employed in the production and marketing of any commodity and may contribute to mitigating likelihood of entry or spread of *S. maydis*.	Entry/Spread
Limits on soil	Limits on soil are an efficient measure.	Entry/Spread
Soil treatment	The control of soil organisms by chemical and physical methods listed below: (a) Fumigation; (b) Heating; (c) Solarisation; (d) Flooding; (e) Soil suppression; (f) Augmentative Biological control; (g) Biofumigation *S. maydis* survives in infected plant debris in soil. Therefore, soil and other growing media disinfection with chemical or physical (heat, soil solarisation) means albeit potentially effective is not an economic viable option for control in case of maize.	Entry/Establishment/Spread/ Impact
Use of non-contaminated water	Chemical and physical treatment of water to eliminate waterborne microorganisms. The measures addressed in this information sheet are chemical treatments (e.g. chlorine, chlorine dioxide, ozone); physical treatments (e.g. membrane filters, ultraviolet radiation, heat); ecological treatments (e.g. slow sand filtration). The pathogen could potentially spread via contaminated irrigation water. Treatment of the water would be a potential measure. However for maize grown in Europe, this is not an economically feasible option.	Spread/Impact
Waste management	Treatment of the waste (deep burial, composting, incineration, chipping, production of bioenergy…) in authorised facilities and official restriction on the movement of waste. Proper waste management could mitigate the risk of spread of the pathogen.	Spread/Establishment

Control measure/ Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Conditions of transport	Specific requirements for mode and timing of transport of commodities to prevent escape of the pest and/or contamination. a) physical protection of consignment b) timing of transport/trade When potentially infected/contaminated material has to be transported (including proper disposal of infected waste material), specific transport conditions (kind of packaging/protection, time of transport, transport mean) should be defined to prevent the pest from escaping. Such measures could be effective.	Entry/Spread
Post-entry quarantine and other restrictions of movement in the importing country	This information sheet covers post-entry quarantine (PEQ) of relevant commodities; temporal, spatial and end-use restrictions in the importing country for import of relevant commodities; prohibition of import of relevant commodities into the domestic country. 'Relevant commodities' are plants, plant parts and other materials that may carry pests, either as infection, infestation or contamination. The restriction of movement of infected seeds is considered an effective measure.	Establishment/Spread

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 7.

Table 7: Selected supporting measures (a full list is available in EFSA PLH Panel et al., 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Supporting measure	Summary	Risk element targeted (entry/establishment/ spread/impact)
Inspection and trapping	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5). The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques. Symptoms can be detected visually (seedling blight, stem rot, ear rot) on the plant but symptoms are similar to those caused by *S. macrospora* or other biotic/abiotic agents and further testing is required for identification of *S. maydis*. The pest cannot be detected visually on seeds.	Establishment/Spread
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests. Diagnostic protocols and molecular methods are available to reliably detect the pathogen.	Entry/Spread

Supporting measure	Summary	Risk element targeted (entry/establishment/spread/impact)
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing. For inspection, testing and/or surveillance purposes, the sample may be taken according to a statistically based or a non-statistical sampling methodology. Necessary as part of other risk reduction options	Entry/Spread
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5) a) export certificate (import) b) plant passport (EU internal trade) Recommended for host plants, in particular maize seeds for sowing.	Entry/Spread
Certified and approved premises	Mandatory/voluntary certification/approval of premises is a process including a set of procedures and of actions implemented by producers, conditioners and traders contributing to ensure the phytosanitary compliance of consignments. It can be a part of a larger system maintained by the NPPO in order to guarantee the fulfilment of plant health requirements of plants and plant products intended for trade. Key property of certified or approved premises is the traceability of activities and tasks (and their components) inherent the pursued phytosanitary objective. Traceability aims to provide access to all trustful pieces of information that may help to prove the compliance of consignments with phytosanitary requirements of importing countries. Certified and approved premises reduce the likelihood of the plants and plant products originating in those premises to be infected by the pathogen	Entry/Spread
Certification of reproductive material (voluntary/official)	Maize seeds come from within an approved propagation scheme and are certified pest free (level of infestation) following testing. Used to mitigate against pests that are included in a certification scheme.	Entry/Spread
Delimitation of Buffer zones	ISPM 5 defines a buffer zone as 'an area surrounding or adjacent to an area officially delimited for phytosanitary purposes in order to minimise the probability of spread of the target pest into or out of the delimited area, and subject to phytosanitary or other control measures, if appropriate' (ISPM 5). The objectives for delimiting a buffer zone can be to prevent spread from the outbreak area and to maintain a pest-free production place (PFPP), site (PFPS) or area (PFA). Delimitation of a buffer zone is an effective measure to prevent further spread of the pathogen.	Spread
Surveillance	Surveillance is an effective measure to define pest-free areas or pest-free places of production as well as to prevent further spread of the pathogen.	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

None.

3.7. Uncertainty

There are no key uncertainties affecting the conclusions of this categorisation.

4. Conclusions

Stenocarpella maydis is known to be present in the EU (Czech Republic, Spain), with restricted distribution. The pathogen satisfies the criteria that are within the remit of EFSA to assess for this species to be regarded as a potential Union quarantine pest (Table 8).

Table 8: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of *S. maydis* is clearly defined.	None
Absence/presence of the pest in the EU (Section 3.2)	*S. maydis* is reported to be present in the EU (Czech Republic, Italy and Spain), with restricted distribution	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*S. maydis* is able to (re-)enter, (re-) establish and spread in the EU territory. The main pathway of entry and spread is via maize seeds for sowing.	None
Potential for consequences in the EU (Section 3.5)	Further introduction and spread of *S. maydis* are likely to have yield and quality impacts on maize production.	None
Available measures (Section 3.6)	Although not specifically targeted against *S. maydis*, existing phytosanitary measures mitigate the likelihood of the pathogen's (re-)entry into the EU territory. Potential additional measures also exist to further mitigate the risk of (re-)introduction, or spread of the pathogen within the EU.	None
Conclusion (Section 4)	The pathogen satisfies the criteria that are within the remit of EFSA to assess for this species to be regarded as a potential Union quarantine pest	None
Aspects of assessment to focus on/ scenarios to address in future if appropriate:	None	

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Abbreviations

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

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2018)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018)
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2018)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2018)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2018)
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2018)

Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2018)
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO, 2018)

Appendix A – Distribution of *Stenocarpella maydis*

Distribution records based on EPPO Global Database (EPPO, online), CABI CPC and literature

Region	Country	Subnational (e.g. State)	Status	References
North America	Canada	Ontario	Present	McKeen (1953), Mortimore et al. (1965)
	Mexico		Present	Petatan-Sagahon et al. (2011)
	USA	Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Luisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dacota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Washington, West Virginia, Wisconsin	Present	Anderson and White (1987), Byrnes and Carroll (1984), Calvert et al. (1969), Carson and Wicks (1993), Clayton (1927), Dien et al. (2012), Dorrance et al. (1999), Gatch et al. (2002), Haarmann et al. (1993), Hooker and White (1976), Hooker (1977), Johann (1940), Kappelman Thompson (1966), Loesch et al. (1972), Luna et al. (2017), Manns and Adams (1923), Michaelson (1957), Mortimore et al. (1965), Murphy et al. (1974), Nelson et al. (2011), Nyhus et al. (1989), Nyhus et al. (1988), Nyhus et al. (1989), Rabie et al. (1987), Romero et al. (2015), Romero et al. (2016), Romero et al. (2017), Rogers et al. (2014), Warren et al. (1975), Satour et al. (1969), Smith et al. (1934), Thompson et al. (1971), Wicklow et al. (2011), Young et al. (1977)
Central America	Belize		Present	
	El Salvador		Present	Mendoza et al. (2017)
	Guatemala		Present	Mendoza et al. (2017)
	Honduras		Present	
South America	Argentina		Present	Odriozola et al. (2005).
	Brazil	Distrito Federal, Mato Grosso do Sul, Minas Gerais, Rio Grande do Sul, Santa Catarina, Parana, Tocantins, Sao Paulo	Present	Blum et al. (2003), Casa et al. (2007), Costa et al. (2018), Costa et al. (2019), Faiad et al. (1996), Faria et al. (2017), Fedrigo et al. (2016), Fessehaie et al. (2010), Mário et al. (2017), Mendes et al. (2011), Salgado et al. (1985), Siqueira et al. (2014), Siqueira et al. (2016), Kuhnem, J. et al. (2012), Rigal dos et al. (2016)
	Bolivia		Present	Macdonald et al. (1997)
	Colombia		Present	
	Ecuador		Present	
	Honduras		Present	
EU (27)	Czech Republic		Present	
	Spain		Present	Riva et al. (2019)
	Serbia		Present	Pencic et al. (1991)

Region	Country	Subnational (e.g. State)	Status	References
Other Europe				
Africa	Congo, Democratic Republic of the		Present	
	Congo, Republic of the		Present	
	Eswatini		Present	
	Ethiopia		Present	
	Ghana		Present	Macdonald et al. (1997)
	Kenya		Present	Macdonald et al. (1997)
	Malawi		Present	Macdonald et al. (1997)
	Nigeria		Present	Marley et al. (2004)
	South Africa	Eastern Cape, Free State, Gauteng, KwaZulu Natal, Limpopo, Mpumalanga, North West, Transvaal	Present	Aveling et al. (2020), Barros et al. (2008), Botha et al. (2020), Craven et al. (2017), Dorrance et al. (1999), Flett et al. (1991), Flett et al. (1992), Flett et al. (2001), Kellerman et al. (1985), Lamprecht et al. (2011), Mabuza et al. (2018), Rao et al. (2001), Van, R. et al. (1997), van, R. and J. J. B (2000), Rabie et al. (1987), Xia et al. (2011)
	Tanzania		Present	
	Uganda		Present	Bigirwa et al. (2007)
	Zambia		Present	Mukanga et al. (2010)
	Zimbabwe		Present	
Asia	China	Gansu, Guangdong, Guanxi, Guizhou, Henan, Hubei, Jiangsu, Jilin, Lianoning, Shanxi, Sichuan, Tibet, Yunnan		
	India	Sikkim		
	Iran			
	Nepal			Macdonald et al. (1997)
	Pakistan			Gardezi and A. S. R (2006), Niaz et al. (2009)
	Philippines			Baer et al. (2021)
	South Korea			
	Taiwan			
	Thailand			
Oceania	Australia	New South Wales, Queensland		Blaney et al. (1981), Francis et al. (1975), Williams et al. (1992)
	New Zealand			Sayer and T. S (1991), Sayer et al. (1991)

Appendix B – EU 27 annual imports of maize from countries where *Stenocarpella maydis* is present, 2017–2021 (in 100 kg)

Source: Eurostat accessed on 22/07/2022
Import of maize (maize or corn, HS 1005)

	January–December 2017	January–December 2018	January–December 2019	January–December 2020	January–December 2021
Argentina	1895102.34	2418558.86	1397943.12	1485999.86	1324732.46
Australia	19821.10	20988.74	30.32	1.97	20.88
Bolivia, Plurinational State of	189.05	329.00	126.00	55.20	167.75
Brazil	40422755.38	45533847.79	49693132.47	41527814.75	31460730.51
Canada	6624917.95	14272409.90	7996006.38	5468820.31	10049678.55
Congo, Democratic Republic of					0.50
Congo					0.09
China	49315.06	13505.70	1857.99	536.71	375.87
Colombia		97.22		0.04	0.08
Ecuador	80.00	312.78	61.57	30.00	30.02
Ethiopia (incl. Eritrea 'ER' - > 1993)		0.70			0.00
Ghana	0.89		6.00	0.01	36052.23
Honduras		0.07			
India	110.41	9903.18	663.15	2040.51	2412.22
Iran, Islamic Republic of	13.71	198.98			12.68
Kenya	528.97	384.28	228.81	250.00	690.09
Korea, Republic of (South Korea)	0.90	5.19	4.15	25.88	14.95
Malawi	0.88	0.50			0.00
Mexico	1446.94	427406.39	2773.28	1461.51	2359.14
Nigeria	12.67	3.01	0.72	116.26	5.82
New Zealand	11497.71	6745.75	12994.65	966.30	627.05
Philippines	0.18	1.93	0.68	0.92	2.94
Pakistan					3.86
Thailand	1841.34	1801.98	1615.47	6117.68	5250.64
Taiwan				1.33	3.04
Tanzania, United Republic of		0.02	0.21		
Uganda	3.48	1.76	3.71	4.45	3.59
United States (incl. Navassa Island (part of 'UM') from 1995 - > 2000)	6638863.65	17748274.58	175400.69	113408.35	71631.03
Serbia	5431196.20	2482126.76	11927127.15	14038300.19	13135050.99
South Africa (incl. Namibia 'NA' - > 1989)	45595.31	2563570.36	508866.58	318013.64	2743740.64
Zambia	6.75	0.47	2.45	0.95	77.34
Zimbabwe	0.00		0.03	44.18	0.18
Sum	61143300.87	85500475.90	71718845.58	62964011.00	58833675.14

Import of maize seed for seeding (HS 100510)

	January–December 2017	January–December 2018	January–December 2019	January–December 2020	January–December 2021
Argentina	790.35	42.23	53.45	64.57	87.41
Australia	0.90	0.38	30.26	0.47	1.32
Bolivia, Plurinational State of					
Brazil	0.64	0.63	0.97	0.78	3.83
Canada	1.87	20.32	10.55	25.54	5.88
Congo, Democratic Republic of					0.50
Congo					
China	0.12	5.08	0.21	0.05	1.59
Colombia					
Ecuador					
Ethiopia (incl. Eritrea 'ER' -> 1993)					
Ghana					
Honduras					
India	0.00	0.21	4.23	1.32	14.67
Iran, Islamic Republic of		198.98			
Kenya	3.20				0.02
Korea, Republic of (South Korea)					
Malawi	0.88	0.19			
Mexico	1333.64	1369.71	1480.72	1070.18	1573.44
Nigeria	2.73	0.11			
New Zealand	11497.71	6744.00	12994.65	966.22	627.05
Philippines	0.18	0.26	0.68	0.92	1.17
Pakistan					
Thailand	0.39	1.52	0.52	9.25	1.68
Taiwan					
Tanzania, United Republic of		0.02	0.21		
Uganda			0.01	0.50	
United States (incl. Navassa Island (part of 'UM') from 1995 -> 2000)	46241.68	35856.15	20771.26	24027.41	15730.99
Serbia	127560.53	100162.99	125357.84	109159.37	114935.80
South Africa (incl. Namibia 'NA' -> 1989)	117.42	1272.89	3.07	2011.45	27.19
Zambia	6.75	0.47	2.45	0.95	77.34
Zimbabwe	0.00		0.03	0.08	0.08
Sum	187558.99	145676.14	160711.11	137339.06	133089.96

Appendix C – EU 27 and member state cultivation/harvested/production area of Stenocarpella maydis host maize (in 1000 ha)

Source EUROSTAT (accessed 7 June 2022).

Maize	2017	2018	2019	2020	2021
EU 27	8,266.64	8,252.47	8,910.74	9,354.73	9,231.62
Belgium	49.00	53.99	48.64	51.88	48.20
Bulgaria	398.15	444.62	560.91	581.53	573.02
Czechia	86.00	81.85	74.83	87.23	102.44
Denmark	5.10	6.30	5.40	6.20	6.40
Germany	432.00	410.90	416.00	419.30	430.70
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00
Greece	132.49	113.45	115.50	116.78	112.82
Spain	333.63	322.37	356.83	343.78	346.93
France	1,435.70	1,426.26	1,506.10	1,691.13	1,547.12
Croatia	247.12	235.35	255.89	288.40	287.00
Italy	645.74	591.21	628.80	602.86	588.60
Cyprus	0.00	0.00	0.00	0.00	0.00
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	9.93	13.39	12.77	20.20	17.87
Luxembourg	0.08	0.09	0.14	0.12	0.07
Hungary	988.82	939.08	1,027.59	981.01	1,043.11
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	12.25	13.76	19.01	19.42	17.20
Austria	209.48	209.90	220.69	212.60	218.20
Poland	562.11	645.41	664.95	946.06	998.47
Portugal	86.52	83.36	77.02	72.99	73.45
Romania	2,405.24	2,443.95	2,681.93	2,680.10	2,572.56
Slovenia	38.29	37.08	38.88	39.83	41.68
Slovakia	187.81	179.03	197.24	191.48	203.36
Finland	0.00	0.00	0.00	0.00	0.90
Sweden	1.19	1.11	1.62	1.85	1.54