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Pest categorisation of *Colletotrichum gossypii*

EFSA Panel on Plant Health (PLH),

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Abstract

The Panel on Plant Health performed a pest categorisation of *Colletotrichum gossypii*, the fungal agent of anthracnose and ramulosis diseases of cotton, for the EU. The identity of the pest is well established and reliable methods exist for its detection/identification. The pest is present in most of the cotton-growing areas worldwide, including Bulgaria and Romania in the EU. *Colletotrichum gossypii* is listed as *Glomerella gossypii* in Annex IIB of Directive 2000/29/EC and is not known to occur in Greece, which is a protected zone (PZ). The only hosts are *Gossypium* species, with *G. hirsutum* and *G. barbadense* being the most susceptible. The pest could potentially enter the PZ on cotton seeds originating in infested third countries or EU infested areas. Entry into PZ by natural means from EU infested areas is possible, although there is uncertainty on the maximum distance the pest can travel by wind or insects. Bolls and unginned cotton are minor pathways of entry. Pest distribution and climate matching suggest that the pest could establish and spread in cotton-producing areas of northern Greece. In the infested areas, the pest causes damping-off, leaf/boll spotting, boll rot, witches' broom symptoms and stunting resulting in yield and quality losses. It affects also the lint and seeds reducing fibres quality and seed germinability. It is expected that its introduction and spread in the EU PZ would impact cotton yield and quality. The agricultural practices and control methods currently applied in Greece would not prevent pest establishment and spread. *Colletotrichum gossypii* meets all the criteria assessed by EFSA for consideration as potential quarantine pest for the EU PZ of Greece. The criteria for considering *C. gossypii* as a potential Union regulated non-quarantine pest are also met since cotton seeds are the main means of spread.

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

Council Directive 2000/29/EC¹ on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community establishes the present European Union plant health regime. The Directive lays down the phytosanitary provisions 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. In the Directive's 2000/29/EC annexes, the list of harmful organisms (pests) whose introduction into or spread within the Union is prohibited, is detailed together with specific requirements for import or internal movement.

Following the evaluation of the plant health regime, the new basic plant health law, Regulation (EU) 2016/2031² on protective measures against pests of plants, was adopted on 26 October 2016 and will apply from 14 December 2019 onwards, repealing Directive 2000/29/EC. In line with the principles of the above mentioned legislation and the follow-up work of the secondary legislation for the listing of EU regulated pests, EFSA is requested to provide pest categorizations of the harmful organisms included in the annexes of Directive 2000/29/EC, in the cases where recent pest risk assessment/pest categorisation is not available.

1.1.2. Terms of Reference

EFSA is requested, pursuant to Article 22(5.b) and Article 29(1) of Regulation (EC) No 178/2002,³ to provide scientific opinion in the field of plant health.

EFSA is requested to prepare and deliver a pest categorisation (step 1 analysis) for each of the regulated pests included in the appendices of the annex to this mandate. The methodology and template of pest categorisation have already been developed in past mandates for the organisms listed in Annex II Part A Section II of Directive 2000/29/EC. The same methodology and outcome is expected for this work as well.

The list of the harmful organisms included in the annex to this mandate comprises 133 harmful organisms or groups. A pest categorisation is expected for these 133 pests or groups and the delivery of the work would be stepwise at regular intervals through the year as detailed below. First priority covers the harmful organisms included in Appendix 1, comprising pests from Annex II Part A Section I and Annex II Part B of Directive 2000/29/EC. The delivery of all pest categorisations for the pests included in Appendix 1 is June 2018. The second priority is the pests included in Appendix 2, comprising the group of *Cicadellidae* (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), the group of *Tephritidae* (non-EU), the group of potato viruses and virus-like organisms, the group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L. and the group of *Margarodes* (non-EU species). The delivery of all pest categorisations for the pests included in Appendix 2 is end 2019. The pests included in Appendix 3 cover pests of Annex I part A section I and all pest categorisations should be delivered by end 2020.

For the above mentioned groups, each covering a large number of pests, the pest categorisation will be performed for the group and not the individual harmful organisms listed under "such as" notation in the Annexes of the Directive 2000/29/EC. The criteria to be taken particularly under consideration for these cases, is the analysis of host pest combination, investigation of pathways, the damages occurring and the relevant impact.

Finally, as indicated in the text above, all references to 'non-European' should be avoided and replaced by 'non-EU' and refer to all territories with exception of the Union territories as defined in Article 1 point 3 of Regulation (EU) 2016/2031.

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

² Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants. OJ L 317, 23.11.2016, p. 4–104.

³ Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31/1, 1.2.2002, p. 1–24.

1.1.2.1. Terms of Reference: Appendix 1

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

<i>Aleurocantus</i> spp.	<i>Numonia pyrivorella</i> (Matsumura)
<i>Anthonomus bisignifer</i> (Schenkling)	<i>Oligonychus perditus</i> Pritchard and Baker
<i>Anthonomus signatus</i> (Say)	<i>Pissodes</i> spp. (non-EU)
<i>Aschistonyx eppoi</i> Inouye	<i>Scirtothrips aurantii</i> Faure
<i>Carposina niponensis</i> Walsingham	<i>Scirtothrips citri</i> (Moultex)
<i>Enarmonia packardi</i> (Zeller)	<i>Scolytidae</i> spp. (non-EU)
<i>Enarmonia prunivora</i> Walsh	<i>Scrobipalopsis solanivora</i> Povolny
<i>Grapholita inopinata</i> Heinrich	<i>Tachypterellus quadrigibbus</i> Say
<i>Hishomonus phycitis</i>	<i>Toxoptera citricida</i> Kirk.
<i>Leucaspis japonica</i> Ckll.	<i>Unaspis citri</i> Comstock
<i>Listronotus bonariensis</i> (Kuschel)	

(b) Bacteria

Citrus variegated chlorosis	<i>Xanthomonas campestris</i> pv. <i>oryzae</i> (Ishiyama)
<i>Erwinia stewartii</i> (Smith) Dye	Dye and pv. <i>oryzicola</i> (Fang, et al.) Dye

(c) Fungi

<i>Alternaria alternata</i> (Fr.) Keissler (non-EU pathogenic isolates)	<i>Elsinoe</i> spp. Bitanc. and Jenk. Mendes
<i>Anisogramma anomala</i> (Peck) E. Müller	<i>Fusarium oxysporum</i> f. sp. <i>albedinis</i> (Kilian and Maire) Gordon
<i>Apiosporina morbosa</i> (Schwein.) v. Arx	<i>Guignardia piricola</i> (Nosa) Yamamoto
<i>Ceratocystis virescens</i> (Davidson) Moreau	<i>Puccinia pittieriana</i> Hennings
<i>Cercoseptoria pini-densiflorae</i> (Hori and Nambu) Deighton	<i>Stegophora ulmea</i> (Schweinitz: Fries) Sydow & Sydow
<i>Cercospora angolensis</i> Carv. and Mendes	<i>Venturia nashicola</i> Tanaka and Yamamoto

(d) Virus and virus-like organisms

Beet curly top virus (non-EU isolates)	Little cherry pathogen (non- EU isolates)
Black raspberry latent virus	Naturally spreading psorosis
Blight and blight-like	Palm lethal yellowing mycoplasma
Cadang-Cadang viroid	Satsuma dwarf virus
Citrus tristeza virus (non-EU isolates)	Tatter leaf virus
Leprosis	Witches' broom (MLO)

Annex IIB

(a) Insect mites and nematodes, at all stages of their development

<i>Anthonomus grandis</i> (Boh.)	<i>Ips cembrae</i> Heer
<i>Cephalcia lariciphila</i> (Klug)	<i>Ips duplicatus</i> Sahlberg
<i>Dendroctonus micans</i> Kugelán	<i>Ips sexdentatus</i> Börner
<i>Gilpinia hercyniae</i> (Hartig)	<i>Ips typographus</i> Heer
<i>Gonipterus scutellatus</i> Gyll.	<i>Sternochetus mangiferae</i> Fabricius
<i>Ips amitinus</i> Eichhof	

(b) Bacteria

Curtobacterium flaccumfaciens pv. *flaccumfaciens*
(Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton

Hypoxyton mammatum (Wahl.) J. Miller

Gremmeniella abietina (Lag.) Morelet

1.1.2.2. Terms of Reference: Appendix 2

List of harmful organisms for which pest categorisation is requested per group. The list below follows the categorisation included in the annexes of Directive 2000/29/EC.

Annex IAI**(a) Insects, mites and nematodes, at all stages of their development**

Group of Cicadellidae (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), such as:

- | | |
|--|---|
| 1) <i>Carneocephala fulgida</i> Nottingham | 3) <i>Graphocephala atropunctata</i> (Signoret) |
| 2) <i>Draeculacephala minerva</i> Ball | |

Group of Tephritidae (non-EU) such as:

- | | |
|--|---|
| 1) <i>Anastrepha fraterculus</i> (Wiedemann) | 12) <i>Pardalaspis cyanescens</i> Bezzi |
| 2) <i>Anastrepha ludens</i> (Loew) | 13) <i>Pardalaspis quinaria</i> Bezzi |
| 3) <i>Anastrepha obliqua</i> Macquart | 14) <i>Pterandrus rosa</i> (Karsch) |
| 4) <i>Anastrepha suspensa</i> (Loew) | 15) <i>Rhacochlaena japonica</i> Ito |
| 5) <i>Dacus ciliatus</i> Loew | 16) <i>Rhagoletis completa</i> Cresson |
| 6) <i>Dacus curcurbitae</i> Coquillet | 17) <i>Rhagoletis fausta</i> (Osten-Sacken) |
| 7) <i>Dacus dorsalis</i> Hendel | 18) <i>Rhagoletis indifferens</i> Curran |
| 8) <i>Dacus tryoni</i> (Froggatt) | 19) <i>Rhagoletis mendax</i> Curran |
| 9) <i>Dacus tsuneonis</i> Miyake | 20) <i>Rhagoletis pomonella</i> Walsh |
| 10) <i>Dacus zonatus</i> Saund. | 21) <i>Rhagoletis suavis</i> (Loew) |
| 11) <i>Epochra canadensis</i> (Loew) | |

(c) Viruses and virus-like organisms

Group of potato viruses and virus-like organisms such as:

- | | |
|----------------------------------|--|
| 1) Andean potato latent virus | 4) Potato black ringspot virus |
| 2) Andean potato mottle virus | 5) Potato virus T |
| 3) Arracacha virus B, oca strain | 6) non-EU isolates of potato viruses A, M, S, V, X and Y (including Yo, Yn and Yc) and Potato leafroll virus |

Group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L., such as:

- | | |
|--------------------------------------|--|
| 1) Blueberry leaf mottle virus | 8) Peach yellows mycoplasma |
| 2) Cherry rasp leaf virus (American) | 9) Plum line pattern virus (American) |
| 3) Peach mosaic virus (American) | 10) Raspberry leaf curl virus (American) |
| 4) Peach phony rickettsia | 11) Strawberry witches' broom mycoplasma |
| 5) Peach rosette mosaic virus | 12) Non-EU viruses and virus-like organisms of <i>Cydonia</i> Mill., <i>Fragaria</i> L., <i>Malus</i> Mill., <i>Prunus</i> L., <i>Pyrus</i> L., <i>Ribes</i> L., <i>Rubus</i> L. and <i>Vitis</i> L. |
| 6) Peach rosette mycoplasma | |
| 7) Peach X-disease mycoplasma | |

Annex IIAI**(a) Insects, mites and nematodes, at all stages of their development**

Group of *Margarodes* (non-EU species) such as:

- | | |
|--|--|
| 1) <i>Margarodes vitis</i> (Phillipi) | 3) <i>Margarodes prieskaensis</i> Jakubski |
| 2) <i>Margarodes vredendalensis</i> de Klerk | |

1.1.2.3. Terms of Reference: Appendix 3

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IAI**(a) Insects, mites and nematodes, at all stages of their development**

<i>Acleris</i> spp. (non-EU)	<i>Longidorus diadecturus</i> Eveleigh and Allen
<i>Amauromyza maculosa</i> (Malloch)	<i>Monochamus</i> spp. (non-EU)
<i>Anomala orientalis</i> Waterhouse	<i>Myndus crudus</i> Van Duzee
<i>Arrhenodes minutus</i> Drury	<i>Nacobbus aberrans</i> (Thorne) Thorne and Allen
<i>Choristoneura</i> spp. (non-EU)	<i>Naupactus leucoloma</i> Boheman
<i>Conotrachelus nenuphar</i> (Herbst)	<i>Premnotrypes</i> spp. (non-EU)
<i>Dendrolimus sibiricus</i> Tschetverikov	<i>Pseudopityophthorus minutissimus</i> (Zimmermann)
<i>Diabrotica barberi</i> Smith and Lawrence	<i>Pseudopityophthorus pruinosus</i> (Eichhoff)
<i>Diabrotica undecimpunctata howardi</i> Barber	<i>Scaphoideus luteolus</i> (Van Duzee)
<i>Diabrotica undecimpunctata undecimpunctata</i> Mannerheim	<i>Spodoptera eridania</i> (Cramer)
<i>Diabrotica virgifera zea</i> Krysan & Smith	<i>Spodoptera frugiperda</i> (Smith)
<i>Diaphorina citri</i> Kuway	<i>Spodoptera litura</i> (Fabricius)
<i>Heliothis zea</i> (Boddie)	<i>Thrips palmi</i> Karny
<i>Hirschmanniella</i> spp., other than <i>Hirschmanniella gracilis</i> (de Man) Luc and Goodey	<i>Xiphinema americanum</i> Cobb sensu lato (non-EU populations)
<i>Liriomyza sativae</i> Blanchard	<i>Xiphinema californicum</i> Lamberti and Bleve-Zacheo

(b) Fungi

<i>Ceratocystis fagacearum</i> (Bretz) Hunt	<i>Mycosphaerella larici-leptolepis</i> Ito et al.
<i>Chrysomyxa arctostaphyli</i> Dietel	<i>Mycosphaerella populorum</i> G. E. Thompson
<i>Cronartium</i> spp. (non-EU)	<i>Phoma andina</i> Turkensteen
<i>Endocronartium</i> spp. (non-EU)	<i>Phyllosticta solitaria</i> Ell. and Ev.
<i>Guignardia laricina</i> (Saw.) Yamamoto and Ito	<i>Septoria lycopersici</i> Speg. var. <i>malagutii</i> Ciccarone and Boerema
<i>Gymnosporangium</i> spp. (non-EU)	<i>Thecaphora solani</i> Barrus
<i>Inonotus weirii</i> (Murril) Kotlaba and Pouzar	<i>Trechispora brinkmannii</i> (Bresad.) Rogers
<i>Melampsora farlowii</i> (Arthur) Davis	

(c) Viruses and virus-like organisms

Tobacco ringspot virus	Pepper mild tigré virus
Tomato ringspot virus	Squash leaf curl virus
Bean golden mosaic virus	Euphorbia mosaic virus
Cowpea mild mottle virus	Florida tomato virus
Lettuce infectious yellows virus	

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex I A II**(a) Insects, mites and nematodes, at all stages of their development**

Meloidogyne fallax Karssen

Rhizoecus hibisci Kawai and Takagi

Popillia japonica Newman

(b) Bacteria

Clavibacter michiganensis (Smith) Davis et al. ssp. *sepedonicus* (Spieckermann and Kotthoff) Davis et al.

Ralstonia solanacearum (Smith) Yabuuchi et al.

(c) Fungi

Melampsora medusae Thümen

Synchytrium endobioticum (Schilbersky) Percival

Annex I B**(a) Insects, mites and nematodes, at all stages of their development**

Leptinotarsa decemlineata Say

Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Glomerella gossypii is one of a number of pests listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest for the area of the European Union (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.

Glomerella gossypii has been renamed as *Colletotrichum gossypii*. Therefore, for the purposes of this pest categorisation, the current scientific name will be used. The pest is regulated in the protected zone of Greece only. Therefore, the scope of this pest categorisation is the EU protected zone (Greece), instead of the whole EU territory.

2. Data and methodologies**2.1. Data****2.1.1. Literature search**

A literature search on *G. gossypii* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database. The search focussed on *Glomerella gossypii*, (including its synonyms) and its geographic distribution, life cycle, host plants and the damage it causes. The following search terms (TS) and combinations were used: TS = (("Glomerella gossypii" OR "Colletotrichum gossypii" OR Anthracnose OR Ramulosis) AND (geograph* OR distribution OR "life cycle" OR lifecycle OR host OR hosts OR plant* OR damag*) AND cotton). Relevant papers were reviewed and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plan Protection Organization (EPPO) Global Database (EPPO, online) and relevant publications.

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 - online).

The Europhyt database (online) was 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 SANTE) of the European Commission, and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The Europhyt database manages 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 (MS) and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *C. gossypii* following guiding principles and steps presented in the EFSA guidance on the harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union regulated non-quarantine pest in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required in accordance with the specific terms of reference received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as a regulated non-quarantine pest. If one of the criteria is not met, the pest will not qualify. A pest that does not qualify as a quarantine pest may still qualify as a regulated non-quarantine pest that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

It should be noted that 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, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, whereas addressing social impacts is outside the remit of the Panel, in agreement with EFSA guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

Table 1: Pest categorisation criteria under evaluation, as 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	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, 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 widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pest must be present in the risk assessment area)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future	The protected zone system aligns with the pest free area system under the International Plant Protection Convention (IPPC) The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone)	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?
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!	Is the pest able to enter into, become established in, and spread within, the protected zone areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
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	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met

The Panel will not indicate in its conclusions of the pest categorisation whether to continue the risk assessment process, but following the agreed two-step approach, will continue only if requested by the risk managers. However, during the categorisation process, experts may identify key elements and knowledge gaps that could contribute significant uncertainty to a future assessment of risk. It would be useful to identify and highlight such gaps so that potential future requests can specifically target the major elements of uncertainty, perhaps suggesting specific scenarios to examine.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

YES. The identity of the pest is well-established

Colletotrichum gossypii Edgerton, 1909 is a fungus of the family Glomerellaceae. The Index Fungorum database (www.indexfungorum.org) provides the following taxonomical identification:

Current scientific name: *Colletotrichum gossypii* Southw. 1891

Family – Glomerellaceae

Genus – *Colletotrichum*

Species – *gossypii*

Other reported synonyms (EPPO, online): *Gloeosporium rufomaculans* (Berkeley) von Thümen;
Glomerella rufomaculans Shear & Wood

Preferred common name: anthracnose of cotton

Other common names: pink boll rot of cotton; seedling blight of cotton

Colletotrichum gossypii was originally described from the USA and was reported to cause disease symptoms on all parts of cotton plants, but especially on seedlings and bolls (Southworth, 1891; Edgerton, 1909). Isolates identified as *C. gossypii* by Shear and Wood (1907) were reported to be associated in culture with a teleomorphic state belonging to the genus *Glomerella*. Later, Edgerton (1909) described *G. gossypii* from diseased, mature cotton plants in the USA.

3.1.2. Biology of the pest

Colletotrichum gossypii is carried both on and inside cotton seeds (Arndt, 1953) due to its ability to infect the fruits (bolls) (Hillocks, 1992). The survival potential of the pathogen in cotton seed, as indicated by the percentage of emerged infected seedlings, has been shown to be affected by the moisture content of the seed and the storage temperature (Arndt, 1946). More specifically, when the moisture content of infected cotton seeds ranged between 8% and 16%, the pest survived up to 17 months (max. period studied) but only when the seeds were stored at 1°C (Arndt, 1946). The pathogen also survives in infected cotton plant residues (EPPO, online) on which perithecia with ascospores of the teleomorph (*G. gossypii*) are produced (Watkins, 1981; Hillocks, 1992). Therefore, infected seed and crop residues provide the initial inoculum for infection of cotton crops (Hillocks, 1992). Like other *Glomerella* species (Kaiser and Lukezic, 1966), in the presence of water (rain, irrigation) or high humidity, ascospores are forcibly ejected from perithecia and are disseminated by air currents to infect susceptible hosts.

The optimum conditions for infection are high humidity and 25°C. Infection is greatly reduced at temperatures below 20°C and does not occur at 36°C (Arndt, 1944). Davis et al. (1981) reported that the disease on cotton seedlings is severe at temperatures 20–26°C. Ling (1944) showed that a prolonged dry period with an average humidity lower than 70% after the emergence of cotton seedlings resulted in a low percentage of infection. In the USA, seed infection rates were high when frequent rainfall occurred after boll-split (Arndt, 1956). Nevertheless, according to Leakey and Perry (1966), in the presence of wounds (mechanical or insect feeding) the fungus causes an extensive rot of the boll wall and lint, irrespective of the humidity level.

Usually, only the conidial stage of the pathogen (*C. gossypii*) is present on cotton plants during the growing period (EPPO, online). Conidia produced in acervuli in a mucilaginous mass and dispersed mainly by rain, wind-driven rain and insects (e.g. *Dysdercus* spp.) are responsible for the secondary infections of cotton plants (Cauquil, 1960; Davis, 1981).

Converse (1919), Edgerton (1912), Weindling et al. (1941) and Cauquil (1960) showed that the pest is also able to survive a considerable length of time as a saprophyte on dead or apparently healthy stems and leaves of cotton without causing symptoms. During its saprophytic life, the fungus

has many chances to contaminate the seeds when still in open bolls through the rain water and later during the ginning process. Weindling et al. (1941) further demonstrated that *C. gossypii* conidia could contaminate healthy seeds during the ginning process when the seeds were mixed with infected plant debris. This was thought to account for the considerable amount of inoculum on seed obtained from fields in the southern USA in which very little or no anthracnose symptoms were apparent on bolls during the growing period.

3.1.3. Intraspecific diversity

In South America (Brazil, Paraguay, Venezuela and Colombia), a physiological variant of *C. gossypii*, named *C. gossypii* var. *cephalosporioides*, has been reported to cause on cotton a disease different from anthracnose, which is known as ramulosis (or ramulose), escobilla or witches' broom (Costa and Fraga, 1939; Malaguti, 1955; Watkins, 1981; Mathieson and Mangano, 1985; Silva-Mann et al., 2002; Monteiro et al., 2009; Moreno-Moran and Burbano-Figueroa, 2016).

Colletotrichum gossypii var. *cephalosporioides* differs from *C. gossypii* in virulence, aggressiveness, morphology, growth on various synthetic media and ability to grow at less than 30°C (Follin and Mangano, 1983). High relative humidity (100%) and temperatures between 21°C and 25°C for at least 8–10 h are required for infection of cotton plants by *C. gossypii* var. *cephalosporioides* and no infection occurs at 32°C. According to Do Nascimento et al. (2006), infection of cotton plants by *C. gossypii* var. *cephalosporioides* is favoured by high rainfall and temperatures between 25°C and 30°C.

Nevertheless, a rDNA comparison study showed that *C. gossypii* and *C. gossypii* var. *cephalosporioides* are identical with 99.5% homology, which does not justify them to be distinct species (Bailey et al., 1996). Both *C. gossypii* and its variant belong to the *C. gloeosporioides* species complex (Bailey et al., 1996; Silva-Mann et al., 2005).

Based on the above, the Panel decided to perform the pest categorisation at the species level of *C. gossypii*.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes. *Colletotrichum gossypii* can be detected and identified based on host association, symptomatology, morphology and molecular methods.

Colletotrichum gossypii can be detected and identified based on host association, symptomatology, and cultural/morphological characteristics of its colonies and fructifications in agar media. Nevertheless, molecular methods are necessary for confirming the identification of the pest based on morphology. A rapid and reliable molecular method based on the β -tubulin gene is available for the identification of *C. gossypii* in culture and its differentiation from other related *Colletotrichum* species belonging to the *C. gloeosporioides* species complex (Nawaz et al., 2018).

A seed testing method is also available for the detection of *C. gossypii* in cotton seeds (EPPO, online).

Symptoms

Anthracnose caused by *C. gossypii* affects all parts of cotton plants at all growth stages but are most serious on seedlings and bolls (Davis, 1981; Hillocks, 1992; EPPO, online). In young plants, which are more susceptible than mature plants, the pathogen causes spots on the cotyledons and a reddish-brown cortical rot at the base of the hypocotyl resulting in girdling, yellowing of the leaves and post-emergence damping-off and soreshin (Arndt, 1944; Cognee, 1960; Davis, 1981; Hillocks, 1992). Lesions may also develop on the stems and leaves of mature plants, sometimes producing a scald-like effect (Cai et al., 2009; EPPO, online). If infection is severe, large areas of leaf tissue around the main veins become necrotic (Hillocks, 1992).

The initial symptoms on bolls usually occur near the tip, often due to infection during flowering, as small, round, water-soaked spots on the capsule, which rapidly enlarge, sometimes covering one-fourth to one-half of the boll surface, become sunken and finally develop reddish borders with pink centres (Davis, 1981). Under dry weather conditions, lesions may appear greyish in colour. If weather conditions favour the development of the pathogen, acervuli are formed on the diseased areas, which later may be covered with a pink, pasty conidial mass (Davis, 1981; Hillocks, 1992). Severely infected bolls become mummified (darkened and hardened) and never open. As soon as *C. gossypii* enters the boll, it spreads rapidly through the lint and seed (Davis, 1981). Lint from diseased bolls is frequently tinted pink and of

inferior quality (EPPO, online). The fungus infects the seeds internally and remains entirely latent until the seeds are planted (Watkins, 1981; Bailey et al., 1992). Studies in Brazil showed that the fungus penetrated the embryo in 0.4–2% of the seeds (Lima et al., 1985). Both lint and seeds are often destroyed, even with little external evidence of the disease (Davis, 1981). If boll matures before the lint and seed are completely destroyed, usually opens (Davis, 1981). Seedlings emerging from infected seeds wilt and die (Davis, 1981; EPPO, online). Symptoms caused by anthracnose on cotton seedlings and mature plants resemble those caused by other pathogens, such as *Rhizoctonia solani*, *Xanthomonas axonopodis* pv. *malvacearum*, *Fusarium* spp., *Nematospora* spp., *Alternaria* spp., *Nigrospora* spp., *Ascochyta gossypii*, *Diplodia gossypina*, etc.

First symptoms of ramulosis caused by *C. gossypii* var. *cephalosporioides* appear on leaves, petioles, and branches as nearly circular necrotic spots (Paiva et al., 2001; Monteiro et al., 2009), which enlarge with time resulting on crispy leaves and sporulating star-shaped lesions (Mathieson and Mangano, 1985; Araújo et al., 2003; Saran, 2009). Infected leaf tissue drops from the plant, causing an irregular shot-hole varying from 1 to 10 mm in diameter (Monteiro et al., 2009). During advanced stages of the disease, the fungus infects the apical meristem causing its necrosis, and subsequently, the extensive sprouting of lateral buds resulting in a witches' broom type of symptoms (Do Nascimento et al., 2006). In young plants (less than 60 days old), the pathogen infects the new branches emerging after the necrosis of the apical meristem (Juliatti and Algodão, 1997). Severely infected plants appear stunted with numerous branches and short internodes (Mathieson and Mangano, 1985; Araújo et al., 2003; Saran, 2009). Infected bolls remain green for a long time without opening (Watkins, 1981). Seeds also become infected by the pathogen and they often germinate abnormally inside the unopened bolls (Watkins, 1981; Lima et al., 1985; Lima and Chaves, 1992). Pre-bloom infection can lead to flower abortion and, in extreme cases, plants become totally unproductive (Juliatti and Algodão, 1997).

According to Monteiro et al. (2009) studies conducted in controlled environment conditions, the incubation period of ramulosis, which varied according to temperature and length of wetness duration, was approximately 15 days at 15°C, 11 days at 20°C, 10 days at 25°C and 9 days at 30°C.

Morphology

Perithecia of the teleomorph (*G. gossypii*) do not usually form in a stroma, but are distinct and separate (Watkins, 1981). They are 80–120 × 100–160 µm, superficial, pyriform, black, often sclerotial in form, with irregular walls and a papillate ostiole lined with periphyses. Asci are 55–70 × 10–14 µm, eight-spored, clavate, usually short-stalked, the apex obtuse to rounded with an inconspicuous iodine-negative apical ring. Ascospores are 12–20 × 5–8 µm, ellipsoidal, often slightly curved, hyaline, aseptate, without a mucous sheath or appendages and contents often appearing granular (Edgerton, 1909; Mordue, 1971).

Colletotrichum gossypii acervuli are accompanied by dark setae, which sometimes form conidia at their tips (Mordue, 1971; Sutton, 1992). Conidiomata are often absent, at least in culture, with the conidiogenous cells formed directly from vegetative mycelium. Conidia are 12–17 × 3–4.5 µm, cylindrical with rounded ends, straight and parallel-sided, hyaline, aseptate without a mucous sheath or appendages. Germinating conidia form appressoria on contact with the host, which are clavate, 6–20 × 4–12 µm, dark brown, flat and sometimes lobed.

Colonies formed in agar media are greyish-white to dark brown, usually with reduced aerial mycelium and often brownish on the reverse (Mordue, 1971; Sutton, 1992).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

According to EPPO Global Database (EPPO, online), *C. gossypii* (as *Glomerella gossypii*) is present in most of the cotton-producing countries worldwide (Figure 1, Table 2).

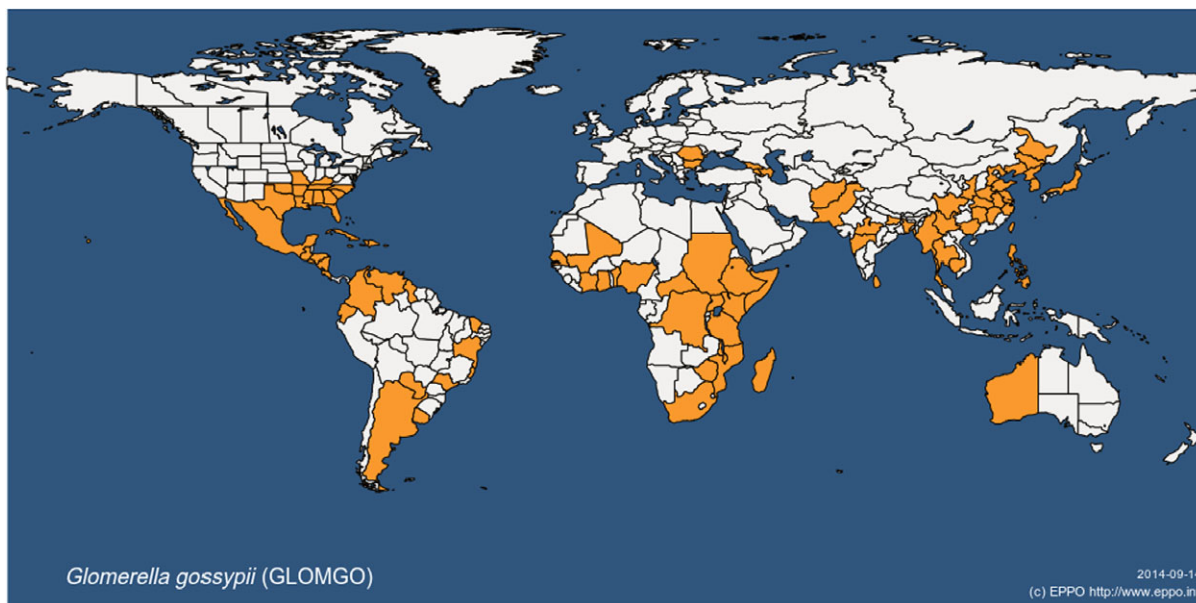


Figure 1: Global distribution map for *Colletotrichum gossypii* (as *Glomerella gossypii*) extracted from the EPPO Global Database accessed on 20/4/2018

Table 2: Global distribution of *Colletotrichum gossypii* (as *Glomerella gossypii*) based on information extracted from the EPPO Global Database (last updated: 9/2/2010; last accessed: 20/4/2018)

Continent	Country	Status
Africa	Benin	Present, widespread
	Central African Republic	Present, no details
	Congo, Democratic republic of the	Present, no details
	Cote d'Ivoire	Present, no details
	Ethiopia	Present, no details
	Ghana	Present, no details
	Kenya	Present, no details
	Madagascar	Present, no details
	Malawi	Present, no details
	Mali	Present, no details
	Mozambique	Present, no details
	Nigeria	Present, no details
	Senegal	Present, no details
	Somalia	Present, no details
	South Africa	Present, widespread
	Sudan	Present, no details
	Tanzania	Present, no details
Uganda	Present, no details	
Zimbabwe	Present, widespread	
America	Argentina	Present, no details
	Barbados	Present, no details
	Bermuda	Present, no details
	Brazil	Present, no details
	Colombia	Present, no details
	Costa Rica	Present, no details
	Cuba	Present, no details

Continent	Country	Status
	Dominican Republic	Present, no details
	Ecuador	Present, restricted distribution
	El Salvador	Present, no details
	Guatemala	Present, no details
	Guyana	Present, no details
	Haiti	Present, no details
	Honduras	Present, no details
	Jamaica	Present, no details
	Mexico	Present, no details
	Nicaragua	Present, no details
	Paraguay	Present, restricted distribution
	Puerto Rico	Present, no details
	Trinidad and Tobago	Present, no details
	United States of America	Present, restricted distribution
	Uruguay	Present, no details
	Venezuela	Present, no details
Asia	Afghanistan	Present, no details
	Bangladesh	Present, widespread
	Cambodia	Present, no details
	China	Present, restricted distribution
	India	Present, no details
	Indonesia	Present, no details
	Japan	Present, restricted distribution
	Korea Dem. People's Republic	Present, no details
	Korea, Republic	Present, no details
	Myanmar	Present, no details
	Pakistan	Present, no details
	Philippines	Present, no details
	Sri Lanka	Present, no details
	Taiwan	Present, few occurrences
Thailand	Present, no details	
Europe (non-EU countries)	Armenia	Present, no details
	Azerbaijan	Present, no details
	Georgia	Present, no details
Oceania	Australia	Present, restricted distribution
	Guam	Present, no details

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?

YES. *Colletotrichum gossypii* is known to be present, but with a restricted distribution, in two EU MSs, i.e. Bulgaria and Romania. The pest is not known to be present in the EU protected zone (Greece)

According to EPPO Global Database (EPPO, online), *C. gossypii* (as *G. gossypii*) is present with a restricted distribution in Bulgaria and Romania.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

Colletotrichum gossypii (as *Glomerella gossypii*) is listed in Council Directive 2000/29/EC. Details are presented in Tables 3 and 4.

Table 3: *Colletotrichum gossypii* (as *Glomerella gossypii*) in Council Directive 2000/29/EC

Annex II, Part B			
Harmful organisms whose introduction into, and whose spread within, certain protected zones shall be banned if they are present on certain plants or plant products			
(c)	Fungi		
	Species	Subject of contamination	Protected zone(s)
1.	<i>Glomerella gossypii</i> Edgerton	Seeds and fruits (bolls) of <i>Gossypium</i> spp.	EL

3.3.2. Legislation addressing the hosts of *Colletotrichum gossypii* (as *Glomerella gossypii*)

Table 4: Regulated hosts and commodities that may involve *Colletotrichum gossypii* (as *Glomerella gossypii*) in Annexes III, IV and V of Council Directive 2000/29/EC

Annex IV, Part B			
Special requirements which shall be laid down by all member states for the introduction and movement of plants, plant products and other objects into and within certain protected zones			
	Plants, plant products and other objects	Special requirements	Protected zone(s)
28.	Seeds of <i>Gossypium</i> spp.	Official statement that: (a) the seed has been acid-delinted, and (b) no symptoms of <i>Glomerella gossypii</i> Edgerton have been observed at the place of production since the beginning of the last complete cycle of vegetation, and that a representative sample has been tested and has been found free from <i>Glomerella gossypii</i> Edgerton in those tests.	EL
28.1.	Seeds of <i>Gossypium</i> spp.	Official statement that the seed has been acid-delinted.	EL, E (Andalucia, Catalonia, Extremadura, Murcia, Valencia)
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			
Section II			
Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for certain protected zones, and which must be accompanied by a plant passport valid for the appropriate zone when introduced into or moved within that zone			
Without prejudice to the plants, plant products and other objects listed in Part I.			
1.8.	Seeds of <i>Beta vulgaris</i> L., <i>Castanea</i> Mill., <i>Dolichos</i> Jacq., <i>Gossypium</i> spp. and <i>Phaseolus vulgaris</i> L.		
1.9.	Fruits (bolls) of <i>Gossypium</i> spp. and unginned cotton, fruits of <i>Vitis</i> L.		

Part B	Plants, plant products and other objects originating in territories, other than those territories referred to in Part A
Section II	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for certain protected zones
	Without prejudice to the plants, plant products and other objects listed in I.
6.	Seeds and fruits (bolls) of <i>Gossypium</i> spp. and unginned cotton.

3.4. Entry, establishment and spread in the EU

Since the pest is regulated only in the EU protected zone of Greece, the pest potential for entry, establishment and spread were evaluated for the protected zone, instead of the whole EU territory.

3.4.1. Host range

Colletotrichum gossypii affects species of the genus *Gossypium* (cotton, Family Malvaceae) (EPPO, online). The two main species of *Gossypium* cultivated for cotton production, *Gossypium hirsutum* and *G. barbadense* (they account for about 95% and 3% of world production, respectively), are both susceptible to the pest (Anonymous, 2007a; EPPO, online). *Gossypium hirsutum* is the only species grown in the protected zone of Greece (Avgoulas et al., 2005).

There are no reports of the pest affecting other genera of the Family Malvaceae (Bailey et al., 1996).

3.4.2. Entry

Is the pest able to enter the EU protected zones? If yes, identify and list the pathways!

Yes. Under the current EU legislation, the pest could potentially enter the EU protected zone (Greece) through the seed pathway. The entry of the pest through the cotton fruits (bolls) and unginned cotton pathways is unlikely because of the end-use of these plant parts. The pest could also potentially enter the protected zone of Greece via natural spread from EU infested areas.

In the absence of the current EU legislation, the PLH Panel identified the following pathways for the entry of *C. gossypii* from infested third countries or EU infested areas into the protected zone of Greece:

- Cotton seeds
- Cotton fruits (bolls), and
- Unginned cotton.

In addition, the pest could potentially enter the protected zone of Greece by natural means (see Section 3.4.4) from EU infested areas.

Of the above-mentioned pathways, the cotton seed is a major pathway of entry. The cotton fruits (bolls) and the unginned cotton pathways are of minor importance because the end-use of these plant parts (clothing, home furnishings, medical supplies, industrial thread, tarpaulins, oil for human consumption, oilseed cake for animal feed) makes unlikely the transfer of the pathogen from the pathway to cotton crops grown in the EU protected zone. Uncertainty exists on whether the pest could enter the protected zone of Greece by natural means from EU infested areas (i.e. Bulgaria, Romania) because there is lack of information on the maximum distance the pest can travel by air currents and/or insects.

Therefore, the cotton fruits (bolls) and the unginned cotton pathways are not further considered in this pest categorisation.

The current EU legislation prohibits the import into the protected zone of Greece of cotton seeds except for acid-delinted seeds that originate in a pest-free place of production or production site and have been found free of the pathogen in appropriate testing in the country of origin.

According to Eurostat (online), during the period 2011–2016, Greece imported 89% of the total volume of cotton seeds imported into the EU28 (Table 5). Of those imports, 1% in 2011 originated from infested third countries. In 2011, 2013 and 2014, Greece imported 201, 96 and 53 tonnes of cotton seeds, respectively, originating in infested EU MS, i.e. Bulgaria (Table 6).

Table 5: Volume (in tonnes) of cotton seed for sowing imported during the period 2011–2015 into the EU protected zone from third countries (Source: Eurostat, extracted on 27/3/2018)

Reporter	2011	2012	2013	2014	2015
EU28	3,995	3,662	1,260	313	854
Greece	3,670	3,505	1,161	246	422
% from infested third countries	1	0	0	0	0

Table 6: Volume (in tonnes) of cotton seed for sowing imported during the period 2011–2015 into the EU protected zone from Bulgaria (Source: Eurostat, extracted on 20/4/2018)

REPORTER	2011	2012	2013	2014	2015
Greece	201	:	96	53	:

: = no data available.

There is no record of interception of *C. gossypii* on cotton in the Europhyt database (online – search performed on 10 March 2018).

3.4.3. Establishment

Is the pest able to become established in the EU protected zones?

Yes. *Colletotrichum gossypii* is already established in the EU territory (Bulgaria and Romania), and the biotic (host availability) and abiotic (climate suitability) factors suggest that it could potentially establish in the protected zone of Greece.

3.4.3.1. EU distribution of main host plants

Cotton is grown in Greece, Spain and to a lesser extent in Bulgaria (Table 7; Source: Eurostat, data extracted on 26/3/2018). Based on FAOstat (data extracted on 20/4/2018), two tonnes of cotton were produced in Romania in 2014. However, no data was found on the area grown with cotton in Romania. According to ISTAT (data extracted on 28/3/2018), in Italy, an area between 0 and 2 ha/year has been grown with cotton during the last 10 years.

Table 7: Area cultivated with *Gossypium* spp. for cotton production in the EU between 2011 and 2015 (in 1,000 ha) - Source: Eurostat, extracted on 26/3/2018

Countries*	2011	2012	2013	2014	2015	Mean of EU area grown with <i>Gossypium</i> spp. (in 1,000 ha)
European Union (28 countries)	Not applicable due to data gaps					
Bulgaria	0.40	0.40	0.00	0.29	2.17	0.652
Greece	238.28	247.55	243.04	280.37	283.24	258.496
Spain	67.12	69.66	63.52	74.27	63.33	67.58

*: During the last 10 years, cotton is also grown in Italy on an area of up to 2 ha/year (ISTAT, online - data extracted on 28/4/2018).

3.4.3.2. Climatic conditions affecting establishment

Colletotrichum gossypii is known to occur in two EU MSs, Bulgaria and Romania (Table 3), which are characterised by humid continental climate, specifically the Dfa (cold, without dry season, dry summer) and the Dfb (cold, without dry season, warm summer) Köppen–Geiger climate types (Peel et al., 2007) (Figure 2). The same climate types occur in the northern part of the protected zone of Greece (Macedonia, Thrace; Figure 2), where cotton is also grown (Tsaliki, 2005; Anonymous, 2007b, 2018). The only area in the rest of the world where these climate types are present in association with *C. gossypii* is the North of Tennessee (USA), which has a Dfa climate type (Figure 3). In the other cotton-growing areas of Greece (central Greece: Thessaly, Sterea Ellada), cotton is grown under Mediterranean climate (specifically, Csa: temperate, dry summer, hot summer). *C. gossypii* is not known to occur in areas characterised by Csa climate type.

Therefore, the abiotic (climate suitability) factors suggest that the pest could potentially establish in the northern part of the EU protected zone (Greece). There is no evidence that the climatic conditions occurring in the other cotton-growing areas of the protected zone of Greece are suitable for the establishment of *C. gossypii*. However, uncertainty exists on whether irrigation, commonly applied to cotton crops in Greece, would favour the establishment of *C. gossypii* in those areas, too.

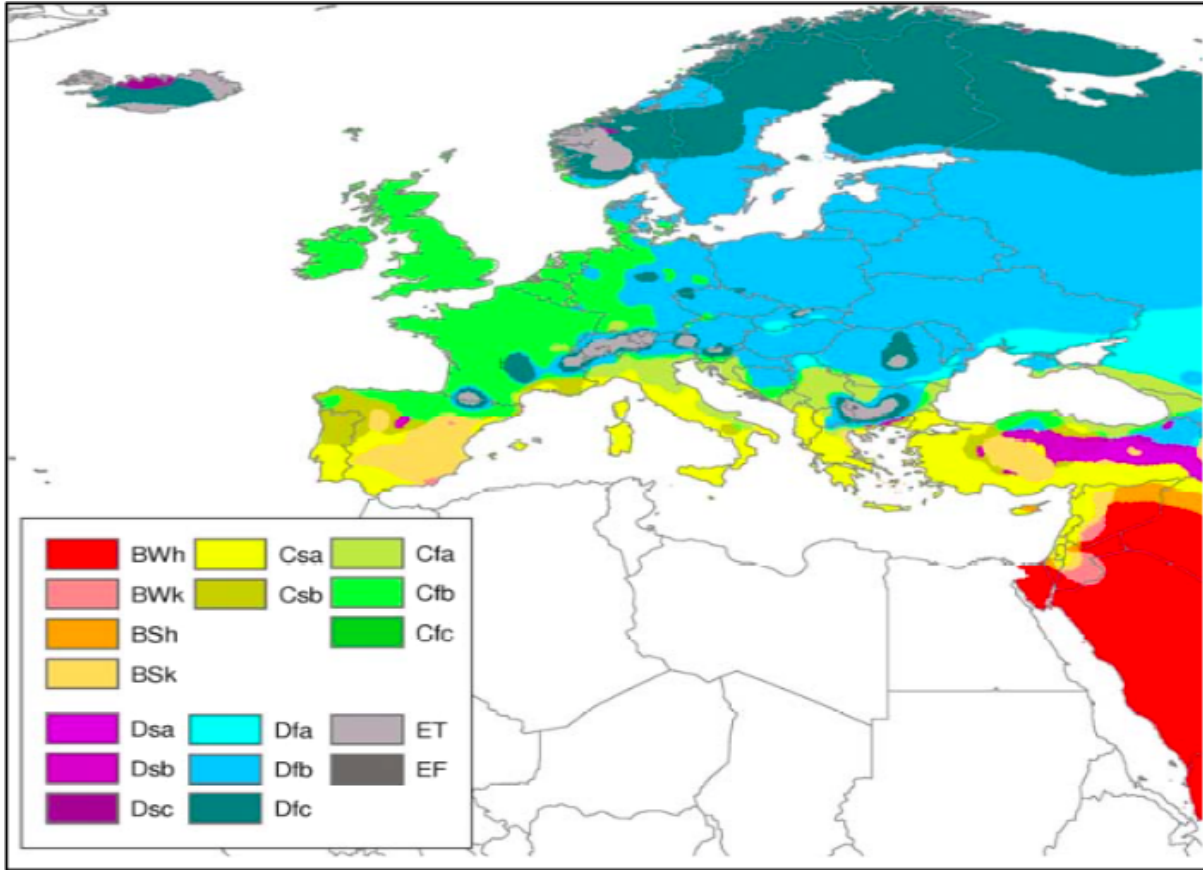


Figure 2: Köppen–Geiger climate type map of Europe, from Peel et al. (2007)

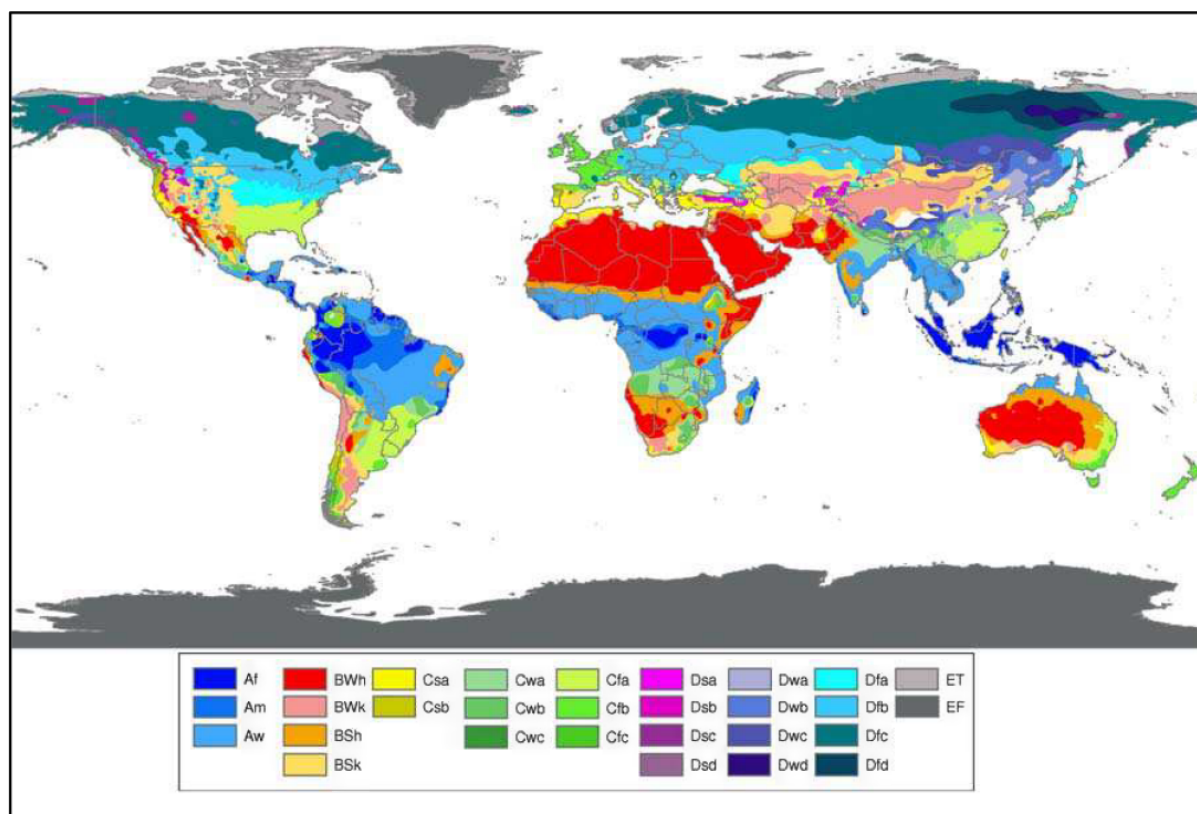


Figure 3: Köppen–Geiger climate type world map from Peel et al. (2007)

3.4.4. Spread

3.4.4.1. Vectors and their distribution in the EU (if applicable)

Is the pest able to spread within the EU protected zones following establishment? **Yes**

How? By natural and human-assisted means

RNQPs: Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?

No. Spread of the pest may occur via cotton seeds for sowing and by natural means.

Once established in the EU protected zone, *C. gossypii* could spread by both natural and human-assisted means.

Spread by natural means. No specific information exists in the available literature on the spread potential of the pathogen by air currents and/or water splash. In general, ascospores are airborne and their discharge from perithecia is triggered by high humidity or rainfall (Kaiser and Lukežic, 1966). Based on the Lagrangian stochastic model of Savage et al. (2012), the majority of fungal spores having the characteristics of the *Glomerella* ascospores can travel up to a distance of 0.5–1 km and only < 1% of them can travel up to 10 km. Ascospores of another *Glomerella* species affecting apple, i.e. *G. cingulata*, have been shown to travel at distances > 60 m within apple orchards (Sutton and Shane, 1983). Conidia generated in water-soluble mucilage, such as those of the *Colletotrichum* species are dispersed over short distances by water run-off and splashed droplets (rain, overhead irrigation) (Nicholson and Moraes, 1980; Fitt et al., 1989; Rajasab and Chawda, 2009). It has been also shown that insects can carry spores of *C. gossypii* passively on their bodies, thus contributing to its spread (Leakey and Perry, 1966). Based on the above, uncertainty exists about the maximum distance the pest can travel by air currents and insects.

Spread by human-assisted means. The pathogen can spread over long distances via the movement of contaminated or infected cotton seeds (Monteiro et al., 2009). Transmission rate from seeds has

been found to be variable and dependent on several factors, such as environmental temperature, soil moisture, infection level and inoculum location in seeds (Teixeira et al., 1997).

3.5. Impacts

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

Yes, the introduction of the pest would potentially cause yield and quality losses to cotton crops grown in the EU protected zone of Greece.

Although cotton anthracnose has become less important as a seedling disease since the general practice of seed treatment with fungicides (EPPO online), it is still prevalent on seedlings and bolls in the more humid parts of eastern USA (Simpson et al., 1973). In north-west Côte d'Ivoire (Boundiali sector), *C. gossypii* has been shown, either alone or in combination with insect larvae, to reduce boll production by about 25%, with 15–18% of bolls being mummified (EPPO, online). The disease also causes reduced length and thickness of fibres and abnormal seed weight (Weir et al., 2012), whereas infected seeds show reduced rate of germination (Leakey, 1962; Tanaka, 1995). In Senegal in the 1970s, rot caused by fungi, including *C. gossypii*, affected 2.7% of bolls, although, in severe cases, 40–60% losses on bolls have been reported. In India, anthracnose became serious in 1953 and, by 1959, it was the limiting factor in cotton production (EPPO, online).

Ramulosis is the most important cotton disease in the Brazilian savanna (Do Nascimento et al., 2006; Moreno-Moran and Burbano-Figueroa, 2017). Without an effective fungicide spray programme, severe yield losses may occur (Cia and Fuzatto, 1999; Paiva et al., 2001; Silva-Mann et al., 2002). The disease severity is high on plants of less than 60 days old, because the new branches emerging after the apical meristem death also become infected (Cia, 1977; Kimati, 1980; Juliatti and Algodão, 1997). Depending upon the climatic conditions and cultivar susceptibility, yield losses can reach more than 85% and individual farmers frequently report total crop losses (Cia, 1977; Carvalho et al., 1994; Do Nascimento et al., 2006). The Sinú Valley, the largest cotton-producing area of Colombia, is the region most severely affected by ramulosis (Oliveira et al., 2010). Without timely fungicide sprays, the disease can provoke total crop loss, especially on smallholders.

Based on the above, it is expected that the introduction and spread of the pathogen in the EU protected zone (Greece) would cause yield and quality losses to cotton production.

3.6. Availability and limits of mitigation measures

Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU protected zones such that the risk becomes mitigated?

Yes, the likelihood of pest entry into the EU protected zone of Greece can be mitigated if cotton seeds are sourced from pest-free areas or pest-free places of production and are acid-delinted and fungicide-dressed as well as lab tested for the detection of *C. gossypii* both at the place of origin and at the entry point of the protected zone. In the infested areas, agricultural practices combined with sanitation and chemical control measures are applied for disease management.

Measures for preventing the entry of the pest into the EU protected zone include:

- sourcing cotton seeds from pest-free areas or pest-free places of production;
- import only certified cotton seed;
- import only acid-delinted and fungicide-dressed cotton seeds;
- phytosanitary certificate for the import into the protected zone of cotton seeds originating in infested third countries;
- phytosanitary passport for the movement of cotton seeds from infested EU areas to the protected zone of Greece;
- laboratory testing of cotton seeds both at the place of origin and at the entry point of the protected zone.

Measures for preventing the establishment of the pest in the EU protected zone:

- surveillance for the early detection of the pathogen;
- use of sanitation measures (e.g. removal of infected plants);

- management of crop residues;
- application of fungicide sprays to the crops.

Measures for preventing the spread of the pest in the EU protected zone:

- prevent the movement within the EU protected zone of cotton seeds sourced from infested areas/places of production;
- prevent the movement within the EU protected zone of cotton seeds, except for acid-delinted seeds that are fungicide-dressed and laboratory tested;
- phytosanitary passport for the movement of cotton seeds within the protected zone.

3.6.1. Phytosanitary measures

In the current EU legislation, the following phytosanitary measures are relevant for the EU protected zone of Greece:

- Pest free place of production
- Seed treatment (i.e. acid-delinted seed)
- Laboratory testing
- Plant health inspection
- Phytosanitary certificate
- Phytosanitary passport.

These measures can mitigate the risk of entry of *C. gossypii* into the protected zone of Greece, but they cannot completely eliminate the pathogen being present on cotton seeds originating in infested countries, as during its saprophytic phase, the pathogen may contaminate the seed of cotton plants that show little or no disease symptoms during the growing season (latently infected plants) (see Section 3.1.2). Using acid to delint seeds is also not fully effective as a phytosanitary measure (see Section 3.6.1.1).

3.6.1.1. Biological or technical factors limiting the feasibility and effectiveness of measures to prevent the entry, establishment and spread of the pest

The following biological and technical factors could potentially limit the feasibility and effectiveness of measures to prevent the entry into, establishment in and spread of *C. gossypii* within in the EU protected zone (Greece):

- The similarity of symptoms caused by *C. gossypii* on cotton seedlings, leaves, stems, bolls and lint with those caused by other cotton pathogens (e.g. *Rhizoctonia solani*, *Fusarium* spp., *Ascochyta gossypii*, *Nematospora* spp., *Xanthomonas axonopodis* pv. *malvacearum*, etc.) and the absence of symptoms on infected cotton seeds make visual inspection for the detection of the pathogen difficult (see Section 3.1.3).
- The acid-delinting procedure may eliminate the inoculum present as contaminant on the surface of the seed, but not that located inside the seed.
- Fungicide dressing usually applied to cotton seed for sowing may reduce the effectiveness of lab testing for the detection of the pathogen.

3.6.2. Pest control methods

In the infested areas, use of high-quality pest-free seed, treating seed with fungicides or acid, application of fungicide sprays during the growing season and crop rotation are the most important measures for the management of anthracnose (Davis, 1981; Hillocks, 1992). Cultural practices, such as destruction of crop residues and fall ploughing, are also used for the reduction of inoculum sources in the field (Davis, 1981). Application of pesticides for the control of insects also reduces infection of bolls by microorganisms, including *C. gossypii* (Pinckard et al., 1981).

In Brazil, management of ramulosis is based on crop rotation and sanitation to reduce inoculum sources, use of cultivars with some level of resistance, and fungicide sprays (Miranda and Suassuna, 2004). Fungicide sprays are required for disease management because most producers plant susceptible cultivars due to the market demand (Cia and Fuzatto, 1999). Growers start applying fungicides for the control of ramulosis when disease severity reaches 2%. This threshold is usually reached within 3 weeks after plant emergence. After that, a calendar-based schedule is followed in which fungicides are applied 4–5 times per crop cycle at intervals of 4 weeks. If increased severity

level is detected, the interval between applications is reduced to 3 weeks, and sometimes 2 weeks. In some cases, as many as eight fungicide sprays are applied during the growing season.

Cultivars may show some tolerance to *C. gossypii* infection and are often used against the more aggressive variant of the pest (*C. gossypii* var. *cephalosporioides* (Carvalho et al., 1984).

Currently, in the EU protected zone of Greece, the only *Gossypium* species cultivated for cotton production, i.e. *G. hirsutum* (Avgoulas et al., 2005), is susceptible to infection by the pest (EPPO, online) and there are no fungicides registered for the control of other diseases on cotton crops (http://www.minagric.gr/syspest/SYSPEST_CROPS_skeyasma.aspx). Therefore, it is expected that the agricultural practices and chemical control methods currently applied to cotton crops in the protected zone of Greece would not prevent the establishment of *C. gossypii*.

3.7. Uncertainty

- 1) **Entry.** Uncertainty exists on whether the pest could enter the protected zone of Greece by natural means from EU infested areas because there is lack of information on the maximum distance the pest can travel by air currents and/or insects (see Section 3.4.4).
- 2) **Establishment.** Uncertainty exists on whether the irrigation applied to cotton crops could make the microclimate in cotton-growing areas of central Greece more favourable for the establishment of the pathogen (see Section 3.4.3.2).
- 3) **Spread.** Uncertainty exists on the maximum distance ascospores and conidia of *C. gossypii* can be disseminated by natural means because of lack of information in the available literature (see Section 3.4.4).
- 4) **Eradication.** It is unknown whether *C. gossypii* has ever been eradicated somewhere. Uncertainty exists whether the spread of the pest by natural means will prevent eradication in case of introduction of *C. gossypii* in a limited area of the protected zone.

4. Conclusions

Colletotrichum gossypii meets the criteria assessed by EFSA for consideration as a potential quarantine pest for the EU protected zone of Greece (Table 8). The criteria for considering *C. gossypii* as a potential regulated non-quarantine pest for the EU are also met since cotton seeds are the main means of spread.

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 protected zone quarantine pest (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the pest (<i>Colletotrichum gossypii</i>) is clearly defined and there are reliable methods for its detection and identification	The identity of the pest (<i>Colletotrichum gossypii</i>) is clearly defined and there are reliable methods for its detection and identification	None
Absence/presence of the pest in the EU territory (Section 3.2)	The pest is present in Bulgaria and Romania and is not known to occur in the protected zone of Greece	The pest is present in Bulgaria and Romania and is not known to occur in the protected zone of Greece	None

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Regulatory status (Section 3.3)	The pest is currently officially regulated on seeds and fruits (bolls) of <i>Gossypium</i> spp. (Dir 2000/29/EC). It is regulated as a quarantine pest in the EU protected zone of Greece (Annex IIB of Dir. 2000/29/EC). There are no requirements for the EU internal trade outside the protected zone	The pest is currently officially regulated on seeds and fruits (bolls) of <i>Gossypium</i> spp. (Dir 2000/29/EC). It is regulated as a quarantine pest in the EU protected zone of Greece (Annex IIB of Dir 2000/29/EC). There are no requirements for the EU internal trade outside the protected zone	None
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	<p>The pest could potentially enter into, become established in and spread within the EU protected zone of Greece</p> <p>Pathways of entry: Cotton seeds originating in infested third countries and/or EU infested areas</p> <p>The pest could also potentially enter the protected zone of Greece by natural spread (wind, insects) from EU infested areas</p>	<p>The pest could potentially spread in the EU protected zone through the movement of cotton seeds and by natural means</p> <p>Cotton seeds is a main means of spread</p>	<ol style="list-style-type: none"> 1) It is not known whether the pest could potentially enter the protected zone by natural means from EU infested areas (Uncertainty 1) 2) There is uncertainty whether the irrigation applied to cotton crops could make the microclimate in cotton-growing areas of Central Greece more favourable for the establishment of the pathogen (Uncertainty 2) 3) There is no information on the maximum distance ascospores and conidia of the pest can travel by natural means (Uncertainty 3)
Potential for consequences in the EU territory (Section 3.5)	The introduction of the pest into the protected zone of Greece would impact cotton yield and quality	The spread of the pest in the EU protected zone of Greece could potentially cause yield and quality losses as regards the intended use of cotton seeds	None

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Available measures (Section 3.6)	<p>There are measures available to prevent the entry into, establishment and spread of the pest within the EU protected zone. These include pest-free area, pest-free place of production, certified cotton seed for sowing, seed treatment with acid and fungicides, application of fungicide sprays to the crop, management of crop residues, crop rotation, etc. Nevertheless, the currently applied phytosanitary measures are not fully effective in preventing the entry of the pest into the protected zone</p> <p>Eradication after introduction of the pest in a new area is considered as difficult because of existing natural means of spread</p> <p>There is not information about successful eradication of the pest somewhere</p>	There are no fully effective measures to prevent pest presence on cotton seeds	It is not known whether the spread of the pest by natural means would prevent eradication in case of introduction of <i>C. gossypii</i> in a limited area of the protected zone (Uncertainty 4)
Conclusion on pest categorisation (Section 4)	<i>Colletotrichum gossypii</i> meets all the criteria assessed by EFSA for consideration as potential quarantine pest for the EU protected zone of Greece	The criteria for considering <i>C. gossypii</i> as a potential regulated non-quarantine pest for the EU are also met since cotton seeds are the main means of spread	None
Aspects of assessment to focus on/ scenarios to address in future if appropriate	None		

References

- Anonymous, 2007a. Cotton Exporter's Guide. International Trade Centre. Product and market development. Genova. 365 p. Available online: <http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/Cotton%20Guide%20August%202013%20small.pdf>
- Anonymous, 2007b. Study on the cotton sector in the European Union. Final Report. LMC International. 282 p. Available online: <https://ec.europa.eu/agriculture/sites/agriculture/files/external-studies/2007/cotton/fulltext.pdf>
- Anonymous, 2018. Greece. Cotton and Products Annual 2018. GAIN Report Number IT1806. USDA Foreign Agricultural Service. 7 p. Available online: https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Cotton%20and%20Products%20Annual_Rome_Greece_3-29-2018.pdf

- Araújo AE, Suassuna ND, Farias FJC and Freire EC, 2003. Escalas de notas para avaliação de doenças foliares do algodoeiro. Available online: www.cnpa.embrapa.br/produtos/algodao/publicacoes/trabalhos_cba4/163.pdf
- Arndt CH, 1944. Infection of cotton seedlings by *Colletotrichum gossypii* as affected by temperature. *Phytopathology*, 34, 861–869.
- Arndt CH, 1946. Effects of storage conditions on survival of *Colletotrichum gossypii*. *Phytopathology*, 36, 24–29.
- Arndt CH, 1953. Survival of *Colletotrichum gossypii* on cotton seeds in storage. *Phytopathology*, 43, 220.
- Arndt CH, 1956. Cotton seed produced in South Carolina in 1934 and 1955, its viability and infestation by fungi. *Plant Disease Reporter*, 40, 1001–1004.
- Avgoulas C, Bouza L, Koutrou A, Papadopoulou S, Kosmas S, Makridou E, Papastylianou P and Bilalis D, 2005. Evaluation of five most commonly grown cotton cultivars (*Gossypium hisrutum* L.) under Mediterranean conditions: productivity and fibre quality. *Journal of Agronomy and Crop Science*, 191, 1–9. Available online: <https://doi.org/10.1111/j.1439-037x.2004.00139.x>
- Bailey JA, Connell O, Pring RJ and Nash C, 1992. Infection strategies of *Colletotrichum* species. In: Bailey JA and Jeger MJ (eds.). *Colletotrichum: Biology and Control*. CAB International, Wallingford. pp. 88–120.
- Bailey JA, Nash C, Morgan LW, O'Connell RJ and TeBeest DO, 1996. Molecular taxonomy of *Colletotrichum* species causing anthracnose on the Malvaceae. *Phytopathology*, 86, 1076–1083.
- Cai L, Hyde KD, Taylor PWJ, Weir BS, Waller JM, Abang MM, Zhang JZ, Yang YL, Phoulivong S, Liu ZY, Prihastuti H, Shivas RG, McKenzie EHC and Johnston PR, 2009. A polyphasic approach for studying *Colletotrichum*. *Fungal Diversity*, 39, 183–204.
- Carvalho LP, Cavalcanti FB, Lima EF and Santos EO, 1984. Effect of ramulosis on fibre characteristics and yield of cotton. *Fitopatologia Brasileira*, 9, 593–598.
- Carvalho LP, Cruz CD, Morais CF and Lima EF, 1994. Hereditariedade da resistência do algodoeiro à ramulose causada por *Colletotrichum gossypii* South var. *cephalosporioides* A. S. Costa. *Revista Ceres, Viçosa*, 41, 245–262.
- Cauquil J, 1960. L' anthracnose du cotonnier en Côte d' Ivoire. *Phytiatrie-Phytopharmacie*, 9, 199–206.
- Cia E, 1977. Ocorrência e reconhecimento das doenças de algodoeiro anual *Gossypium hirsutum* L. no Brasil. *Summa Phytopathologica, Botucatu*, 3, 167–193.
- Cia E and Fuzatto MG, 1999. Cotton disease management. In: Cia E, Freire EC and Santos WJ (eds.). *The Cotton Crop*. Piracicaba, Potafos, SP, Brazil. pp. 121–131 (in Portuguese).
- Cognee N, 1960. Premières observations sur les fontes de semis de cotonniers à la Station de Bambari. *Phytiatrie-Phytopharmacie*, 9, 207–222.
- Converse E, 1919. Report of botany division. Report of South Carolina Agricultural Experimental Station, 32, 29–34.
- Costa AS and Fraga Jr C, 1939. Sobre a natureza de ramulose ou superbrotamento do algodoeiro. *Journal de Agronomia*, 2, 151–160.
- Davis RG, 1981. Anthracnose. In: Watkins GM (ed.). *Compendium of Cotton Diseases*. The American Phytopathological Society, St. Paul, Minnesota, USA. pp. 30–31.
- Davis RG, Bird LS, Chambers AY, Garber RH, Howell CR, Minton EB, Sterne R and Johnson LF, 1981. Seedling disease complex. In: Watkins GM (ed.). *Compendium of Cotton Diseases*. The American Phytopathological Society, St. Paul, Minnesota, USA. pp. 13–20.
- Do Nascimento JF, Zambolim L, Vale FXR, Berger PG and Cecon PR, 2006. Cotton resistance to ramulose and variability of *Colletotrichum gossypii* f. sp. *cephalosporioides*. *Summa Phytopathologica*, 32, 9–15. Available online: <https://doi.org/10.1590/s0100-54052006000100001>
- Edgerton CW, 1909. The perfect stage of the cotton anthracnose. *Mycologia*, 1, 115–120.
- Edgerton CW, 1912. The rots of the cotton boll. *Bulletin of the Louisiana Agricultural Experiment Station*, 137, 113 pp.
- EFSA PLH Panel (EFSA Panel on Plant Health), 2010. PLH Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options by EFSA. *EFSA Journal* 2010;8(2):1495, 66 pp. <https://doi.org/10.2903/j.efsa.2010.1495>
- EPPO (European and Mediterranean Plant Protection Organization), online. EPPO Global Database. Available online: <https://gd.eppo.int> [accessed: April 4, 2018]
- Europhyt, online. The European Network of Plant Health Information System. EUROPHYT database. Available online: <https://europhyt.ec.europa.eu> [accessed: March 10, 2018]
- EUROSTAT, online. Available online: <http://ec.europa.eu/eurostat/web/agriculture/data/database> [accessed: April 20, 2018]
- FAO (Food and Agriculture Organization of the United Nations), 2004. ISPM (International Standards for Phytosanitary Measures) 21—Pest risk analysis of regulated non-quarantine pests. FAO, Rome, 30 pp. Available online: https://www.ippc.int/sites/default/files/documents//1323945746_ISPM_21_2004_En_2011-11-29_Refor.pdf
- FAO (Food and Agriculture Organization of the United Nations), 2013. ISPM (International Standards for Phytosanitary Measures) 11—Pest risk analysis for quarantine pests. FAO, Rome, 36 pp. Available online: https://www.ippc.int/sites/default/files/documents/20140512/ispm_11_2013_en_2014-04-30_201405121523-494.65%20KB.pdf
- Fitt BDL, McCartney HA and Walklate PJ, 1989. The role of rain in dispersal of pathogen inoculum. *Annual Review of Phytopathology*, 27, 241–270.
- Follin JC and Mangano V, 1983. Étude sur la ramulose du cotonnier. Comparaison du *Colletotrichum* responsable à *C. gossypii* Conditions d'attaques. *Coton et Fibres Tropicales*, 38, 209–215.

- Hillocks RJ, 1992. Cotton diseases. In: Hillocks RJ (ed.). CAB International, Wallingford, UK, 415 p.
- ISTAT, online. Database of the Italian National Institute of Statistics – Agriculture and Animal science. Available online: <http://agri.istat.it/jsp/dawinci.jsp?q=plC160000010000012000&an=2009&ig=1&ct=264&id=15A|18A|29A> [Accessed: April 28, 2018]
- Juliatti FC and Algodão RO, 1997. In: Vale FXR and Zambolim L (eds.). Controle de doenças de plantas: grandes culturas. Viçosa, Departamento de Fitopatologia, Universidade Federal de Viçosa, Brasília, Ministério da Agricultura e do Abastecimento, 2, 555–570.
- Kaiser WJ and Lukezic FL, 1966. Occurrence, sporulation and pathogenicity studies with *Glomerella cingulata* associated with crown rot of boxed bananas. *Mycologia*, 58, 397–405.
- Kimati H, 1980. Doenças do algodoeiro. In: Galli F, Tokeshi H, Carvalho PCT, Balmer E, Kimati H, Cardoso CON and Salgado CL (eds.). *Manual de Fitopatologia*. 2nd Edition. São Paulo, Ceres, Brazil. pp. 143–158.
- Leakey CL, 1962. Outbreaks and new records, Uganda. *FAO Plant Protection Bulletin*, 10, 70 p.
- Leakey CL and Perry DA, 1966. The relation between damage caused by insect pests and boll rot associated with *Glomerella cingulata* (*Colletotrichum gossypii*) on Upland cotton in Uganda. *Annals of Applied Biology*, 57, 337–344.
- Lima EF and Chaves GM, 1992. Variabilidade de *Colletotrichum gossypii* var. *cephalosporioides*. *Fitopatologia Brasileira*, Fortaleza, 17, 61–66.
- Lima EF, Carvalho JMFC, Carvalho LP and Costa JN, 1985. Transporte e transmissibilidade de *Colletotrichum gossypii* var. *cephalosporioides* através da semente do algodoeiro. *Fitopatologia Brasileira*, 10, 99–109.
- Ling L, 1944. Factors influencing the development of cotton diseases. *Annals of Applied Biology*, 31, 194–204.
- Malaguti G, 1955. La escobilla del algodón en Venezuela. *Agronomia Tropical*, 5, 73–86.
- Mathieson JT and Mangano V, 1985. Ramulose, a new cotton disease in Paraguay caused by *Colletotrichum gossypii* var. *cephalosporioides*. *Summa Phytopathologica*, 11, 115–118.
- Miranda JE and Suassuna ND, 2004. Guia de identificação e controle das principais pragas e doenças do algodoeiro. Campina Grande: Embrapa CNPA, Circular Técnica 76.
- Monteiro JEBA, Sentelhas PC, Gleason ML, Esker PD and Chiavegato EJ, 2009. Development of ramulosis disease of cotton under controlled environment and field conditions. *Phytopathology*, 99, 659–665.
- Mordue JEM, 1971. *Glomerella cingulata*. Descriptions of Pathogenic Fungi and Bacteria No. 315. CAB International, Wallingford, UK.
- Moreno-Moran M and Burbano-Figueroa O, 2016. First report of *Colletotrichum gossypii* var. *cephalosporioides* causing cotton ramulosis in Colombia. *Plant Disease*, 100, 653.
- Moreno-Moran M and Burbano-Figueroa O, 2017. Dynamics of cotton ramulosis epidemics caused by *Colletotrichum gossypii* var. *cephalosporioides* in Colombia. *European Journal of Plant Pathology*, 149, 443–454.
- Nawaz HH, Usmani A, He Q, Miao WG, Rajaofera N and Liu W, 2018. Development of SNP-based markers to identify *Colletotrichum gossypii* in upland cotton. *Plant Disease*, 0. <https://doi.org/10.1094/PDIS-10-17-1672-RE>
- Nicholson RL and Moraes WBC, 1980. Survival of *Colletotrichum graminicola*: Importance of the spore matrix. *Phytopathology*, 70, 255–261.
- Oliveira MAC, Duarte JB, Morello CL, Suassuna ND and Oliveira AB, 2010. Mixed inheritance in the genetic control of ramulosis (*Colletotrichum gossypii* var. *cephalosporioides*) resistance in cotton. *Genetics and Molecular Research*, 15, 1–9. Available online: <https://www.alice.cnptia.embrapa.br/bitstream/doc/1065802/1/Mixedinheritanceinthegeneticcontrol.pdf>
- Paiva FA, Asmus GL and Araújo AE, 2001. Diseases. In: Cotton: Production Technology. Embrapa Agropecuária Oeste, Brazil. pp. 245–272.
- Peel MC, Finlayson BL and McMahon TA, 2007. Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences*, 11, 1633–1644.
- Pinckard JA, Ashworth LJ, Snow JP, Russell TE, Roncadori RW and Sciombato GL, 1981. Boll rots. In: Watkins GM (ed.). *Compendium of Cotton Diseases*. The American Phytopathological Society, St. Paul, Minnesota, USA. pp. 20–24.
- Rajasab AH and Chawda HT, 2009. Dispersal of the conidia of *Colletotrichum gloeosporioides* by rain and the development of anthracnose on onion. *Grana*, 33, 162–165. Available online: <https://doi.org/10.1080/00173139409428994>
- Saran PE, 2009. Manual de Doenças do Algodoeiro. FMC Agricultural Products. Available online: www.fmcdireto.com.br/portal/manuais/doencas_algodoeiro/index.html
- Savage D, Barbetti MJ, MacLeod WJ, Salam MU and Renton M, 2012. Mobile traps are better than stationary traps for surveillance of airborne fungal spores. *Crop Protection*, 36, 23–30.
- Shear CL and Wood AK, 1907. Ascogenous forms of *Gloeosporium* and *Colletotrichum*. *Botanical Gazette*, 43, 259.
- Silva-Mann R, Salgado KCC, Vieira MGGC and Machado JC, 2002. Variabilidade genética de isolados do complexo *Colletotrichum* associados a semente de algodoeiro por meio de técnicas moleculares e inoculação em plantas. *Fitopatologia Brasileira*, 27, 27–32. Available online: <https://doi.org/10.1590/s0100-41582002000100004>
- Silva-Mann R, Vieira MGC, Machado JC, Bernardino Filho JR, Salgado KCC and Stevens MR, 2005. AFLP markers differentiate *Colletotrichum gossypii* from *C. gossypii* var. *cephalosporioides*. *Fitopatologia Brasileira*, 30, 169–172.

- Simpson ME, Marsh PB and Filsinger EC, 1973. Geographical localization of infections of cotton bolls with *Colletotrichum gossypii*. Plant Disease Reporter, 57, 828–832.
- Southworth EA, 1891. Anthracnose of cotton. Journal of Mycology, 6, 100–105.
- Sutton BC, 1992. The genus *Glomerella* and its anamorph *Colletotrichum*. In: Bailey JA and Jeger MJ (eds.). Colletotrichum: Biology, Pathology and Control. CABI, Wallingford, UK. pp. 1–26.
- Sutton TB and Shane WW, 1983. Epidemiology of the perfect stage of *Glomerella cingulata* on apples. Phytopathology, 73, 1179–1183.
- Tanaka MAS, 1995. Problemas da detecção do agente causal da ramulose em sementes de algodão. In: Menten JOM (ed.). Patógenos em Sementes: Detecção, Danos e Controle Químico. São Paulo, Ciba Agro. pp. 93–108.
- Teixeira H, Machado JC and Vieira MGGC, 1997. Influência de *Colletotrichum gossypii* South.no desenvolvimento inicial do algodão (*Gossypium hirsutum* L.) em função da função da localização do inóculo e desinfestação das sementes. Revista Brasileira de Sementes, 19, 9–13.
- Tsaliki E, 2005. Cotton situation in Greece. NAGREF-Cotton and Industrial Plants Institute. 8 p. Available online: https://www.icac.org/cotton_school/research_associate_prog/res_prog_05/greece.pdf
- Watkins GM, 1981. Escobilla (Witches' Broom). In: Watkins GM (ed.). Compendium of Cotton Diseases. The American Phytopathological Society, St. Paul, Minnesota, USA. pp. 31–32.
- Weindling R, Miller PR and Ullstrup AJ, 1941. Fungi associated with diseases of cotton seedlings and bolls with special consideration to *Glomerella gossypii*. Phytopathology, 31, 158–167.
- Weir BS, Johnston PR and Damm U, 2012. The *Colletotrichum gloeosporioides* species complex. Studies in Mycology, 73, 115–180.

Abbreviations

DG SANTÉ	Directorate General for Health and Food Safety
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
MS	Member State
PLH	EFSA Panel on Plant Health
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference