

EPPO Datasheet: *Colletotrichum gossypii*

Last updated: 2023-02-07

IDENTITY

Preferred name: *Colletotrichum gossypii*

Authority: Southworth

Taxonomic position: Fungi: Ascomycota: Pezizomycotina: Sordariomycetes: Hypocreomycetidae: Glomerellales: Glomerellaceae

Other scientific names: *Glomerella gossypii* Edgerton

Common names: anthracnose of cotton, pink boll rot of cotton, seedling blight of cotton

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EPPO Categorization: A2 list

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EU Categorization: PZ Quarantine pest ((EU) 2019/2072 Annex III)

EPPO Code: GLOMGO



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Notes on taxonomy and nomenclature

The fungus that was found to cause anthracnose of cotton in the USA was first described by Southworth (1809) who named it *Colletotrichum gossypii*; subsequently it was referred to as the teleomorph form *Glomerella gossypii* (Edgerton, 1909).

Weir *et al.* (2012) reviewed the history of the taxonomy of the *Colletotrichum gloeosporioides* complex and described how von Arx (1957) considered *C. gossypii* to be a synonym of *C. gloeosporioides* and also how von Arx & Muller (1954) regarded *G. gossypii* to be a synonym of *Glomerella cingulata*; they stated that modern authors recognise two pathogens of cotton, *C. gossypii* and its variant *C. gossypii* var. *cephalosporioides*. The variant has been reported to cause a different disease on cotton known as ramulosis or witches' broom. Using rDNA sequencing, Bailey *et al.* (1996) found the two to be 99.5% homologous to each other and 97% homologous to *C. gloeosporioides*; they considered isolates of both organisms obtained from cotton to be *forma speciales* of *C. gloeosporioides*. Using AFLP analysis, Silva-Mann *et al.* (2005) also considered *C. gossypii* to be genetically distinct from *C. gossypii* var. *cephalosporioides*.

Weir *et al.* (2012) stated that due to the limited availability of DNA sequences of isolates of both pathogens, their relationship with the *C. gloeosporioides* species complex could not be resolved and further work was needed. EFSA (2018) and CABI (2022) wonder whether *C. gossypii* var. *cephalosporioides* is truly distinct from *C. gossypii*. CABI (2022) also stated that witches' broom symptoms are not typically caused by a *Colletotrichum* pathogen; they wondered if the symptoms might be the result of a disease complex involving *C. gossypii* (unpublished data, in CABI, 2022), with further studies being needed to determine if the two are distinct. Needless to say, a recent paper does consider them to be distinct. By inoculating growing plants of cotton, Oliveira *et al.* (2022) found that cultures considered to be *C. gossypii* expressed anthracnose symptoms, whereas ramulosis symptoms were observed only in plants inoculated with *C. gossypii* var. *cephalosporioides*.

This datasheet covers *C. gossypii* and *C. gossypii* var. *cephalosporioides*.

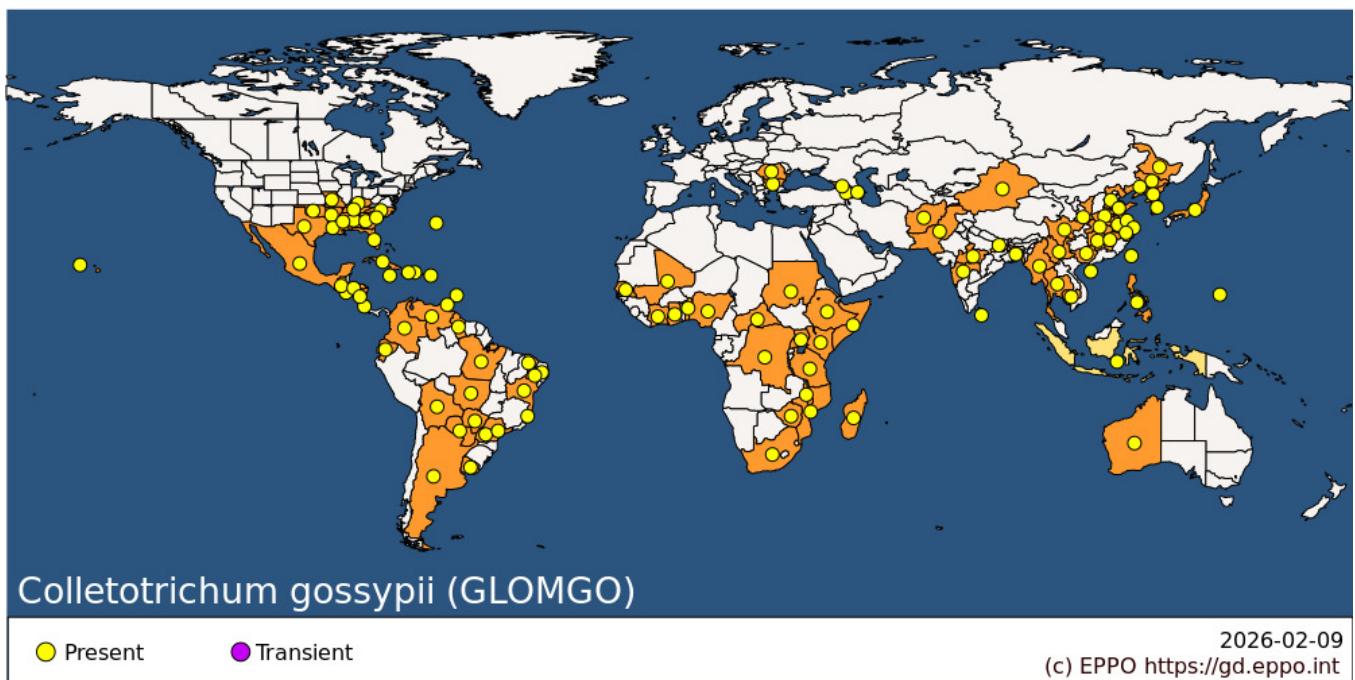
HOSTS

The main host is cotton (*Gossypium*) and the two main species which are cultivated for cotton production, *G. hirsutum* and *G. barbadense*, are susceptible. Tomato (*Solanum lycopersicum*) has recently been identified as a natural host for the first time (Nawaz *et al.*, 2019).

Host list: *Gossypium anomalum*, *Gossypium arboreum*, *Gossypium barbadense*, *Gossypium davidsonii*, *Gossypium herbaceum*, *Gossypium hirsutum*, *Gossypium thurberi*, *Gossypium*, *Solanum lycopersicum*

GEOGRAPHICAL DISTRIBUTION

C. gossypii was originally reported from the USA (Southworth, 1891, Edgerton, 1909) and now occurs in most cotton-growing areas throughout the world, although it tends to be localised in the higher rainfall areas (Hillocks, 2001). There are uncertainties as to the current distribution of the pathogen as many records held by EPPO date back to before 1975.



EPPO Region: Armenia, Azerbaijan, Bulgaria, Georgia, Romania

Africa: Benin, Central African Republic, Congo, The Democratic Republic of the, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Nigeria, Senegal, Somalia, South Africa, Sudan, Tanzania, United Republic of, Uganda, Zimbabwe

Asia: Afghanistan, Bangladesh, Cambodia, China (Anhui, Guangxi, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong, Shanghai, Sichuan, Xinjiang, Yunnan, Zhejiang), India (Bihar, Madhya Pradesh, Maharashtra), Indonesia, Japan (Honshu), Korea, Democratic People's Republic of, Korea, Republic of, Myanmar, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand

North America: Mexico, United States of America (Alabama, Arkansas, Florida, Georgia, Hawaii, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas)

Central America and Caribbean: Barbados, Bermuda, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Puerto Rico, Trinidad and Tobago

South America: Argentina, Bolivia, Brazil (Bahia, Ceara, Espirito Santo, Mato Grosso, Mato Grosso do Sul, Para, Paraiba, Parana, Pernambuco, Sao Paulo), Colombia, Ecuador, Guyana, Paraguay, Uruguay, Venezuela

Oceania: Australia (Western Australia), Guam

BIOLOGY

C. gossypii is primarily transmitted through seed in which it remains latent until the seed is planted. It may also

overwinter in the field in infected cotton plant debris on which fruiting bodies of the sexual stage known as perithecia are formed. In the presence of water (rain, irrigation) or humidity, these structures forcibly release ascospores which are the primary inoculum source for a growing crop; these are disseminated by air currents.

Optimum conditions for infection of cotton seedlings are high relative humidity, abundant rainfall and 25°C (Hillocks, 2001). However, where wounds are present (mechanical damage or insect feeding) infection can occur regardless of humidity levels (Leakey & Perry, 1966). Arndt (1956) found that the degree of infestation of cotton seed was directly related to the amount and frequency of rainfall at boll opening.

During the growing season, usually, only the conidial spore stage is seen on the cotton plant. These asexual spores are produced in a mucilaginous mass in acervuli and are spread by rain; they have the potential to be spread passively by insects (e.g. *Dysdercus* spp.) that feed on cotton, as they can carry spores on their bodies (Leakey & Perry, 1966).

For ramulosis, Monteiro *et al.* (2009) found that the optimum temperature for disease development with *C. gossypii* var. *cephalosporioides* was 27°C, and the average latent period at that temperature was 10 days. Maximum disease severity occurred from 20 to 30°C, with sharp decreases in severity at lower and higher temperatures. Disease severity increased with leaf wetness duration and cumulative rainfall.

Moreno-Moran & Burbano-Figueroa (2017) found that severe epidemics of ramulosis on cotton in Colombia were mainly driven by rainfall which was dependent on planting date, however the effect of temperature and relative humidity on disease development was negligible.

Infection of the fruits (bolls) leads to seed infection (Hillocks, 2001) and seed contamination. The pathogen can also survive saprophytically on dead or healthy stems without causing symptoms (Hillocks, 2001).

The recent report of infection of tomato, Nawaz *et al.*, 2019 supposed that the inoculum originated from nurseries of cotton plants located nearby.

DETECTION AND IDENTIFICATION

Symptoms

All parts of the cotton plant can become infected by *C. gossypii* at all stages of growth. The disease is most serious on seedlings and bolls. EFSA (2018) reviewed the literature on symptom expression and their findings are summarised below:

- - Where seedlings become infected, spots appear on the cotyledons and a reddish-brown cortical rot occurs at the base of the hypocotyl. This leads to girdling, yellowing of the leaves and post-emergence damping-off;
- - On mature plants, lesions may also develop on the stems and leaves, sometimes producing a scald-like effect. When infection is severe, leaf tissue becomes necrotic around the main veins;
- - As a result of infection during flowering, initial symptoms on bolls normally occur near the tip. Small, round, water-soaked spots appear on the capsule, these enlarge, become sunken and ultimately develop reddish borders with a pink centre. When bolls become severely infected, they mummify becoming hard and dark in appearance and they fail to open. Lint from diseased bolls is often pink and of poor quality and seeds and lint are often destroyed. If the boll matures before such damage occurs, it usually opens.

Under dry conditions, lesions may be grey in colour. Under conditions which are favourable to the pathogen, acervuli form and the conidial mass may appear pink.

Symptoms purported to be caused by *C. gossypii* var. *cephalosporioides* include nearly circular spots at first on leaves, petioles and branches, progressing to 'crispy' leaves, star-shaped lesions and shot holes, as well as necrosis of the apical meristem leading to excessive sprouting of lateral buds with witches' broom type symptoms (Moreno-Moran & Burbano-Figueroa, 2017). Artificial inoculation of the meristem of cotton plants by *C. gossypii* var. *cephalosporioides* has been shown to cause ramulosis (Oliveira *et al.*, 2022).

The first report of *C. gossypii* on tomato described the symptoms as light grey, irregular spots (0.6 to 6 cm in diameter) on leaves, and severe defoliation (Nawaz *et al.*, 2019).

Morphology

The anamorph was first described by Southworth (1891) and the teleomorph was described in 1909 (Edgerton, 1909).

There are no reliable morphological descriptions of *C. gossypii* available. Hillocks (2001) provides the following: Conidia (9-24 x 3-6 µm) are oblong, rounded at both ends, and aseptate and are produced in acervuli with numerous setae. Ascospores are produced in dark brown to black globose perithecia (85-300 µm in diameter) embedded in the host tissue. Ascii are clavate to cylindrical, thickened at the apex, and contain eight ascospores. Ascospores (12-20 x 5-8 µm) are hyaline, oval to cylindrical or fusiform, sometimes slightly curved and unicellular.

Detection and inspection methods

C. gossypii can be detected and identified based on association with the host, the symptoms it causes and its characteristics when grown on agar media. CABI (2022) advise culturing suspect tissues on nutrient-rich agar (e.g. PDA) to promote aerial mycelium and pigment production, and on a nutrient poor medium (e.g. PCA) to encourage conidiomata and conidia; they also advise that film cultures to study appressorium morphology are necessary. Molecular methods have recently been developed: e.g. Nawaz *et al.* (2018) described a reliable molecular method based on the b-tubulin gene which allows putative *C. gossypii* in culture to be differentiated from other species in the *C. gloeosporioides* species complex; Figueiro de Almeida *et al.* (2020) developed a PCR test to detect *C. gossypii* and *Colletotrichum gossypii* var. *cephalosporioides* in seed.

A seed testing method involving germination of seeds and detection of symptoms on seedlings which was developed by Halfon-Meiri & Volcani (1977) has been recommended in EPPO Standard PM 3/41 *Glomerella gossypii*. Inspection and test methods for cotton seeds.

PATHWAYS FOR MOVEMENT

Local spread is via the movement of spores by air or via insects on which *C. gossypii* can be carried as a contaminant (Leakey & Perry, 1966). The maximum distance spores will travel is uncertain as there are no specific data for the pathogen. However, as an indication of potential spread, ascospores of *G. cingulata* have been shown to travel more than 60 m in apple orchards (Sutton & Shane, 1983); conidia of both forms of *C. gossypii* form in water soluble mucilage which will only allow short distance spread via water run-off and water splash.

Over long distances and in international trade, movement will mainly be with infected cotton seeds. Cotton fruits (bolls), and unginned cotton (cotton that has not been processed) are possible pathways, but the end-uses of the fruits and the unginned cotton makes it unlikely that the pathogen could transfer to cotton crops (EFSA, 2018).

Movement of infected plants of cotton could facilitate movement of the pathogen but there is no such trade known.

The recent finding of *C. gossypii* on tomato plants in China (Nawaz *et al.*, 2019) raises uncertainties about the risks from movement of seeds, plants and fruit of tomato but there are no other records on tomato to date and no studies on seed transmission in tomato seed.

PEST SIGNIFICANCE

Economic impact

No up-to-date statistics on the economic impact of the pathogen could be found. However, without treatment the pathogen can have a significant impact. Recent scientific articles mentioning impact mainly refer to *C. gossypii* var. *cephalosporioides* in Brazil. Recent reviews of cotton diseases (e.g. Chohan *et al.*, 2020) do not mention *C. gossypii*

as a major disease.

Cotton anthracnose became less important as a seedling disease due to the use of pest-free seed (either treated or certified).

The disease used to be prevalent on seedlings and bolls in the more humid parts of the Eastern USA, possibly as a result of cultural methods to increase vegetative growth (Simpson *et al.*, 1973). There are a number of historic reports of economic impact, for example, in the north-west of the Côte d'Ivoire, *G. gossypii* (as it was then known) was shown, either alone or in combination with insect larvae, to reduce boll production by about 25%, with 15-18% of bolls being mummified (Cauquil, 1960).

The disease also reduced the length and thickness of cotton fibres and caused abnormal seed weight (Weir *et al.*, 2012); infected seeds show a reduced rate of germination (Leakey, 1962; Tanaka, 1995).

Although there appears to be some debate as to whether *C. gossypii* var. *cephalosporioides* is a separate entity to *C. gossypii*, there is recent experimental evidence that the former causes ramulosis symptoms whereas the latter does not (Oliveira *et al.*, 2022). Ramulosis is considered to be the most important cotton disease in the Brazilian savanna (Do Nascimento *et al.*, 2006; Moreno-Moran & Burbano-Figueroa, 2017). Without an effective fungicide spray programme, severe yield losses may occur (Cia & Fuzatto, 1999; Paiva *et al.*, 2001; Silva-Mann *et al.*, 2002). On plants of less than 60 days old, disease severity is high, since new branches emerging after apical meristem death also become infected (Cia, 1977; Kimati, 1980; Juliatti & Algodão, 1997). Yield losses can reach more than 85% depending upon climatic conditions and cultivar susceptibility; individual farmers have frequently reported complete crop losses (Cia, 1977; Carvalho *et al.*, 1994; Do Nascimento *et al.*, 2006) but the current situation is unknown. The Sinú Valley, the largest cotton-producing area of Colombia, has been the region most severely affected by ramulosis (Oliveira *et al.*, 2010).

Control

In areas where *C. gossypii* is present, to reduce the risk of cotton anthracnose, the use of healthy seed and treating seed with fungicides and/or acid along with the application of fungicide sprays (where approved) during the growing season and crop rotation are the most effective measures for production of a healthy cotton crop (Davis, 1981; Hillocks, 2001). As with other diseases, cultural practices, such as the destruction of crop residues and ploughing in the autumn are also used for the reduction of inoculum sources in the field (Davis, 1981). The use of pesticides to control insect pests also reduces the risk of infection of bolls (Pinckard *et al.*, 1981).

Management of ramulosis caused by *C. gossypii* var. *cephalosporioides* in Brazil is based on the use of pest-free seed, crop rotation and sanitation to reduce inoculum sources, use of cultivars with some level of resistance, and fungicide sprays (Miranda & Suassuna, 2004; Guerra, 2005; Goulart, 2021). Fungicide sprays have been required for disease management because most producers used to plant susceptible cultivars due to the market demand (Cia & Fuzatto, 1999). Cultivars may show some tolerance to *C. gossypii* infection and were often planted to reduce the risk of infection of *C. gossypii* var. *cephalosporioides* (Carvalho *et al.*, 1984). As of 2021, no resistant cultivars were available in Brazil (Goulart, 2021).

Phytosanitary risk

C. gossypii is of minor economic importance in the EPPO countries where it now occurs, as in general, cotton is not grown in high-rainfall areas within the EPPO region; and these are the conditions which most favour the disease. It may be noted that as of 2016 cotton ('Seed cotton, unginned') was no longer reported as grown in Romania (FAOSTAT, 2023). In the EPPO region, several countries are major cotton producers (e.g. Turkey, Greece, Uzbekistan; Khan *et al.*, 2020). The use of irrigation where necessary in cotton crops would increase the risk of disease should *C. gossypii* (including *C. gossypii* var. *cephalosporioides*) be introduced to countries where it is currently not known to occur such as Greece. Based on pest distribution and climate matching, EFSA (2018) considered that, in the EU, *C. gossypii* could establish and spread in cotton-producing areas of Northern Greece. 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 and, at the time of writing, there were no fungicides registered for the control of other (unspecified) diseases in cotton crops that may occur there (EFSA, 2018) so it is assumed that control would be difficult. In recent years, the demand for organic cotton has been growing worldwide

and this may increase the risk of impact of this disease.

PHYTOSANITARY MEASURES

Cotton seed should be pest-free. This can be achieved by importing seed from pest-free areas or pest-free places of production, or producing seed within a certification scheme (including inspection and testing). Seed may also be treated (acid-delinted and fungicide-dressed).

EFSA (2018) reviewed measures available for the EU Protected Zone of Greece and concluded that the risk of entry could be reduced 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 laboratory tested for the detection of *C. gossypii* both at the place of origin and at the entry point of the Protected Zone. These measures were considered by EFSA to be required in combination as they were concerned that during its saprophytic phase, the pathogen may contaminate the seed of cotton plants that have shown few or no disease symptoms during the growing season (latently infected plants).

As tomato has only been recently recorded as a host and in only one location (Nawaz *et al.*, 2019), and seed transmission is as yet unproven, measures are not yet specifically recommended for tomato.

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1982 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2023. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the

database. For other sections, the date of last revision is indicated on the right.

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