EPPO Datasheet: *Elsinoë fawcettii*

Last updated: 2020-10-27

IDENTITY

Preferred name: *Elsinoë fawcettii*
Authority: Bitancourt & Jenkins
Taxonomic position: Fungi: Ascomycota: Pezizomycotina: Dothideomycetes: Dothideomycetidae: Myriangiales: Elsinoaceae
Other scientific names: *Elsinoe fawcettii* Bitancourt & Jenkins, *Ramularia scabiosa* McAlpine & Tryon, *Sphaceloma citri* (Butler) Ciferri, *Sphaceloma fawcettii var. scabiosa* (McAlpine & Tryon) Jenkins, *Sphaceloma fawcettii* Jenkins, *Sporotrichum citri* Butler
Common names: common scab of orange, scab of citrus, scab of mango, scab of sour orange
view more common names online...
EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: ELSIFA

more photos...

Notes on taxonomy and nomenclature

Scab diseases of citrus are caused by two *Elsinoë* species, *E. fawcettii* (citrus scab) and *E. australis* (sweet orange scab); *E. fawcettii* being more widely spread than *E. australis. E. fawcettii* was the first species described causing citrus scab. This description was based on the asexual morph *Sphaceloma fawcettii* (Jenkins, 1925) which is currently synonymized with *Sphaceloma citri*, *S. citri* var. *scabiosae*, *S. fawcettii* var. *scabiosae* and a number of species in other genera. The perfect stage, *E. fawcettii*, was later described from Brazil (Bitancourt & Jenkins, 1936). According to the 'one fungus/one name rule' (Hawksworth *et al.*, 2011) adopted in fungal nomenclature, the preferred name is now *E. fawcettii*.

E. fawcettii has high intraspecific diversity and comprises many pathotypes described based on host range (Hou *et al.*, 2014; Hyun *et al.*, 2009; Timmer *et al.*, 1996; Than *et al.*, 1996). Hyun *et al.*, (2009) obtained the delimitation and geographic distribution of at least six pathotypes (FBHR, FNHR, SGGC, Tryon's, Sweet orange and Lemon) based on pathogenicity tests on eight differential hosts including 61 isolates of *E. fawcettii* from six countries. The number of *E. fawcettii* pathotypes described increased to 11 when Hou *et al.* (2014) used 46 Chinese isolates on nine different citrus species.

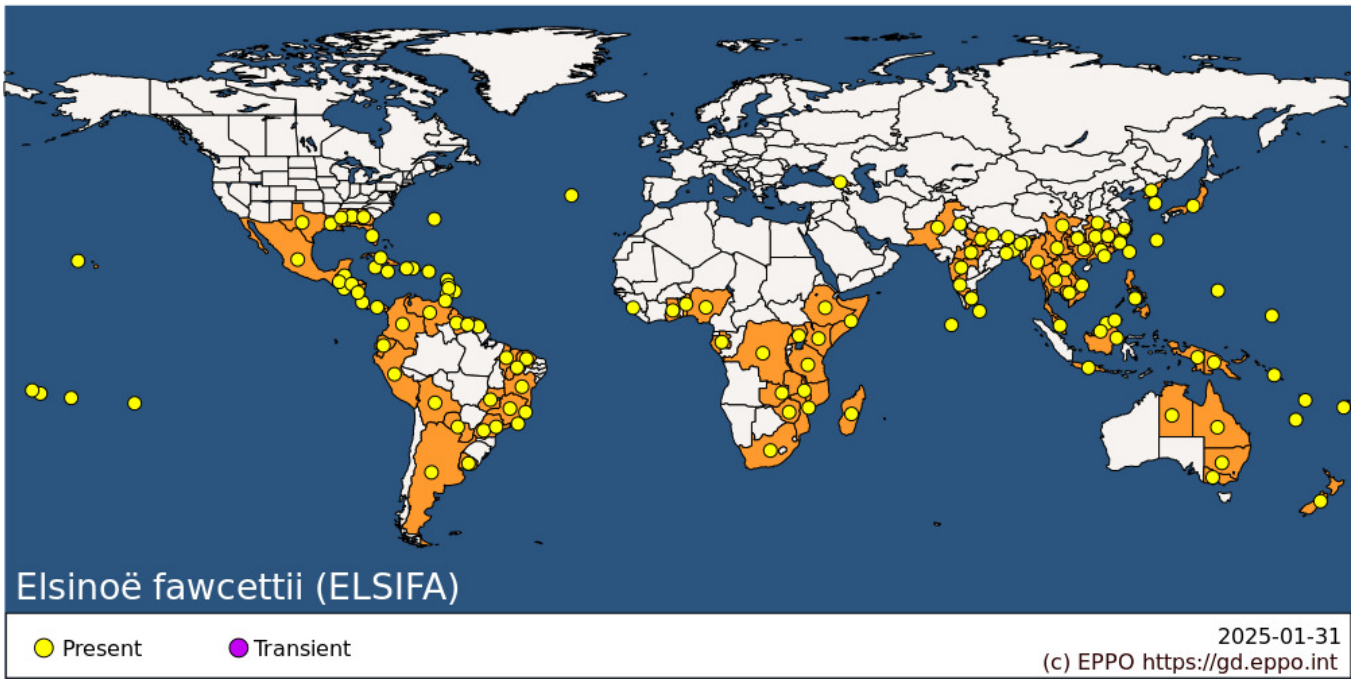
HOSTS

E. fawcettii is a pathogen capable of infecting diverse host plants in the family of Rutaceae, mainly *Citrus* species and their cultivars and hybrids. Highly susceptible hosts are sour oranges (*Citrus aurantium*), lemons (*C. limon*), grapefruits (*C. paradisi*), mandarins (*C. reticulata*), and tangelos (*C. paradisi* x *C. reticulata*). Many other species and hybrids of Rutaceae include susceptible or moderately susceptible cultivars or clones, e.g. calamondins (*C. madurensis*), x *Citrofortunella microcarpa*, *Citroncirus, C. deliciosa*, *C. limonia*, *C. nobilis*, *Poncirus trifoliata*, rough lemons (*C. jambhiri*) and satsumas (*C. unshiu*). Some cultivars of kumquats (*Fortunella* spp.), limes (*C. aurantiifolia*) are incidental hosts. Not susceptible or immune citrus types are sweet orange (*C. sinensis*), pummelo (*C. grandis*).

Host list: *Citroncirus, Citrus hystrix, Citrus maxima, Citrus medica, Citrus reticulata, Citrus trifoliata, Citrus x aurantiifolia, Citrus x aurantium var. deliciosa, Citrus x aurantium var. paradisi, Citrus x aurantium var. sinensis, Citrus x aurantium var. unshiu, Citrus x aurantium, Citrus x latifolia, Citrus x limon, Citrus x limonia var. jambhiri, Citrus x limonia, Citrus x nobilis, Citrus x tangelo, Citrus, Fortunella japonica, Fortunella margarita, Fortunella, x Citrofortunella microcarpa*

GEOGRAPHICAL DISTRIBUTION

Citrus scab caused by *E. fawcettii* is widely distributed, but mainly occurs in humid citrus-growing regions in the world. Although both the anamorph *Sphaceloma fawcettii* and the teleomorph *E. fawcettii* have been described based on material collected in São Paulo, Brazil, there is not sufficient information available to consider that the origin of the fungus is in Brazil or in South America. In addition, the distribution history of citrus scab caused by *E. fawcettii* is unknown. Citrus-growing regions in the tropics are particularly affected by scab disease. In the North Temperate Zone, the disease distribution is still restricted, and Georgia is presently the only country in the EPPO region with a confirmed record.



EPPO Region: Georgia, Portugal (Azores)
Africa: Benin, Congo, Democratic republic of the, Ethiopia, Gabon, Ghana, Kenya, Madagascar, Malawi, Mozambique, Nigeria, Sierra Leone, Somalia, South Africa, Tanzania, Uganda, Zambia, Zimbabwe
Asia: Bangladesh, Brunei Darussalam, Cambodia, China (Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan, Xianggang (Hong Kong), Yunnan, Zhejiang), India (Assam, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Punjab, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal), Indonesia (Irian Jaya, Java, Kalimantan), Japan (Honshu, Ryukyu Archipelago), Korea Dem. People's Republic, Korea, Republic, Laos, Malaysia (Sabah, Sarawak, West), Maldives, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam
North America: Mexico, United States of America (Alabama, Florida, Georgia, Hawaii, Louisiana, Mississippi, Texas)
Central America and Caribbean: Barbados, Belize, Bermuda, Cayman Islands, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Nicaragua, Panama, Puerto Rico, Saint Lucia, Trinidad and Tobago
South America: Argentina, Bolivia, Brazil (Bahia, Ceara, Espirito Santo, Goias, Maranhao, Minas Gerais, Parana, Piaui, Rio de Janeiro, Sao Paulo), Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela
Oceania: American Samoa, Australia (New South Wales, Northern Territory, Queensland, Victoria), Cook Islands, Fiji, French Polynesia, Guam, Micronesia, New Caledonia, New Zealand, Papua New Guinea, Samoa, Solomon Islands, Vanuatu

BIOLOGY

Inoculum for new infections consists mainly of conidia. These are produced in the acervuli on the surface of scab lesions on young fruits and leaves throughout the year. *E. fawcettii* produces two types of conidia: hyaline conidia and coloured, spindle-shaped conidia. Hyaline conidia are one-celled, elliptical, and represent the primary source of

inoculum. Their survival and infectious ability are reliant on wet conditions, and they quickly die if exposed to dry conditions. Spindle-shaped, dark-pigmented conidia are formed on scab lesions and may germinate to produce hyaline conidia (Timmer *et al*., 1996; Whiteside, 1975). Conidia are formed abundantly on wet scabs, in a nearly saturated atmosphere at optimum temperature between 20 and 28°C. Dispersal occurs mainly by rain or water splash, but winds in excess of 2 $m.s^{-1}$ can disseminate spindle-shaped conidia over short distances. Infection severity depends on the available inoculum load and the incidence of wetting periods. Germination of conidia and infection do not require liquid water, both processes being possible with dew, fog or under high moisture conditions. A minimum wetness period of 1-2 h is needed for sporulation, while a wet period of 2.5-3.5 h is needed for conidial infection (Timmer, 2000). Scab incidence is usually much higher in low areas with frequent wetting, compared to elevated areas (Chung, 2011). The temperature range required for germination of conidia is 13-32°C, but infection does not take place below 14°C or above 25°C (Whiteside, 1975). The incubation period is of at least 5 days. The optimal temperature for disease development is 24-27°C (Timmer, 2000).

The sexual form of *E. fawcettii* is very uncommon and has been reported only in Brazil (Bitancourt & Jenkins, 1936). Stromata contain numerous spherical asci, each harboring eight filamentous hyaline ascospores (Holliday, 1980). There is no information available on the role played by the ascospores in the disease propagation.

Leaves, shoots and fruits are infected when they are young, with variable infection periods. Leaves are susceptible to infection just after emergence until they reach 25 % expansion, they become tolerant when reaching one half of their full size. Immature fruits are susceptible to infection from the petal fall until up to 2-3 months.

E. fawcettii is able to survive in scab pustules on leaves, fruits and twigs remaining on the tree (Chung, 2011), providing the inoculum for the next season. Even in resistant cultivars, the fungus can survive on diseased shoots sprouting from susceptible rootstocks (Whiteside, 1975, 1988; Yamada, 1961).

DETECTION AND IDENTIFICATION

Symptoms

Citrus scab symptoms vary with the age of infected tissues and among cultivars (Chung, 2011). Lesions on young leaves begin as minute water-soaked spots which subsequently evolve into amphigenous, creamy-yellowish or variously bright-coloured pustules (EPPO/CABI, 1992). These lesions grow as irregular, globose or conical excrescences, which coalesce and extend mostly along the main veins to cover a large part of the blade, particularly on the lower surface. The central area of these wart-like outgrowths is depressed and becomes drab, greyish and velvety when the fungus is fruiting. Old scab lesions have a rough surface, are dusky-coloured and become cracked and fissured. Affected leaves become stunted, malformed, wrinkled or puckered, with irregular torn margins. Defoliation often follows severe infections. Similar warty lesions and corky eruptions are formed on young twigs, tender shoots and stems of nursery plants, which can grow bushy and stunted. Also blossom pedicels and buttons are susceptible to infections.

Fruits are infected in the early stages of their development, grow misshapen and are subject to premature fall. On the rind of developed fruits, raised lesions are formed with different shapes, sizes and colours according to species and cultivar affected. They appear as scattered protuberances, conical projections or crater-like outgrowths or they coalesce to give scabby patches or extensive areas of fine eruptions. Scab however does not extend to the flesh (CABI, 2020). *E. fawcettii* scabs are typically irregular, warty and deeply fissured.

Citrus scab may be confused with other diseases, e.g. bacterial canker (*Xanthomonas citri* pv. *citri*) and melanose (*Diaporthe citri*), or with injuries caused by various agents (e.g. rub scratches caused by wind), and it is difficult to differentiate it based on symptoms alone (Fawcett, 1936; Brun, 1971; Knorr, 1973; Klotz, 1978; Whiteside *et al.*, 1988).

Morphology

The teleomorph, *E. fawcettii*, forms pulvinate, globose, dark, pseudoparenchymatous, multilocular, up to 80-120 µm thick ascomata containing numerous asci. Asci up to 20 per locule, subglobose or ovoid, bitunicate, inner wall

thickened at the top, 12-16 µm diameter, eight-spored. Ascospores hyaline, ellipsoidal or oblong-ellipsoidal, with two to four cells, usually constricted at the central septum, 10-12 x 5-6 µm diameter. Only known from Brazil.

Acervuli intra-epidermal or sub-epidermal, scattered or confluent, pseudoparenchymatous. Conidiogenous cells originated from the upper cells of the pseudoparenchyma or from the hyaline or pale-brown phialidic conidiophores, which have 2-4 septa. Conidia hyaline, unicellular, ellipsoid, biguttulate, 3-4 x 4-8 µm (Timmer, 2000). Mycelium hyaline, scanty, septate, short-branched. Colonies in culture very slow-growing, beige to tan or vinaceous to black, well raised above the agar surface and covered by tufts of short erect hyphae. Most strains of *E. fawcettii* secrete red pigments after 10-15 days incubation in the light (Gopal *et al.,* 2014).

The anamorphs of *E. fawcettii* and *E. australis* are practically identical. Thus, it is difficult to obtain reliable identification and differentiation based on morphology alone (Sivanesan & Critchett, 1974a, b, c).

Detection and inspection methods

Other pathogens of citrus cause lesions similar to those of citrus scab, therefore, detection cannot be based solely on the visual observations of symptoms. Isolation of the fungus is very challenging, but semi-selective media containing antibiotics and fungicides (dodine) have been developed to successfully isolate *E. fawcettii* from scab lesions (Whiteside, 1988). For species separation, Timmer *et al.* (1996) found out that it is not possible to distinguish *Elsinoë* species by cultural characteristics such as conidial size and shape and colony colour, and they are more reliably differentiated by pathogenicity. Pathogenicity tests have been implemented for species and pathotype identification (Timmer *et al.,* 1996, Tan *et al.,* 1996). In addition, the possibility of using immunochemical methods for pathogen detection has been envisaged (Peláez Abellán *et al.,* 1986).

For molecular methods, a PCR test based on random amplified polymorphic DNA (RAPD) of ITS sequences has been used for differentiating *E. fawcettii* from *E. australis* (Tan *et al.,* 1996) and partially resolved *E. fawcettii* pathotypes (Hyun *et al.,* 2009). In addition, specific primers have been successfully used in the detection of both species individually. The PCR tests are effective for either fungal cultures or infected plant tissues. Combined analysis of several genetic loci is more effective for distinguishing *Elsinoë* species causing citrus scab (Hyun *et al.,* 2009; Fan *et al.,* 2017). Sequence analysis of the internal transcribed spacer (ITS) region and the translation elongation factor 1 ? (TEF) gene clearly distinguished isolates of *E. fawcettii* and *E. australis,* and provided fixed nucleotide differences that distinguished subgroups separated by RAPD-PCR within the two species. Fan *et al.* (2017) employed combined analyses of ITS, LSU, rpb2 and TEF1-? DNA to refine the phylogeny and taxonomy of *Elsinoë* with descriptions of new species based on isolates originally identified as causal agents of citrus scab.

Validated international protocols for detection and characterization of *E. fawcettii* are currently not available.

PATHWAYS FOR MOVEMENT

Long-distance movement of *E. fawcetti* can occur via international trade of plants for planting of host species (excluding seeds) and citrus fruits (with or without leaves and peduncles) originating in infected countries. Local and short-distance dissemination of the pathogen is mostly due to rain (or irrigation water), although insects and, to a certain extent, wind-carried water droplets containing spores may contribute to its spread.

PEST SIGNIFICANCE

Economic impact

In citrus orchards, *E. fawcettii* affects mostly sour oranges and susceptible cultivars of lemons, mandarins, tangelos and grapefruits, whereas most cultivars of oranges and limes are less or not affected. The disease is particularly serious in the nursery on susceptible rootstocks, such as sour oranges, rough lemons, *Poncirus trifoliata* and *Citrus limonia* (CABI, 2020). It may stunt seedlings or make them bushy and difficult to bud. Scabs are present, particularly on the young growth. Citrus scab causes yield and quality losses. Infected fruits present superficial damage produced by scabs, they are scarred and distorted and consequently unmarketable.

Citrus scab is important only in areas where susceptible species or cultivars of citrus fruit are grown for the fresh market and where young plants or new growth develops under favourable conditions of temperature, moisture and shade (CABI, 2020). Losses largely depend on seasonal and local weather conditions and impact may be extremely reduced in areas with a limited annual rainfall of less than 1300 mm.

In Uruguay, Bernal (2000) reported that untreated plots in untreated plots, up to 98% of fruit had to be rejected due to to scab (*Elsinoë* sp.). The disease incidence was reduced to 0.7–7.4% after applying fungicides. In Florida, Whiteside (1974, 1981) indicated a scab incidence caused by *E. fawcettii* from 15% to 78% of affected fruit in untreated control plots. It is not known and even difficult to predict if agronomic practices and climatic conditions in the citrus-growing areas of the EPPO region will lead to similar levels of impact.

Control

Scab disease caused by *E. fawcettii* can be controlled by agricultural practices, sanitation and chemical treatments. Management measures may include the use of resistant citrus cultivars (Ieki, 1982; Yoshida & Shichijo, 1984; Reddy *et al.*, 1986), as well as adequate tree spacing, row orientation and pruning in order to improve orchard ventilation. Sanitation measures represent the most effective strategy for scab management and aim to eliminate inoculum sources of *E. fawcettii*, through burial of fallen infected leaves, removal of symptomatic fruits, and destruction of all diseased trees. In countries where the disease occurs, chemical control is widely used and several synthetic fungicides such as benomyl, thiophanate methyl, azoxystrobin, trifloxystrobin, pyraclostrobin, ferbam, and copper compounds have been proven to be effective. When using copper in preventive treatments, several sprays are needed, as the entire fruit surface must be continuously covered by a copper layer during the susceptible stage (Gopal *et al.*, 2014). However, sustainability of chemical control requires the use of appropriate fungicide spray programmes (González, 1980; Rao, 1983; Reddy *et al.*, 1983). In Argentina, two chemical sprays are applied for the control of citrus scab; the first one when 25% of the flowers are open and the second one 7–10 days after the first treatment (Timmer, 2000; Schultz *et al.*, 2013). In Florida, a control programme with two fungicide sprays, one at petal fall followed by a second one 2–3 weeks later, is used (Chung, 2011). As extensive use of these chemicals may lead to harmful effects on the human health and the environment, alternative treatments using plant extracts have been tested with positive effect in vitro (Rehman *et al.*, 2016). Repeated applications of fungicides may also lead to the development of resistance in *E. fawcettii*. Benzimidazole-tolerant strains of *E. fawcettii* have been detected in the USA (Florida), Uruguay (Whiteside, 1980; Bernal, 2000) and New Zealand (Tyson & Fullerton 2001).

Phytosanitary risk

The import of citrus plants and fruits from countries where the pathogen is present may present a risk of introduction of *E. fawcettii* into the citrus-growing areas of the EPPO region. Citrus plants, the main hosts of *E. fawcettii*, are cultivated on a vast area around the Mediterranean Basin. It has been considered that the conditions prevailing in most citrus-growing areas of the EPPO region were favourable to the establishment of *E. fawcettii* (EFSA, 2017). Additionally, the prevailing climate in these citrus-growing areas combined to the practice of sprinkle and micro-sprinkle irrigation might create climatic conditions suitable to the establishment of *E. fawcettii* (EFSA, 2017). Once established, the pest is highly likely to spread naturally or by means of human assistance.

PHYTOSANITARY MEASURES

In many countries of the EPPO region, the import of plants for planting of *Citrus*, *Poncirus*, *Fortunella*, and their hybrids from other parts of the world, is prohibited. Restrictions on fruit trade are also usually implemented. It can be requested that fruit should originate from pest-free areas or from pest-free places of production as demonstrated by crop inspections and laboratory testing prior to export, and that fruit are exported without leaves and peduncles.

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Datasheet history

This datasheet was first published in the CABI/EPPO 'Quarantine Pests for Europe' in 1992 and updated in the second edition in 1997, as well as in 2020. 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.

CABI/EPPO (1992/1997) *Quarantine Pests for Europe (1st and 2nd edition)*. CABI, Wallingford (GB).

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