Prepared by CABI and EPPO for the EU
under Contract 90/399003

Data Sheets on Quarantine Pests

Elsinoë fawcettii and *Elsinoë australis*

IDENTITY

Taxonomic position: Fungi: Ascomycetes: Dothideales
Notes on taxonomy and nomenclature: The quarantine pests specified in EU Directive 77/93 are *Elsinoë* spp. on *Citrus*, *Fortunella*, *Poncirus* and their hybrids. *E. fawcettii* is much the most widespread and important of these, but the category also includes *E. australis* and variety *scabiosa* of the anamorph of *E. fawcettii*.

The teleomorphs are only known from Brazil, so most published information concerns the fungi identified as their anamorphs. Although the three forms can be distinguished by morphology and host range, they cause very similar diseases and Whiteside *et al*. (1988) doubt whether the taxa are really distinct. In most respects, they can be treated together.
EU Annex designation: II/A1 - as *Elsinoë* spp.

- ***Elsinoë fawcettii***
  Name: *Elsinoë fawcettii* Bitancourt & A.E. Jenkins
  Anamorph: *Sphaceloma fawcettii* var. *fawcettii* A.E. Jenkins
  Common names: Citrus scab, common citrus scab, sour orange scab (English)
  Gale commune des agrumes (French)
  Zitrusschorf (German)
  Verrugose dos citros (Portuguese)
  Costra o roña de los ágrios (Spanish)
  Bayer computer code: ELSIFA
- ***Elsinoë australis***
  Name: *Elsinoë australis* Bitancourt & A.E. Jenkins
  Synonyms: *Sphaceloma fawcettii* A.E. Jenkins var. *viscosa* A.E. Jenkins
  Anamorph: *Sphaceloma australis* Bitancourt & A.E. Jenkins
  Common names: Sweet orange scab (English) Anthracnose de l'oranger (French) Antracnosis del naranjo (Spanish)
  Bayer computer code: ELSIAU
- ***Sphaceloma fawcettii* var. *scabiosa***
  Name:*Sphaceloma fawcettii* A.E. Jenkins var. *scabiosa* (McAlpine & Tryon) A.E. Jenkins
  Synonyms: *Ramularia scabiosa* McAlpine & Tryon
  Common names: Australian citrus scab, Tryon's scab (English)
  Scab australien des agrumes (French)
  Bayer computer code: SPHAFS

HOSTS

- ***Elsinoë fawcettii***
  The principal host of *E. fawcettii* is sour oranges (*Citrus aurantium*), but it is also important on grapefruits (*C. paradisi*), lemons (*C. limon*), mandarins (*C. reticulata*) and some cultivars of oranges (*C. sinensis*) 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*), *C. hystrix*, *C. limonia*, *C. nobilis*, *Poncirus trifoliata*, rough lemons (*C. jambhiri*) and satsumas (*C. unshiu*). The potential host range extends to other ornamental *Citrus* and rootstocks. Most cultivars of *C. latifolia*, *Fortunella margarita*, oranges and pummelos (*C. maxima*) are rarely attacked. Some cultivars of citrons (*C. medica*), kumquats (*Fortunella*), limes (*C. aurantiifolia*) and oranges are highly resistant.

- ***Elsinoë australis***
  E. australis is, in contrast, most important on oranges (*C. sinensis*), sour oranges (*C. aurantium*) being rather resistant. It also infects lemons (*C. limon*), mandarins (*C. reticulata*), satsumas (*C. unshiu*), limes (*C. aurantiifolia*), grapefruits (*C. paradisi*) and *Fortunella*.
- ***Sphaceloma fawcettii* var. *scabiosa***
  S. fawcettii var. *scabiosa* is most important on lemons (*C. limon*) and rough lemons (*C. jambhiri*), and is infrequent on sour oranges (*C. aurantium*).

GEOGRAPHICAL DISTRIBUTION

- ***Elsinoë fawcettii***
  Some of the records of *E. fawcettii* have later been shown to concern var. *scabiosa* (see below). It is not always clear whether, in such cases, both forms occur in the countries concerned, or only var. *scabiosa*.
  EPPO region: Apart from its occurrence in Spain (Canary Islands only), all records of this pathogen in the region (Greece, Italy, Lebanon, Morocco, Russia) are dubious. Early records (Greece, Italy) referred to species of *Cladosporium*, and their relation with *E. fawcettii* was not proved.
  Asia: Bangladesh, Brunei Darussalam, Cambodia, China (Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan, Yunnan, Zhejiang), Georgia, Hong Kong, India (Assam, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal), Indonesia (Irian Jaya, Java, Kalimantan), Japan (Honshu, Ryukyu Archipelago), Korea Democratic People's Republic, Korea Republic, Lao, Lebanon (dubious), Maldives, Malaysia (Peninsular, Sabah, Sarawak), Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Viet Nam, Yemen (unconfirmed).
  Africa: Ethiopia, Gabon, Ghana, Kenya, Madagascar, Malawi, Morocco (dubious), Mozambique, Nigeria, Sierra Leone, Somalia, South Africa, Tanzania, Uganda, Zaire, Zambia, Zimbabwe.
  North America: Bermuda, Mexico, USA (Alabama, Florida, Georgia, Hawaii, Louisiana, Mississippi, Texas).
  Central America and Caribbean: Barbados, Belize, Cayman Islands, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Nicaragua, Panama, Puerto Rico, St. Lucia, Trinidad and Tobago.
  South America: Argentina, Bolivia, Brazil (Bahia, Ceará, Espiritu
  Santo, Minas Gerais, Rio de Janeiro, São Paulo), Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela.
  Oceania: American Samoa, Australia (New South Wales, Northern Territories, Queensland, Victoria), Cook Islands, Fiji, French Polynesia, Guam, Micronesia, New Caledonia, New Zealand, Papua New Guinea, Samoa, Solomon Islands, Vanuatu.
  EU: Present.
  Distribution map: See CMI (1986, No. 125).

- ***Elsinoë australis***
  EPPO region: Ciccarone (1957) identified a scab on lemon fruits in Sicily as caused by *E. australis* but there have been no records in Italy since.
  Asia: India (Tamil Nadu; dubious).
  Africa: Ethiopia (unconfirmed).
  Central America and Caribbean: Dominica (unconfirmed).
  South America: Argentina, Bolivia, Brazil (Minas Gerais, Rio de Janeiro, Rio Grande do Sul, São Paulo), Ecuador, Paraguay, Uruguay.
  Oceania: Cook Islands, Fiji, New Caledonia (unconfirmed), Niue, Samoa.
  EU: Absent (doubtful old record only).
  Distribution map: See CMI (1976, No. 55).
- ***Sphaceloma fawcettii* var. *scabiosa***
  EPPO region: Absent.
  Asia: Hong Kong, Indonesia (Irian Jaya), Malaysia (Peninsular, Sabah, Sarawak), Sri Lanka.
  Africa: Comoros, Madagascar, Malawi, Zambia, Zimbabwe.
  South America: Argentina, Brazil.
  Oceania: Australia (New South Wales, Queensland), Fiji, New Caledonia, Papua New Guinea, Solomon Islands.
  EU: Absent.
  Distribution map: See CMI (1990, No. 161).

BIOLOGY

Inoculum for new infections consists of conidia, and presumably ascospores, from scabs formed on leaves, twigs and fruits. Conidia are formed abundantly on wet scabs, in a nearly saturated atmosphere, between 20 and 28°C.

Germination of conidia and infection do not require liquid water, both processes being possible with dew, fog or under high moisture conditions. A wet period of 2.5-3.5 h is needed for conidial infection. 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. The incubation period is at least 5 days. The optimal temperature for disease development is 20-21°C. Leaves, shoots and fruits are infected when young, i.e. when leaves are up to 15 mm wide and fruits are not more than 20 mm across.

The pathogen is able to survive in scab pustules on fruits remaining on the tree and on other plant organs, providing the inoculum for the next season. Even in resistant cultivars, the fungus can survive on diseased shoots from susceptible rootstocks (Whiteside, 1988). For more information, see Yamada (1961), Whiteside (1975; 1988).

Biotypes of the fungus virulent on certain hosts are known (Whiteside, 1978).

DETECTION AND IDENTIFICATION

Symptoms

Lesions on young leaves begin as minute water-soaked spots which subsequently evolve into amphigenous, creamy-yellowish or variously bright-coloured pustules. These 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. Blossom pedicels and buttons may be attacked as well. 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 shape, size and colour 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.

E. fawcettii scabs are typically irregular, warty and deeply fissured, while *E. australis* forms larger, smoother more circular scabs, and *S. fawcettii* var. *scabiosa* forms discoid or crateriform scabs.

Citrus scab may be confused with other diseases, e.g. bacterial canker (*Xanthomonas campestris* pv. *citri*) and melanose (*Diaporthe citri*), or with injuries caused by various agents. For illustrations and further information, see Fawcett (1936), Brun (1971), Knorr (1973), Klotz (1978), Whiteside *et al.* (1988).

Morphology

Ascomata pulvinate, globose, dark, pseudoparenchymatous, multilocular, up to 80-120 µm thick. 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 (12-20 x 4-8 µm for *E. australis*). 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, 5-10 x 2-5 µm. Mycelium hyaline, scanty, septate, short-branched. Colonies in culture very slow-growing, rose to purple, well raised above the agar surface and covered by tufts of short erect hyphae. The anamorphs of *E. fawcettii* and *E. australis* are practically identical, while *S. fawcettii* var. *scabiosa* has larger conidia (8-16 x 2-6 µm).

For more information, see Bitancourt & Jenkins (1936), Sivanesan & Critchett (1974a, b, c), Holliday (1980), Sivanesan (1984).

Detection and inspection methods

Semiselective media containing antibiotics and fungicides (dodine) have been developed for isolating *E. fawcettii* from scab lesions (Whiteside, 1988). The possibility of using immunochemical methods for pathogen detection has been envisaged (Peláez Abellán *et al.*, 1986).

MEANS OF MOVEMENT AND DISPERSAL

Dissemination of the pathogen is mostly by rain (or irrigation water), although insects and, to a certain extent, wind-carried water droplets containing spores may contribute to the spread of the pathogen. In international trade the pathogen can be carried on infected nursery stock, ornamental citrus plants, and fruits.

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*. It may stunt seedlings or make them bushy and difficult to bud. Scabs are present, particularly on the young growth. Severely infected fruits are scarred and distorted and consequently unmarketable. *S. fawcettii* var. *scabiosa* has a very similar impact, but on a different host range (see Hosts). *E. australis* differs in more typically causing fruit scab, mainly on oranges.

Citrus scab is widespread in areas where suitable conditions of temperature and rainfall or high humidity prevail (wet subtropics and cooler tropics). Elsewhere, it occurs when new flush and fruit setting coincide with spells of relatively warm, humid weather. It is also favoured by local conditions such as damp, low-lying soils and dense, shaded citrus groves. Severe outbreaks of citrus scab occur only in areas where susceptible species or cultivars of citrus fruit are grown for the fresh market and where young plants or new growth develop under favourable conditions of temperature, moisture and shade. Losses largely depend on seasonal and local variations in weather. The disease is not a problem in areas with a limited annual rainfall (less than 1300 mm), long-lasting hot seasons (mean monthly temperature above 24°C) or a dry summer. In the Mediterranean region and, more generally, in citrus-growing areas with a dry climate (e.g. California and Arizona in the USA, where the disease has never become established) scab, even if present, is rare or unimportant.

Control

Citrus scab can be controlled using resistant cultivars (Ieki, 1982; Yoshida & Shichijo, 1984; Reddy *et al.*, 1986) and by fungicide applications both in the nursery and in the orchard. Two to three sprays with protectant fungicides (copper, ferbam, thiram, captafol and chlorothalonil have been used) or one to two applications of systemic fungicides (benomyl, carbendazim) before flushing and after petal fall are recommended (see González, 1980; Rao, 1983; Reddy *et al.*, 1983). Benomyl-tolerant strains of the pathogen have been found (Whiteside, 1980).

Phytosanitary risk

E. fawcettii, *E. australis* and *S. fawcettii* var. *scabiosa* are not listed as quarantine pests by EPPO, or by any other regional plant protection organization. They present no serious risk to the Mediterranean region (see Economic impact).

PHYTOSANITARY MEASURES

Crop sanitation, establishing citrus nurseries in dry areas and adoption of proper treatments may help in production of rootstocks and budwood free from the pathogen. The usual procedures for importation of certified citrus planting material should be followed. For more information, see also Knorr (1977), Roistacher *et al*. (1977).

BIBLIOGRAPHY

Bitancourt, A.A.; Jenkins, A.E. (1936) *Elsinoë fawcettii*, the perfect stage of citrus scab fungus. *Phytopathology* **26**, 393-396.

Brun, J. (1971) Les scab des agrumes. *Fruits d'Outre Mer* **26**, 759-767.

Ciccarone, A. (1957) [*Elsinoë australis* Bitancourt et Jenkins, causing a citrus scab in Sicily]. *Rivista di Agrumicoltura* **2**, 1-36.

CMI (1976) *Distribution Maps of Plant Diseases* No. 55 (edition 3). CAB International, Wallingford, UK.

CMI (1986) *Distribution Maps of Plant Diseases* No. 125 (edition 6). CAB International, Wallingford, UK.

CMI (1990) *Distribution Maps of Plant Diseases* No. 161 (edition 4). CAB International, Wallingford, UK.

Fawcett, H.S. (1936) *Citrus diseases and their control*. McGraw Hill, New York, USA.

González, E. (1980) [Study of the effectiveness of various fungicides against scab in Persian lime (*Citrus aurantifolia* Swingle)]. *Cultivos Tropicales* **2**, 129-138.

Holliday, P. (1980) *Fungus diseases of tropical crops*. Cambridge University Press, Cambridge, UK.

Ieki, H. (1982) Resistance of citrus to scab. *Proceedings of the International Society of Citriculture, 1981* Vol. 1, pp. 340-344.

Klotz, L.J. (1978) Fungal, bacterial, and nonparasitic diseases and injuries originating in the seedbed, nursery, and orchard. In: *The citrus industry* (Ed. by Reuther, W.; Calavan, E.C.; Carman, G.E.) Vol. IV, pp. 1-66. University of California, Berkeley, USA.

Knorr, L.C. (1973) *Citrus diseases and disorders*. University of Florida Press, Gainesville, USA.

Knorr, L.C. (1977) Citrus. In: *Plant health and quarantine in international transfer of genetic resources* (Ed. by Hewitt, W.B.; Chiarappa, L.), pp. 111-117. CRC Press, Cleveland, USA.

Peláez Abellán, A.I.; Fernández Martínez, A.I.; García, C. (1986) [Antigenic detection of the fungus *Sphaceloma fawcettii*]. *Ciencias de la Agricultura, Cuba* **26**, 3-8.

Rao, N.N.R. (1983) Efficacy of two copper-based fungicides in the control of citrus scab. *Pesticides* **17**, 31-33.

Reddy, M.R.S.; Naidu, P.H.; Reddy, G.S. (1986) Screening rough lemon and Rangpur lime strains for resistance to citrus scab. *Current Science* **55**, 152-153.

Reddy, M.R.S.; Reddy, B.C.; Reddy G.S. (1983) Control of scab of Rangpur lime (*Citrus limonia* Osb.). *Current Research, University of Agricultural Sciences, Bangalore, India* **12**, 19.

Roistacher, C.N.; Calavan, E.C.; Navarro, L. (1977) Concepts and procedures for importation of citrus budwood. *Proceedings of the International Society of Citriculture* **1**, 133-136.

Sivanesan, A. (1984) *The bitunicate Ascomycetes and their anamorphs*. J. Cramer, Vaduz, Liechtenstein.

Sivanesan, A.; Critchett, C. (1974a) *Sphaceloma fawcettii* var. *scabiosa*. *CMI Descriptions of Pathogenic Fungi and Bacteria* No. 437. CAB International, Wallingford, UK.

Sivanesan, A.; Critchett, C. (1974b) *Elsinoë fawcettii*. *CMI Descriptions of Pathogenic Fungi and Bacteria* No. 438. CAB International, Wallingford, UK.

Sivanesan, A.; Critchett, C. (1974c) *Elsinoë australis*. *CMI Descriptions of Pathogenic Fungi and Bacteria* No. 440. CAB International, Wallingford, UK.

Whiteside, J.O. (1975) Biological characteristics of *Elsinoë fawcettii* pertaining to the epidemiology of sour orange scab. *Phytopathology* **65**, 1170-1175.

Whiteside, J.O. (1978) Pathogenicity of two biotypes of *Elsinoë fawcettii* to sweet orange and some other cultivars. *Phytopathology* **68**, 1128-1131.

Whiteside, J.O. (1980) Detection of benomyl-tolerant strains of *Elsinoë fawcettii* in Florida citrus groves and nurseries. *Plant Disease* **64**, 871-872.

Whiteside, J.O. (1988) Factors contributing to the rare occurrence of scab of sweet orange in Florida. *Plant Disease* **72**, 626-628.

Whiteside, J.O.; Garnsey, S.M.; Timmer, L.W. (1988) *Compendium of citrus diseases*. American Phytopathological Society, St. Paul, USA.

Yamada, S. (1961) [Epidemiological studies on the scab disease of Satsuma orange caused by *Elsinoë fawcettii* Bitancourt et Jenkins and its control]. *Tokai-Kinki National Agricultural Experiment Station, Horticultural Station, Special Bulletin* No. 2, 56 pp.

Yoshida, T.; Shichijo, T. (1984) [Testing for resistance of citrus cultivars to *Elsinoë fawcettii* and segregation of resistance on hybrid seedlings]. *Bulletin, Fruit Tree Research Station, Okitsu, Japan* **11**, 9-16.