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Data Sheets on Quarantine Pests

Alternaria mali

IDENTITY

Name: *Alternaria mali* Roberts
Taxonomic position: Fungi: Ascomycetes (anamorph)
Common names: Alternaria blotch of apple (English)
Alternariose (French)
Mancha foliar (Spanish)
Alternariafäule (German)
Hanten-rakubyo byo (Japanese)
Notes on taxonomy and nomenclature: *A. mali* belongs in the *A. alternata* (E.M. Fries) Keissler group and is distinguished mainly by its pathogenicity towards *Malus.* However, the name may have been used, in different parts of the world for fungi differing in pathogenicity. The fungus originally described as *A. mali* in North America (Roberts, 1924) seems to be a relatively minor pathogen, causing less damage than the fungus now given the same name in Asia. The Asian fungus produces a specific toxin (AM toxin; Shimomura *et al.*, 1993) and Dickens & Cook (1995) refer to it as the "toxigenic strain of *A. mali*". There seems to be no recent work on the original North American *A. mali*, which makes comparisons difficult. Sawamura (1990) does not consider it a significant pathogen, while Farr *et al.* (1989) show it to have been recorded from *Cydonia*, *Prunus* and *Pyrus* as well as *Malus*, which is not consistent with its being the same fungus.
Bayer computer code: ALTEMA
EPPO A1 list: No. 277
EU Annex designation: II/A1 - as *Alternaria alternata*, non-European isolates pathogenic to *Malus*

HOSTS

The main host of *A. mali* is apples, cultivated (*Malus pumila*) and wild (*M. sylvestris*). *A. alternata*, the related non-specific secondary parasite, has a very wide host range, including many plant families. It has been recorded from a range of species of *Malus*.

GEOGRAPHICAL DISTRIBUTION

A. mali has been recorded in only a limited number of countries (see also Notes on taxonomy and nomenclature), while *A. alternata* is extremely widespread, having been recorded on *Malus* and *Pyrus* in most parts of the world. Recent outbreaks, since 1987, in North Carolina (USA) (Filajdic & Sutton, 1991) seem to be of the Asian fungus, presumably introduced and different from the *A. mali* present elsewhere in North America.
EPPO region: Recently reported from Yugoslavia (Bulajic *et al.*, 1996).
Asia: China (Anhui, Gansu, Hebei, Heilongjiang, Henan, Jilin, Jiangsu, Liaoning, Sichuan, Shandong, Shaanxi, Shanxi, Yunnan, Zhejiang), India, Japan (Honshu), Korea Republic, Taiwan.

Africa: Zimbabwe (unattributed record given in Sawamura, 1990).
North America: Canada (Manitoba, New Brunswick, Prince Edward Island, Quebec), USA (Florida, Illinois, Indiana, North Carolina, Oregon, Washington). According to Sawamura (1990), only the record in North Carolina concerns the "pathogenic" strain of *A. mali*; the others are "non-pathogenic". Farr *et al.* (1989) give *A. mali* in "eastern USA".
South America: Chile.
Oceania: Australia (Western Australia).
EU: Absent.

BIOLOGY

The fungus infects mainly leaves of apple. According to Sawamura (1990), it does not typically infect fruits, except the very susceptible cv. Indo, which shows fruit-spotting but not subsequent rotting on the tree or in storage.

Disease spread is favoured by rainfall and high temperatures. A model of the relationship between the temperature threshold for infection and the influence of rainfall has been developed to predict the severity of the disease (Kim *et al.*, 1986). It may be noted that *A. alternata,* a very common saprophyte on dead plant tissues, has been recorded on apple causing only a fruit rot. For more information, see Sawamura (1972).

DETECTION AND IDENTIFICATION

Symptoms

The fungus causes leaf spots, which enlarge in zonate circular or crescent-shaped rings. Hyphae are normally scant or lacking on the host surface, but abundant light-grey mycelium can be produced on the surface under moist storage conditions. The fungus also infects the fruit, causing a soft rot, particularly where the skin is already damaged through other causes (it is not clear whether this fruit rot occurs any more frequently or seriously than non-specific *A. alternata* rot).

Morphology

The cultural characteristics, conidial size and septation of *A. alternata* are highly variable, so that the morphological characters supposed to distinguish *A. mali* from it are not very useful for routine diagnosis. However, Dickens & Cook (1995) report that two isolates of toxigenic *A. mali* included in their comparative study appeared to correspond to group 1 of Simmons & Roberts (1993), within *A. alternata sensu lato*. A full description of the fungus is given in Roberts (1924). Hyphal segments are short, mostly unbranched and without constrictions at their septa and 3-8 µm wide. Conidia are produced in chains of 3-9 and average 28 x 12 µm (maximum 29 x 13 µm). They are similar to those of *A. gaisen* (EPPO/CABI, 1996) but smaller. They are typically 3-septate, with transverse and longitudinal septa, with constrictions at the septa, especially when old. Conidiophores are usually fasciculate on apple leaves, are of variable length and show a dark-coloured scar at the point of attachment of the conidium. Dickens & Cook (1995) confirmed that, among a group of *Alternaria* isolates from apple, two pathogenic isolates were *A. mali* by the above criteria, while the others fell into various other groups (3, 4 and 6) of Simmons & Roberts (1993).

MEANS OF MOVEMENT AND DISPERSAL

A. mali is spread by means of conidia and its dispersal is particularly favoured by rainfall. However, this natural dispersal is only local. Internationally, possibilities for spread are fairly limited. The fungus is not liable to be carried on dormant planting material (without leaves). It could be carried in fruits but, since infection occurs on the young fruit, it is relatively unlikely that infected fruits would be harvested and traded.

PEST SIGNIFICANCE

Economic impact

While *A. alternata* is, in Europe, a very minor fruit-rotting fungus on apples, affecting only fruits which are already damaged, *A. mali* is important in the Far East because it causes both a leaf and a fruit disease. It can infect up to 85% of leaves on susceptible cultivars, compared with less than 1% on resistant cultivars (Yoon & Lee, 1987). The fact that control measures are actively taken against *A. mali* in the Far East (see below) is the main practical indication of its impact. In the USA, the disease is only important where Asian *A. mali* has been introduced (North Carolina); disease assessment methods have been described by Filajdic & Sutton (1994).

Control

Control of *A. mali* is through the use of resistant cultivars and fungicides. Apple cultivars can be ranked in order of increasing resistance (Sawamura, 1990) as follows: Indo, Red Gold, Raritan, Delicious, Fuji, Golden Delicious, Ralls, Toko, Tsugaru, Mutsu, Jonagold, Jonathan. Yellow Newtown, American Summer Pearmain, McIntosh, Ben Davis and Stayman Winesap are other resistant cultivars, to which Shin *et al.* (1986) would add Gala, Honey Gold and Mollie's Delicious. Resistant cultivars are homozygous for the recessive gene *alt alt*. Certain *Malus* spp. are highly resistant, e.g. *M. asiatica*, *M. baccata* and *M. robusta*, but resistance in these species is controlled by a single dominant gene, epistatic to the dominant gene controlling susceptibility (Saito & Niizeki, 1988). Chemical control of *A. mali* can be achieved through use of fungicides such as iprodione, mancozeb and captan (although some isolates have developed tolerance of these fungicides) (Lee & Kim, 1986; Osanai *et al.*, 1987; Asari & Takahashi, 1988). In Japan, it is one of the most serious diseases of apple, requiring specific and regular control measures. Applications of protectant fungicides are made after petal fall: mancozeb, ziram, thiram, oxine-copper, iminoctadine, polyoxins etc. (Sekita *et al*., 1994). Only iprodione was found to be effective for control of *A. mali* in North Carolina (USA) (Filajdic & Sutton, 1992a). The predictive model developed in the Korea Republic (Kim *et al*., 1986) has been evaluated in the USA (Filajdic & Sutton, 1992b).

Phytosanitary risk

A. mali has recently been added to the EPPO A1 list, but no other regional plant protection organization has specifically rated this fungus as a quarantine pest. *A. alternata*, widespread and only of secondary importance on apples and pears, is evidently not of quarantine significance. Whether it is a separate species or a form of *A. alternata*, *A. mali* clearly differs from *A. alternata* by its capacity to cause damaging leaf diseases of its hosts. No such alternaria disease of apples occurs in the EPPO region at the present time. Unlike *A. gaisen*, which attacks only the Japanese pear species *Pyrus pyrifolia*, *A. mali* presents a direct risk to the main apple crop in the EPPO region. Indeed, it has an even wider host range, extending to fruiting and ornamental *Malus*, and on this basis presents a greater risk than *A. gaisen*. However, *A. mali* is favoured by much warmer and wetter conditions than are usual in the apple production regions of Europe. In addition, there is no very obvious existing pathway for introduction of the fungus into Europe. Asian *A. mali* has been recently introduced into the USA, which shows that it does have the potential to spread. In North Carolina, it encounters conditions somewhat more similar to those of southern Europe. *A. mali* is principally damaging on certain susceptible cultivars, and current cultivar ratings mainly relate to those grown in Asia or North America. So the status of

European cultivars in relation to the disease needs to be assessed. Dickens & Cook (1995) found that American isolates of "toxigenic" *A. mali* only infected leaves of cvs Indo and Red Gold, and not the European cultivars tested. Of the cultivars mentioned under Control, Golden Delicious (widely grown in Europe) is ranked as moderately resistant. It may finally be noted that *A. mali* was recently recorded for the first time in the EPPO region, in Yugoslavia. The consequences of this new record have not yet been assessed.

PHYTOSANITARY MEASURES

Any planting material of *Malus* imported from countries where *A. mali* occurs should be in dormancy, and not carry any leaves or plant debris. Fruits from these countries should be free from symptoms and of good commercial quality.

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