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Data Sheets on Quarantine Pests

Mycosphaerella dearnessii and *Mycosphaerella pini*

IDENTITY

Taxonomic position: Fungi: Ascomycetes: Dothideales

- ***Mycosphaerella dearnessii***

Name: *Mycosphaerella dearnessii* M.E. Barr
Synonyms: *Scirrhia acicola* (Dearness) Siggers
Systremma acicola (Dearness) F.A. Wolf & Barbour
Anamorph: *Lecanosticta acicola* (Thümen) H. Sydow
Synonyms: *Lecanosticta pini* H. Sydow
Septoria acicola (Thümen) Saccardo
Common names: Brown spot needle blight (English)
Bayer computer code: SCIRAC
EPPO A2 list: No. 22
EU Annex designation: II/A1 - as *Scirrhia acicola*

- ***Mycosphaerella pini***

Name: *Mycosphaerella pini* E. Rostrup
Synonyms: *Scirrhia pini* Funk & A.K. Parker
Anamorph: *Dothistroma septospora* (G. Doroguine) Morelet
Synonyms: *Dothistroma pini* Hulbary
Cytosporina septospora G. Doroguine
Common names: Red band needle blight, dothistroma blight (English)
Banda roja (Spanish)
Notes on taxonomy and nomenclature: The organism considered is not *Mycosphaerella pini* (Funk & A.K. Parker) v. Arx. See Evans (1984) for full taxonomic treatment.
Bayer computer code: SCIRPI
EU Annex designation: II/A2 - as *Scirrhia pini*

HOSTS

- ***Mycosphaerella dearnessii***

Potentially all species of *Pinus* are hosts. Of most importance in the EPPO region are: *P. contorta*, *P. halepensis*, *P. muricata*, *P. palustris*, *P. pinaster*, *P. pinea*, *P. radiata*, *P. strobus*, *P. sylvestris*, *P. taeda*. Certain species, such as *P. banksiana*, have been shown to be highly resistant (Skilling & Nicholls, 1974), whilst traces of infection were noted on *Picea glauca* artificially exposed to a heavy spore inoculum.

- ***Mycosphaerella pini***

The principal hosts are *Pinus* spp., and an extensive list has been compiled by Gibson (1979), who also included *Pseudotsuga menziesii* and *Larix decidua*. The most susceptible species of importance in the EPPO region are: *P. canariensis*, *P. contorta*, *P. halepensis*, *P. muricata*, *P. nigra*, *P. pinea*, *P. ponderosa*, *P. radiata*, *P. sylvestris*, *P. thunbergii*. Many of

the Central American pine species are resistant or immune. *P. nigra* has proved to be particularly susceptible in Europe (south Germany), whilst *P. sylvestris* shows little infection even when exposed to severely blighted *P. nigra* (Lang & Karadzic, 1987). Lang (1987) also reported it for the first time on *Picea abies*.

GEOGRAPHICAL DISTRIBUTION

- ***Mycosphaerella dearnessii***

  The fungus appears to be of American origin and has spread to other continents. Its first report in the EPPO region was in 1978 but some forest pathologists have claimed that it was already present in a number of EPPO countries, for example Austria. These suggestions now appear to be false.

  EPPO region: France, Germany, Switzerland, Yugoslavia (confirmed by Evans, 1984, on *P. halepensis*).

  Asia: China (Fujian, Guangdong, Guangxi, Jiangxi, Zheijiang; Gong & Liang, 1988), Georgia.

  Africa: South Africa.

  North America: Canada, Mexico, USA (particularly in the southern coastal states) (Skilling & Nicholls, 1974).

  Central America and Caribbean: Belize, Costa Rica, Cuba, Guatemala, Honduras, Jamaica (doubtful record), Nicaragua (Evans, 1984).

  South America: Colombia.

  EU: Present.

  Distribution map: See IMI (1994, No. 482).

- ***Mycosphaerella pini***

  EPPO region: Austria, Bulgaria, France, Germany, Greece, Italy, Portugal (Azores), Romania, Spain, Switzerland, UK, Yugoslavia.

  Asia: Brunei Darussalam, Georgia, India (Jammu and Kashmir, Tamil Nadu, Uttar Pradesh), Japan (Hokkaido, Honshu; Ito *et al*., 1975), Korea Democratic People's Republic, Korea Republic, Nepal, Pakistan, Philippines, Sri Lanka.

  Africa: Kenya, Malawi, South Africa, Tanzania, Uganda, Zambia, Zimbabwe.

  North America: Canada (British Columbia, Saskatchewan to Newfoundland), USA (California, Florida, Hawaii, Iowa, Idaho, Illinois, Maryland, Minnesota, Montana, Nebraska, Ohio, Oklahoma, Oregon, Virginia, Washington.

  Central America and Caribbean: Costa Rica, Guatemala, Honduras, Jamaica, Nicaragua.

  South America: Argentina, Brazil (Parana, São Paulo), Chile, Colombia, Ecuador, Uruguay.

  Oceania: Australia (New South Wales, Queensland, Tasmania, Victoria), New Zealand.

  EU: Present.

  Distribution map: See CMI (1986, No. 419).

BIOLOGY

- ***Mycosphaerella dearnessii***

  In northern USA, rainfall and temperature are the critical factors for spore dispersal and infection, which occur from June to September (Skilling & Nicholls, 1974). Spores are released only during rainy weather and never at low temperatures (near 2°C). The major infection period is from late June to early July and moisture on the needle surface is necessary for spore germination. The conidia produce appressoria and penetration occurs via stomata. The incubation period is variable depending on host type and age: from 1-2 months on young needles to 4-7 months on older foliage. Acervuli develop and mature in

late August and, although conidia are released in September, infection is restricted, probably due to increased needle resistance. The disease cycle renews the following summer when the overwintering fruiting bodies release conidia as temperature and rainfall increase. However, in warmer,less seasonal climates in Central America, the conidial cirri remain on the needle for many months and it is significant that the conidia in lowland tropical areas are considerably more robust (large, thick-walled, heavily pigmented and ornamented) than those found in high-altitude, cloud-forest localities (Evans, 1984). It is uncertain whether this variation is determined environmentally or genetically.

Acervuli and ascostromata also develop and mature on cast needles and constitute an important source of interseasonal survival.

- ***Mycosphaerella pini***

Conidia are exuded in a white or pale-pink, mucilaginous mass during light rain or misty conditions. After release, these germinate in free water between 8 and 25°C, with an optimum at 18°C (Ivory, 1967). Gilmour (1981) recorded no infection below 7°C nor when leaves remained wet for less than 10 h. The incubation period is similar to that reported for *M. dearnessii* (1-4 months), although Karadzic (1989) put this at 4-6 months under Yugoslavian conditions, with the critical infection period occurring from May to June and symptoms appearing in October-November. Serious needle blight is likely to occur following protracted periods of high humidity and temperatures within the range 15-20°C (Gibson, 1979). *M. pini* is indigenous in the cloud forests of Central America (Honduras, Guatemala) at altitudes of 1600-2200 m (Evans, 1984). In these habitats the pathogen is common but never seriously damaging; the teleomorph forms freely on attached and fallen needles and seems to play an important role in the life-cycle. In Africa, South America and Oceania, only the anamorph has been reported (Gibson, 1979; Evans, 1984).

DETECTION AND IDENTIFICATION

Symptoms

- ***Mycosphaerella dearnessii***

On *Pinus sylvestris* in the USA, symptoms initially appear in August-September on older needles in the form of yellow, resin-soaked spots, approximately 3 mm in diameter, which later become dark-brown in the centre with a prominent yellowish-orange border. These lesions coalesce and infected needles typically die back; eventually the whole needle turns brown and falls prematurely in late autumn to early winter. In lightly infected plantations, only the 2- and 3-year-old needles are cast, but as infection increases in severity, the current-year needles may also be shed. Over several years, this may result in branch and tree death. These symptoms can be confused with those of other needle pathogens, including *M. pini* and several *Lophodermium* and *Ploioderma* species. Final confirmation can only be made when the conidia mature.

- ***Mycosphaerella pini***

As for *M. dearnessii*, the disease first appears on older needles as yellow spots. Generally, however, a profuse reddening develops, and a red pigment may be present around the fructifications. On highly susceptible hosts, red bands containing dense aggregations of stromata are freely formed whilst on other hosts the infected needles appear uniformly reddened or scorched. Reddening of needles has occasionally been observed on *P. radiata* infected with *M. dearnessii* (Evans, 1984); characteristically, however, its fructifications are rarely grouped, being dispersed linearly along the needles. As the disease develops, needle necrosis and subsequent needle cast spreads from the branch bases into the younger foliage. A chronic state may then be reached with the lower parts of the branches denuded and the distal parts bearing isolated groups of diseased needles, often accompanied by the development of epicormic shoots on the stem and major branches.

Morphology

- ***Mycosphaerella dearnessii***

  Acervuli olive to dark-green, subepidermal, innate, becoming erumpent and stromatic, elliptical to elongate, arranged parallel to the long axis of the needle, 100-600(-750) x 80-120 µm, opening by a longitudinal slit. Excessive stromatal development results in loculate acervuli, often misinterpreted as pycnidia. Conidia extremely variable in form, subhyaline to dark-brown, echinulate to verrucose or tuberculate, thick-walled, straight to curved, with one to five septa, fusiform to cylindrical, (10-)12-45(-55) x 2-4.5 µm, with a rounded apex and truncate base. Spermogonia of the *Asteromella* synanamorph present in uniloculate or multiloculate stromata; spermatia subhyaline to pale-green, rod-shaped, 2-4 x 0.8-1.3 µm. Ascostromata scattered, linear, innate, subepidermal, becoming strongly erumpent, black, invariably multiloculate (two to 18 locules), 400-850(-1200) x 120-250 µm. Ascospores hyaline, smooth, one-septate, usually four-guttulate, oblong to cuneate, 7.5-14 x 2-3.5 µm, bluntly rounded at one end, tapering and fusiform at other.

- ***Mycosphaerella pini***

  Acervuli initially white, innate, subepidermal becoming erumpent, black, stromatic and cupulate or loculate (pseudopycnidial), variable in size, see above. Conidia hyaline, smooth, thin-walled, with one to five (or up to seven) septa, short-clavate to long-filiform, (8-)10-32(-40) x 1.8-3 µm, with a rounded apex and truncate base. Spermogonia as described for *M. dearnessii*. Ascostromata densely aggregated in red bands, otherwise similar to *M. dearnessii*. Ascospores slightly longer but essentially similar to *M. dearnessii*.

  Full descriptions of morphological variation of both these fungi in native Central American pine forests are given by Evans (1984).

MEANS OF MOVEMENT AND DISPERSAL

- ***Mycosphaerella dearnessii***

  Under moist conditions, the conidia exude from the acervulus in a mucilaginous, green, wedge-shaped cirrus and are dispersed by rain-splash, this being the main means of tree-to-tree dispersal. The sticky conidia can also be spread by insects and on forestry equipment, especially shearing tools (Skilling & Nicholls, 1974), allowing inter-plantation dissemination. Wind-borne ascospores, produced abundantly in southern USA (Kais, 1971), also allow long-distance dispersal, but they are never formed in the northern states (Skilling & Nicolls, 1974). Long-distance movement is most likely to be on infected nursery stock and this is probably how the pathogen spread northwards from the southern USA (Skilling & Nicholls, 1974). Intercontinental movement is possible in seed lots contaminated with needle debris.

- ***Mycosphaerella pini***

  Similar to *M. dearnessii*, but the hyaline conidia are less adapted to exposure and thus less likely to be transported by methods other than rain-splash. Mist and low cloud may be involved in long-distance dispersal (Gibson, 1972). The rapid intercontinental spread of *M. pini* was the result of man's movement of live plants or contaminated seed stocks (Gibson, 1974). It was probably introduced into southern Germany on infected *P. nigra* (Butin & Richter, 1983).

PEST SIGNIFICANCE

Economic impact

- ***Mycosphaerella dearnessii***

  In North America, *M. dearnessii* is an important pine foliage disease, particularly of *P. palustris* in south-eastern USA, causing severe growth checks to seedlings and young trees

(Gibson, 1979); it is the main limiting factor to the establishment of this species throughout its natural range. Skilling & Nicholls (1974) report its spread and increasing damage to Christmas tree plantations (*P. sylvestris*) in northern USA (Wisconsin, Minnesota), making the affected trees unsaleable. Since the market value for this crop in 1974 was put at 70 million USD, the economic losses may be considerable.

In Central America the pathogen is endemic and omnipresent in native pine forests (*P. caribaea, P. oocarpa, P. maximinoi, P. patula*) from sea level to cloud forest (2000 m altitude) but is never associated with a serious needle blight condition (Evans, 1984). Gibson (1979), on the evidence of its spread and distribution in the USA, considered *M. dearnessii* to be highly adaptable to new hosts and environments and therefore a major threat outside North America. This was corroborated by the finding of severely damaged *P. radiata* in the Altiplano of Colombia (Gibson, 1980).

- ***Mycosphaerella pini***

M. pini causes loss to timber production in susceptible species, notably *P. radiata*, through reduction in growth rate following defoliation. The severity of damage led to the abandonment of *P. radiata* as a major softwood species in many parts of Africa (Gibson, 1979).

Defoliation of more than 25% has a significant effect on diameter increment whilst 50% needle cast reduces this by a half. Repeated attacks lead to tree death. In New Zealand similar losses have been recorded (Pas, 1981), while in Chile a reduction in diameter increment of almost 75% was recorded in 7-year-old *P. radiata*, 1 year after 80% defoliation (Gibson, 1974). *M. pini* has been in the EPPO region for at least 80 years (Evans, 1984) and has been reported sporadically since, but has not had a significant impact on pine cultivation, except perhaps on *P. radiata* in Spain. A combination of low temperature and low humidity may restrict development of this essentially subtropical fungus, although it could be locally important on susceptible hosts in humid Mediterranean regions.

Control

- ***Mycosphaerella dearnessii***

Cultural control is possible by controlled burning to destroy infected litter on the ground. Fungicide applications of chlorothalonil and Bordeaux mixture to nursery stock and young plantations, critically when the newly emerging needles are about half their total length, have been recommended (Skilling & Nicholls, 1974). When inoculum levels are high, a second spray 3-4 weeks later is advised and Kais (1975) reported that a schedule of four to seven treatments over a 6-month period during the height of the growing season in the USA (May-October) is necessary for short-term control in nurseries. Good control has also been noted with benomyl and maneb; Kais *et al*. (1986) used a 5% benomyl root treatment before planting.

- ***Mycosphaerella pini***

M. pini has been successfully controlled through the use of copper fungicides in New Zealand, where aerial spraying with cuprous oxide or copper oxychloride at 2.24-3 kg active copper per ha is routine practice. Pruning has been recommended to reduce infection in *P. radiata* plantations in Australia (Marks & Smith, 1987).

Phytosanitary risk

- ***Mycosphaerella dearnessii***

M. dearnessii is listed as an A2 quarantine pest by EPPO (OEPP/EPPO, 1979), and IAPSC also considers it of quarantine significance. Its very limited distribution in the region (only Yugoslavia) and its adaptability in North America suggests that it presents a considerable risk for other countries in the region.

- ***Mycosphaerella pini***
  M. pini is not listed as a quarantine pest for the EPPO region, although IAPSC does consider it of quarantine significance. Its presence in the region for many years, without great impact, and its preference for subtropical conditions, indicate that it presents only a low phytosanitary risk.

PHYTOSANITARY MEASURES

EPPO recommends (OEPP/EPPO, 1990) that planting material of *Pinus* should come from an area free from *M. dearnessii*, and in addition that the place of production should have been found free. This requirement, appropriate for an A2 pest, was partly conditioned by the suggestion that *M. dearnessii* was more widespread in the EPPO region than previously thought (see Geographical distribution). If the fungus is really restricted to a small area in Yugoslavia, more severe measures could be appropriate and will be discussed within EPPO. If *M. pini* is to be regulated at all, the existing measures for *M. dearnessii* would seem sufficient.

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