European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

Data sheets on quarantine pests
Fiches informatives sur les organismes de quarantaine

Gibberella circinata

Identity

Name: *Gibberella circinata* Nirenberg & O'Donnell
Anamorph: *Fusarium circinatum* Nirenberg & O'Donnell
Synonyms: *Fusarium subglutinans* f. sp. *pini* Hepting; *Fusarium lateritium* f. sp. *pini* Hepting
Taxonomic position: *Fungi*: *Ascomycota*: *Hypocreales*: *Nectriaceae*
Common names: pitch canker of pine (English)
Notes on taxonomy and nomenclature: for many years, the pitch canker pathogen was known only as an anamorph (form or pathotype of *Fusarium subglutinans*; Correll *et al*., 1991). Since its teleomorph was discovered, it is known as *G. circinata* (Nirenberg & O'Donnell, 1998)
EPPO code: GIBBCI
Phytosanitary categorization: EPPO A2 action list no. 306

Hosts

G. circinata infects only *Pinus* spp. In North America, its main native hosts are *Pinus elliottii*, *Pinus palustris*, *Pinus patula*, *Pinus radiata*, *Pinus taeda*, *Pinus virginiana*. It has also been recorded on over 30 other *Pinus* spp., including the European and Mediterranean species *Pinus halepensis*, *Pinus pinaster* and *Pinus sylvestris*, various North American species planted in Europe such as *Pinus contorta* and *Pinus strobus*, and various Asian species (e.g. *Pinus densiflora*, *Pinus thunbergii*). There is an isolated record on *Pseudotsuga menziesii*, not apparently associated with any damage.

Geographical distribution

The origin and spread of *G. circinata* seems obscure. Older records from various parts of the world may be based on inadequate identification. Outside America, records in Japan and South Africa are considered to result from introduction. The fungus is probably native in North America, but some US states (and Mexico) record its introduction. In any case, until 2005, there have been no reliable records in the EPPO region.
EPPO region: Italy (unconfirmed), Spain (Landeras *et al*., 2005)
Asia: Iraq (doubtful), Japan (Kyushu, Ryukyu), Korea (unconfirmed), Philippines (doubtful)
Africa: South Africa, Tanzania (doubtful)
North America: Mexico, USA (mainly in the south and east, but also introduced into California in 1986)
Central America & Caribbean: Haiti, Honduras (doubtful)
South America: Chile (since 2001) (Wingfield *et al*., 2006)
Oceania: Australia (unconfirmed)
EU: unconfirmed
Distribution map: See CABI/EPPO (1998)

Biology

G. circinata infects the branches of pine, causing a bark canker. Since perithecia have not been observed in nature, it is presumed that ascospores are not of great importance for infection of the host. Most infection is by macroconidia and/or microconidia, carried by wind or insects. Bark-feeding insects (e.g. *Pityophthorus*, *Ips*, *Conophthorus*) commonly breed in affected branches and emerging adults commonly carry the pathogen. These insects may also provide a wound suitable for infection (Storer *et al*., 1997).

Moisture is required for an infection to occur, and infections appear to be associated with locations or seasons where atmospheric moisture is readily available and temperatures are relatively warm, such as in the south-eastern USA during summer thunderstorms (Dwinell *et al*., 1985). In California, the disease is most severe in close proximity to the coast. The distribution of the disease also suggests that cooler temperatures are restrictive (Gordon *et al*., 2001). At moderate temperatures, the pathogen can survive for 1 year or more in infected wood.

G. circinata can infest pine seeds internally or be present as a superficial contaminant (Barrows-Broaddus & Dwinell, 1985; Storer *et al*., 1998), but it is not known how this infestation occurs. Seed-borne inoculum can infect and kill pine seedlings.

Detection and identification

Symptoms

G. circinata may be seed-borne, and pine seedlings may be attacked by the fungus in infected seeds, which typically rots the hypocotyl at or near the soil-line so that the seedling collapses. Seedlings may also be infected by soil-borne inoculum. In either case, the symptoms are not particularly distinctive, differing little from those caused by other damping-off pathogens. Root infections are most often observed on seedlings in nurseries or Christmas tree farms, but can also occur on exposed roots of larger trees in landscape plantings. In Christmas tree farms, the pathogen may extensively colonize the root system, causing a brown discoloration and disintegration of the cortex. Above-ground symptoms are generally not apparent until the pathogen has reached the root crown and girdled the stem. This results in a uniform loss of colour in the foliage, which fades first to a dull green, then yellow and finally brown. Removal of the bark on the main stem near the soil-line may reveal resin-soaked tissue with a honey-brown to dark-brown discoloration (pitching).

Branches and stems of pine trees of any age may also be infected. Infection usually begins as a canker and dieback of small branches. Needles wilt above the infection site (becoming chlorotic, then red and brown) and resin accumulates on the branch surface. Repetition of these symptoms throughout the canopy may lead to extensive dieback. The trunk and larger branches may in due course be infected, producing copious amounts of resin and accelerating the decline of the tree. Girdling of the main stem may lead to death of the tree.

Morphology

In culture, *G. circinata* produces macro- and microconidia (Nirenberg & O'Donnell, 1998). Macroconidia are typically 3-septate, with slightly curved walls, $32–48 \times 3.3–3.8$ µm, resembling those of numerous other anamorphs in the form-genus *Fusarium*. Microconidia, typically single-celled, ovoid (or nearly oval or allantoid), are borne in false heads on aerial polyphialides. The proliferation of microconidiophores, coupled with a slight twisting of the aerial mycelium on which they are borne, gives a distinctive colony morphology. Aerial mycelium is white, or slightly violet. Colonies are frequently sectored. These characters do not clearly separate *G. circinata* from other fungi with anamorphs of the *Fusarium subglutinans* group.

Perithecia are also readily produced in culture: dark purple to black, ovoid to obpyriform, 332–396–453 µm high and 288–337–358 µm wide (Britz *et al*., 2002), cylindrical asci $88–100 \times 7.5–8.5$ µm, released by oozing; ascospores 8, 1-septate, ellipsoidal to fusiform. This description is close to that of many related species.

Identification relies on the presence of characteristic symptoms (amber-coloured, resin-soaked appearance of tissue beneath the bark) and isolation and culturing of the fungus. Correll *et al*. (1991) describe a suitable selective medium. A fungus isolated from typically symptomatic material of infected pine and matching the above description should be *G. circinata*. Final confirmation can be obtained by re-inoculation to pine (Gordon *et al*., 1998a).

Pathways for movement

G. circinata is spread locally by wind and insects, but its rate of spread in newly infested areas does not appear to be very high. Over long distances, it can be carried by consignments of pine seeds, or by plants for planting of pine. In principle, it could be carried by infected wood, but this is most likely for particle wood made from small branches and their bark, in which spores of the fungus can survive. Round wood and sawn wood, especially if debarked, are less likely to carry the fungus. In view of the substantial trade in pine wood, and the limited distribution of the fungus, it seems unlikely that this has been a significant pathway in practice.

Pest significance

Economic impact

G. circinata is a chronic problem in the south-eastern USA, where it affects production in plantations, nurseries (Barnard & Blakeslee, 1980) and seed orchards (Dwinell *et al*., 1981; Dwinell *et al*., 1985), but does not significant impact on native forests. It regularly adds to the cost of production but does not result in large financial losses in most years. Most southern pines are affected to some extent, including *P. taeda*, which typically sustains only minor damage and *P. elliottii*, which can be more severely affected (major epidemics in Florida in the 1970s, with an estimated loss of between 13.6 and 30.7 million cubic feet annually in the period from 1974 through 1979; Dwinell *et al*., 1985). However, the use of less susceptible genotypes and changes in silvicultural techniques have greatly reduced the impact since that time.

Since *G. circinata* was introduced into California in 1986, it has caused damage and mortality of *P. radiata* in urban plantings and in native forests. Costs of tree removal and replacement may eventually amount to several million USD in severely affected areas (Templeton *et al*., 1997). Other *Pinus* spp. are also affected. Since its introduction into South Africa, *G. circinata* has caused serious problems in seedling nurseries (Viljoen *et al*., 1994, 1995). In Chile, it occurs in nurseries, but introduction is too recent for the impact to be clear.

Control

In south-eastern USA, the *G. circinata* problem is addressed by controlling the disease as far as possible in well managed seed nurseries, using less susceptible planting material, and preventing the spread of inoculum from infested areas by sanitary precautions (Dwinell *et al*., 1985). Chemical and biological control methods are ineffective or uneconomic, and have at present no particular role to play (except possibly seed treatment with fungicides). Nurseries and Christmas tree farms should be carefully sited. Clean, preferably local, seeds should be used. Wounding and over-fertilization should be avoided. In general, good hygiene should be maintained, and precautions taken for movement of equipment and soil. In plantations, infected material (logs, firewood) should not be moved: chipping or debarking may be used to reduce the risk that the pathogen is spread by insects. Insecticide use to limit spread by insects is not environmentally appropriate.

Large-scale studies of American *Pinus* spp. (Hodge & Dvorak, 2000) have shown considerable differences between species in susceptibility. *P. radiata* was very susceptible, while pines of subsection Oocarpa were extremely resistant. Within *P. radiata*, variation in susceptibility has been observed in California populations of both planted and naturally regenerated trees (Storer *et al*., 1999, 2002), and similar variation is found among species from southern USA: *P. elliottii* (Dwinell & Phelps, 1977) *P. taeda* and *P. virginiana* (Kelley & Williams, 1982; Kuhlman *et al*., 1982; Barrows-Broaddus & Dwinell, 1984).

If individual valuable amenity trees are affected, pruning with appropriate hygienic precautions can restore the value of the tree. In the case of isolated infected trees in an otherwise pest-free area, it may be more appropriate to remove and destroy the tree. In general, in affected areas, it is preferable to use trees other than *Pinus*, or less susceptible *Pinus* spp., in amenity plantings. For example, in California, several exotic pine species that are suitable for a Mediterranean climate are less susceptible than the native species (Gordon *et al*., 1998a,b).

Phytosanitary risk

G. circinata has shown its capacity to spread to new areas (California, Mexico, South Africa, Chile). It could readily be further spread by international movement of infected *Pinus* seeds. Unconfirmed records in the EPPO region may indeed be associated with the import of infected seeds, from which the disease did not establish. The areas to which it has spread have Mediterranean-type climates, so that, within the EPPO region, the Mediterranean area is clearly at risk since *Pinus* spp. are widely planted there. The disease probably presents the greatest danger to forest nurseries. Damage to plantations or native forests seems more likely to arise in a warmer and more humid climate than exists anywhere in the EPPO region.

Phytosanitary measures

G. circinata was added in 2002 to the EPPO A1 action list of pests, and endangered EPPO member countries are thus recommended to regulate it as a quarantine pest. Seeds of *Pinus* spp. imported from countries where *G. circinata* is present should be free from the pest. Seed-testing methods are presented by Anderson (1986) and Correll *et al*. (1991). There is a certain risk of introduction with soil but, in general, most EPPO countries prohibit the import of soil, and restrict the import of plants with soil (OEPP/EPPO, 1994), from other continents. These measures should be effective against *G. circinata*. Host plants for planting should be free from the pest.

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