

Data Sheets on Quarantine Pests

*Gymnosporangium juniperi-virginianae***IDENTITY**

Name: *Gymnosporangium juniperi-virginianae* Schwein

Synonyms: *Gymnosporangium macropus* Link
Gymnosporangium virginianum Sprengel

Anamorph: *Aecidium pyrolatum* Schwein *Roestelia pyrata* Thaxter

Taxonomic position: Fungi: Basidiomycetes: Uredinales

Common names: Cedar apple rust, American apple rust (English)

Notes on taxonomy and nomenclature: For information on the taxonomy of *Gymnosporangium* spp. see Kern (1973).

Bayer computer code: GYMNVJ

EPP0 A1 list: No. 255

EU Annex designation: I/A1 - as *Gymnosporangium* spp. (non-European)

HOSTS

The aecial hosts are apples (*Malus pumila*) and other *Malus* spp. Apples are an important crop grown throughout the EPP0 region. The telial host is *Juniperus virginiana* occasionally grown in central Europe as a timber tree and elsewhere as an ornamental tree or dwarf shrub. Other species of *Juniperus* have been recorded as hosts e.g. *J. scopulorum* (Hepting, 1971).

GEOGRAPHICAL DISTRIBUTION

EPP0 region: Absent.

North America: Canada (Ontario, Quebec) USA (Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Tennessee, Virginia, Washington, Wisconsin, Wyoming).

EU: Absent.

Distribution map: See IMI (1994, No. 61).

BIOLOGY

G. juniperi-virginianae, like other *Gymnosporangium* spp., is heteroecious in that it requires *Juniperus* and rosaceous hosts of subfamily Pomoideae to complete its life cycle. Telia are produced on twigs and branches of *J. virginiana* in the spring. In moist conditions, the telia germinate *in situ* and produce basidiospores which are dispersed and are able to infect nearby apple trees.

Infection from basidiospores gives rise to pycnia borne on the upper surface of the apple leaves or occasionally on fruits; they are visible from late spring to early summer. Later, aeciospores are produced inside tubular protective sheaths (peridia) on the underside

of the leaf. Lesions of *G. juniperi-virginianae* rarely appear on apple fruits. The aeciospores are released when the peridium ruptures and are capable of being wind-borne over long distances to *J. virginiana*. After germinating on *J. virginiana*, an overwintering latent mycelium is produced. Infection of apple does not persist after infected leaves or fruits have fallen. The telial state appears on *J. virginiana* in the spring to begin the life cycle again. The galls on *J. virginiana* are annual, producing only one batch of teliospores, so fresh infections of *J. virginiana* are needed every year for the life cycle to be maintained, in contrast to the behaviour of some other *Gymnosporangium* spp. For more information see Peterson (1967).

DETECTION AND IDENTIFICATION

Symptoms

On *J. virginiana*, *G. juniperi-virginianae* causes galls ("cedar apples") on twigs and branches (see Morphology). On apple, the most conspicuous symptoms are the appearance of the aecia and pycnia on the leaves (see Morphology). Small yellow-orange lesions appear on the upper surface of the leaves and petioles, within which the pycnia are formed. Several weeks later, yellow-brown lesions (1-16.5 mm) appear on the undersurface, within which the aecia are formed (Aldwinckle, 1990). On susceptible cultivars, *G. juniperi-virginianae* can cause very severe defoliation. Occasionally it can cause superficial brown necrotic lesions on apple fruits, sometimes containing pycnia but rarely aecia.

Morphology

On *Juniperus virginiana*

Telia are formed on globoid or reniform galls 1-3 cm in diameter on the sides of twigs or branches. They are long-cylindric, tapered, 10-20 mm long x 1-2 mm wide, rusty-brown. Teliospores are two-celled, cylindric-fusoid, 15-21 x 45-65 µm, wall 0.5-1 µm thick.

On apple

Aecia are roestelioid, hypophyllous with the peridia 3-5 mm high, dehiscent at the apex. The aeciospore mass is reddish-brown. Aeciospores are 20-28 µm in diameter. Details can be found in Laundon (1977).

Detection and inspection methods

The inspection of imported *Juniperus* which may have latent infection is particularly important. A secure quarantine procedure would involve retention under closed conditions for 2 years and frequent inspection during January-May.

MEANS OF MOVEMENT AND DISPERSAL

Under natural conditions, spread of *G. juniperi-virginianae* is by basidiospore dispersal to apple, and by wind-borne aeciospores to *Juniperus virginiana*. In international trade, all plants of *J. virginiana* from North America are liable to be infected by *G. juniperi-virginianae*. Like other *Gymnosporangium* spp., *G. juniperi-virginianae* can be latent during winter (the probable importing period) and may not be detectable at pre-export phytosanitary certification. Infection may also have remained latent on the plants in the previous growing season.

Introduction of *G. juniperi-virginianae* on commercial importations of plants of apple is very unlikely as infection is not persistent in the dormant stage. While fruits can be infected, it is very unlikely that infected fruits would be harvested or meet quality standards for export.

PEST SIGNIFICANCE

Economic impact

G. juniperi-virginianae causes a serious disease on apples in North America, and is much the most important of the North American *Gymnosporangium* spp. (Aldwinckle, 1990). It also causes problems on *Juniperus virginiana*, which is an important timber and amenity tree in North America.

Control

G. juniperi-virginianae can be adequately controlled on apples by routine fungicide applications (e.g. dithiocarbamates, sterol-inhibiting fungicides). A weather-based forecasting system for *G. juniperi-virginianae* and two other apple pathogens has been studied by Arauz *et al.* (1990). Varietal differences in susceptibility are well known for this species (Warner, 1990). Resistant cultivars include Delicious, Liberty, McIntosh, Priscilla and Tydeman's Early Worcester, while Golden Delicious, Jonathan, Prima, Rome Beauty, Twenty Ounce and York Imperial are very susceptible (Aldwinckle, 1990). Joungh *et al.* (1987) have described a method of screening cultivars in tissue culture for resistance to this rust. It is not recommended to plant *J. virginiana* close to orchards, for the sake of either host.

Phytosanitary risk

G. juniperi-virginianae is one of the non-European *Gymnosporangium* spp. listed as A1 quarantine organisms by EPPO (OEPP/EPPO, 1983). It is also listed as a quarantine pest by COSAVE, IAPSC and JUNAC. Other *Gymnosporangium* spp. already occur on apples in Europe, e.g. *G. tremelloides* with *Juniperus communis* as alternate host (Smith *et al.*, 1988). The severity of infection on apples (the important host) is determined by the proximity of infected alternate hosts and, in practice, *G. tremelloides* is of very minor importance. In favour of the quarantine pest status of *G. juniperi-virginianae* is the fact that it appears to be a much more damaging species than its European counterpart, and that it is also damaging to its alternate host *J. virginiana*, grown as a timber tree in some parts of central Europe. Against it is the fact that apple rust is in any case easily controlled, and that *J. virginiana*, as its alternate host, has only locally and to a limited extent been introduced into Europe. Various publications (e.g. Laundon, 1977) suggest that members of *Juniperus* subgenus *Sabina* in general can be hosts, but there is apparently no specific evidence available on this. Thus, though *J. sabina* and related European species occur as wild plants in the mountains of central and southern Europe and are grown as ornamentals, the idea that they might act as alternate hosts of *G. juniperi-virginianae* in Europe is pure conjecture.

PHYTOSANITARY MEASURES

As infection of *Juniperus* is systemic in stems and evergreen leaves, no chemical treatment is likely to be completely effective to treat imported plants found to be infected. The use of cycloheximide has been recommended for the suppression of teliospore production of *G. juniperi-virginianae* in the USA and this may be used as a short-term quarantine treatment of infected plants pending destruction. It may be noted, however, that *G. juniperi-virginianae* is annual on *Juniperus*, while other species are perennial. It is most unlikely that infection from the telial stage could be carried on packing materials and the risk is virtually confined to infected plants.

EPPO proposes (OEPP/EPPO, 1990) that all countries may prohibit importation of plants for planting and cut branches of *Juniperus* from Asia and North America. If plants for planting of *J. virginiana* (or other *Juniperus* spp.) are imported from North America,

the consignment should be kept in quarantine over the growing season and found free from *Gymnosporangium* spp. All countries should require that plants for planting and cut branches of *Juniperus* from North America should come from a field found free, with its immediate vicinity, from these diseases during the last two growing seasons. All countries should also require that plants for planting and cut branches of *Malus* from North America should be dormant and free from leaves.

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