EPPO Datasheet: *Phymatotrichopsis omnivora*

Last updated: 2022-01-17

IDENTITY

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Preferred name: *Phymatotrichopsis omnivora*
Authority: (Shear) Hennebert
Taxonomic position: Fungi: Ascomycota: Pezizomycotina: Pezizomycetes: Pezizales: Rhizinaceae
Other scientific names: *Ozonium omnivorum* Shear, *Phymatotrichum omnivorum* (Shear) Duggar
Common names: Ozonium root rot, Phymatotrichopsis root rot (US), Texas root rot of alfalfa, Texas root rot of bean, Texas root rot of cotton, Texas root rot of grapevine, cotton root rot (US), phymatotrichum root rot, root rot of conifers, root rot of soybean, soft rot of cotton
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EPPO Categorization: A1 list
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EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: PHMPOM

Notes on taxonomy and nomenclature

The causal organism, *Phymatotrichopsis omnivora* (= *Phymatotrichum omnivorum* = *Ozonium omnivorum*), is known only as an asexual (mitosporic) fungus and produces noninfectious microconidia on epigeous spore mats of hyaline conidiophores resembling those of *Botrytis* (=*Phymatotrichum*) and mycelial cords on infected roots resembling the *Ozonium* stage of *Coprinellus* (Psathyrellaceae). Although the corticoid basidiomycetes *Hydnophlebia* (= *Phanerochaete*) *omnivora* (Meruliaceae) and *Sistotrema brinkmannii* (Corticiacea) have been suggested as teleomorphs of *Phymatotrichopsis omnivora*, phylogenetic analyses of multiple isolates indicate that it is neither a basidiomycete nor closely related to *Botrytis* (Sclerotiniaceae, Leotiomycetes). *Phymatotrichopsis omnivora* is a member of the family Rhizinaceae, Pezizales (Ascomycota: Pezizomycetes) allied to *Psilopezia* and *Rhizina* (Marek *et al.*, 2009).

HOSTS

The major host is cotton, including *Gossypium herbaceum*, *G. hirsutum* and *G. barbadense*. The fungus can also infect more than 2000 species of dicots including 31 economic field crops, 58 vegetable crops, 18 fruits and berries including citrus, 35 forest trees and shrubs, 7 herbaceous ornamentals and 20 weeds (Streets, 1937; Streets & Bloss, 1973). When endemic, the fungus causes significant economic losses on many field crops, such as cotton, alfalfa and peanuts. Phymatotrichopsis Root Rot (PRR) can also cause losses on horticultural crops, such as pecans, apples and ornamental trees and shrubs. Monocots are thought to be immune, but fungal strands and sclerotia have been reported on such hosts in nature (Rush *et al.*, 1984b) and in the laboratory (Kankanala *et al.*, 2020). The potential host range in the EPPO region is presumably just as wide.

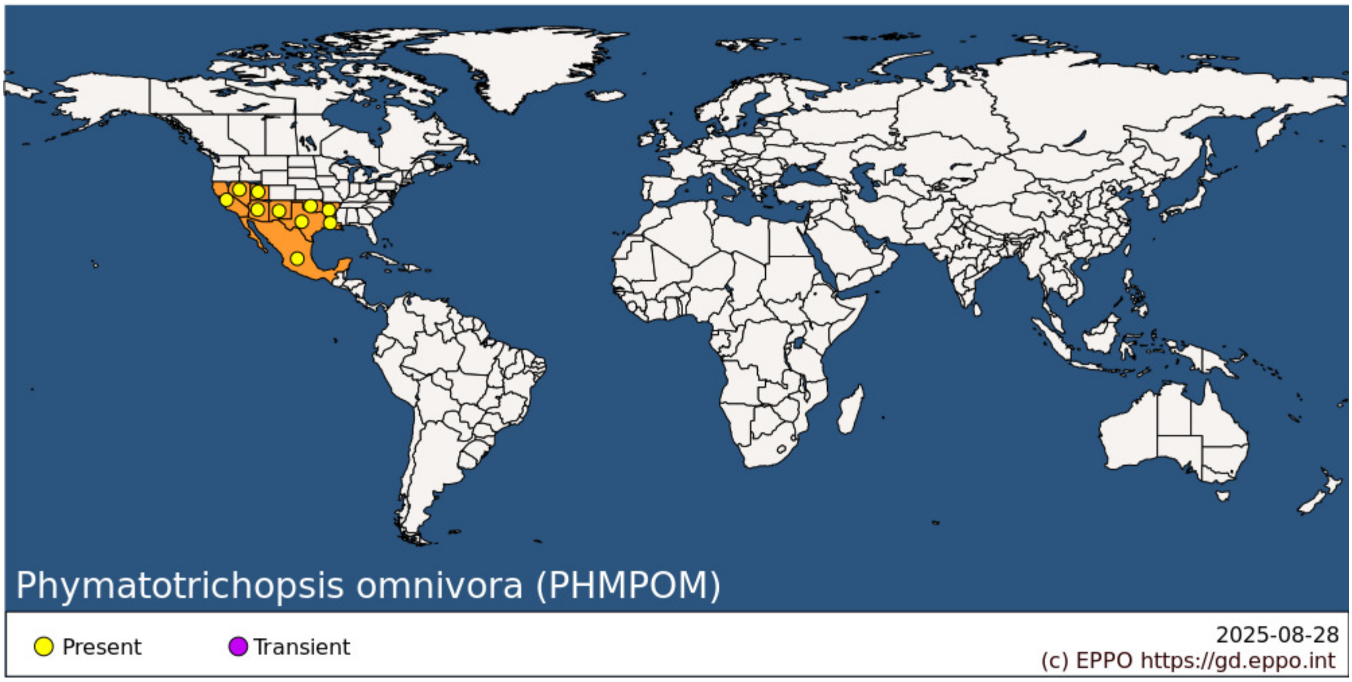
Host list: *Abelia chinensis*, *Abelia x grandiflora*, *Abelmoschus esculentus*, *Abutilon incanum*, *Abutilon theophrasti*, *Acalypha sp.*, *Acer negundo*, *Acer saccharinum*, *Acer saccharum*, *Achillea millefolium*, *Acmispon americanus*, *Aconitum sp.*, *Aesculus hippocastanum*, *Aesculus pavia*, *Ageratina altissima*, *Agrimonia pubescens*, *Agrostemma githago*, *Ailanthus altissima*, *Alcea ficifolia*, *Alcea rosea*, *Allionia sp.*, *Alnus glutinosa*, *Alnus rubra*, *Alnus tenuifolia*, *Amaranthus caudatus*, *Amaranthus graecizans*, *Amaranthus retroflexus*, *Amaranthus spinosus*, *Amaranthus x tamariscinus*, *Ambrosia artemisiifolia*, *Ambrosia bidentata*, *Ambrosia psilostachya*, *Ambrosia trifida*, *Amelanchier alnifolia*, *Amorpha sp.*, *Anethum graveolens*, *Angelica sp.*, *Annona squamosa*, *Anthemis arvensis*, *Anthemis cotula*, *Antirrhinum majus*, *Apios americana*, *Apocynum androsaemifolium*, *Apocynum cannabinum*, *Aquilegia canadensis*, *Arabis sp.*, *Arachis hypogaea*, *Aralia spinosa*, *Araucaria angustifolia*, *Arbutus menziesii*, *Arctium lappa*, *Arctium minus*

, Arctostaphylos manzanita, Arctotis stoechadifolia, Arenaria sp., Argemone mexicana, Argemone platyceras, Argyreia nervosa, Armoracia rusticana, Aronia melanocarpa, Artemisia biennis, Asclepias syriaca, Asclepias tuberosa, Asimina triloba, Astragalus sp., Baccharis sp., Baptisia sp., Bassia scoparia, Bellis perennis, Berberis canadensis, Berberis thunbergii, Berberis vulgaris, Beta vulgaris subsp. vulgaris var. cicla, Beta vulgaris, Betula nigra, Bidens sp., Boerhavia erecta, Brachychiton populneus, Brassica napus subsp. rapifera, Brassica oleracea var. botrytis, Brassica oleracea var. capitata, Brassica oleracea var. gongylodes, Brassica oleracea var. viridis, Brassica rapa, Brickellia sp., Broussonetia papyrifera, Buddleia davidii, Buglossoides arvensis, Caesalpinia gilliesii, Cajanus cajan, Calendula officinalis, Callirhoe involucrata, Callistephus chinensis, Calocedrus decurrens, Calystegia pubescens, Calystegia sepium, Campsis radicans, Cannabis sativa, Capsicum frutescens, Caragana arborescens, Carica papaya, Carissa macrocarpa, Carpinus caroliniana, Carya illinoinensis, Cassia texana, Castanea pumila, Castanea sativa, Catalpa bignonioides, Catalpa speciosa, Cedrus sp., Celastrus orbiculatus, Celtis laevigata, Celtis occidentalis, Cerastium glomeratum, Cerastium holosteoides, Ceratonia siliqua, Cercis canadensis, Cercis occidentalis, Cercis reniformis, Cereus sp., Chaenomeles sp., Chamaecrista fasciculata, Chamaecyparis thyoides, Chamerion angustifolium, Chelidonium majus, Chenopodium album, Chilopsis linearis, Chionanthus virginicus, Chrysanthemum x morifolium, Cichorium endivia, Cichorium intybus, Cicuta maculata, Cinnamomum camphora, Cissus sp., Citrullus lanatus, Citrus medica, Citrus trifoliata, Citrus x aurantiifolia, Citrus x aurantium var. paradisi, Citrus x aurantium var. sinensis, Citrus x aurantium var. unshiu, Citrus x aurantium, Citrus x limon, Citrus x nobilis, Claytonia caroliniana, Clematis sp., Clethra alnifolia, Clitoria mariana, Cnidoscolus texanus, Cocculus carolinus, Cocculus orbiculatus, Codiaeum variegatum, Convolvulus arvensis, Cordia boissieri, Coreopsis sp., Cornus drummondii, Cornus florida, Corylus americana, Corylus cornuta, Cosmos bipinnatus, Cosmos sulphureus, Cotinus coggygria, Cotoneaster sp., Crataegus sp., Crotalaria brevidens var. intermedia, Crotalaria pallida var. obovata, Crotalaria spectabilis, Croton monanthogynus, Croton texensis, Cucumis melo, Cucumis sativus, Cucurbita maxima, Cucurbita melopepo, Cucurbita moschata, Cucurbita pepo, Cupressus sempervirens, Cyamopsis tetragonoloba, Cydonia oblonga, Cynara scolymus, Cynoglossum officinale, Dahlia pinnata, Dalea sp., Datura innoxia, Datura stramonium, Daucus carota subsp. sativus, Delphinium ajacis, Delphinium sp., Descurainia pinnata, Desmodium sp., Dianthus barbatus, Dianthus caryophyllus, Dianthus plumarius, Dichondra repens var. carolinensis, Diervilla lonicera, Dioscorea sp., Diospyros kaki, Diospyros texana, Diospyros virginiana, Dipsacus fullonum, Dolichandra unguis-cati, Dysphania ambrosioides, Echinacea purpurea, Echinocactus sp., Elaeagnus angustifolia, Eleutherococcus sieboldianus, Ephedra sinica, Erechtites hieraciifolius, Erigeron annuus, Erigeron canadensis, Eriobotrya japonica, Eriogonum sp., Eryngium sp., Erythrina sp., Eucalyptus camaldulensis, Eucalyptus polyanthemos, Eucalyptus rudis, Euonymus atropurpureus, Euonymus japonicus, Eupatorium caelestinum, Euphorbia corollata, Euphorbia cyparissias, Euphorbia dentata, Euphorbia maculata, Euphorbia marginata, Euphorbia milii, Euphorbia pulcherrima, Evolvulus sp., Eysenhardtia polystachya, Feijoa sellowiana, Ficus carica, Firmiana simplex, Foeniculum vulgare, Forestiera acuminata, Forsythia sp., Fouquieria splendens, Frangula caroliniana, Franseria sp., Fraxinus sp., Fraxinus velutina, Froelichia sp., Gaillardia aristata, Gaillardia pulchella, Galium sp., Gardenia jasminoides, Garrya flavescens, Gelsemium sempervirens, Geranium carolinianum, Geum aleppicum var. strictum, Geum canadense, Gilia sp., Ginkgo biloba, Glandularia bipinnatifida, Gleditsia triacanthos, Glycine max, Gnaphalium sp., Gordonia lasianthus, Gossypium barbadense, Gossypium herbaceum, Gossypium hirsutum, Grevillea robusta, Grindelia sp., Gutierrezia sp., Gymnocladus dioica, Haplopappus sp., Hedera helix, Helenium amarum, Helenium autumnale, Helianthemum nummularium, Helianthus annuus, Helianthus maximiliani, Helianthus petiolaris, Helianthus tuberosus, Heliopsis helianthoides var. scabra, Heliopsis helianthoides, Heracleum maximum, Hesperocyparis arizonica, Hesperocyparis macrocarpa, Heteromeles arbutifolia, Hibiscus cannabinus, Hibiscus palustris, Hibiscus sabdariffa, Hibiscus syriacus, Hibiscus trionum, Hieracium sp., Houstonia sp., Hydrangea paniculata, Hydrangea petiolaris, Hydrastis canadensis, Hypochaeris radicata, Ilex cassine, Ilex decidua, Ilex vomitoria, Indigofera sp., Ipomoea alba, Ipomoea batatas, Ipomoea hederacea, Ipomoea nil, Ipomoea purpurea, Ipomoea quamoclit, Iva xanthiifolia, Jacaranda acutifolia, Jatropha sp., Juglans ailanthifolia, Juglans californica, Juglans nigra, Juglans regia, Juniperus chinensis, Juniperus communis, Juniperus deppeana var. pachyphloea, Juniperus horizontalis, Juniperus scopulorum, Juniperus virginiana var. silicicola, Juniperus virginiana, Justicia americana, Kalmia latifolia, Kerria japonica, Koelreuteria sp., Krameria lanceolata, Krigia sp., Kuhnia sp., Lablab purpureus, Lactuca sativa, Lactuca serriola, Lagenaria siceraria, Lagerstroemia indica, Lantana horrida, Lappula squarrosa, Larix laricina, Lathyrus odoratus, Lepidium campestre, Lepidium densiflorum, Lepidium sativum, Lepidium virginicum, Lespedeza sp., Lesquerella sp., Leucanthemum vulgare, Leucophyllum frutescens, Liatris pycnostachya, Ligustrum sp., Limonium sp., Linaria vulgaris, Lindera sp., Linum lewisii, Linum rigidum, Linum sulcatum, Lippia sp., Liquidambar styraciflua, Liriodendron tulipifera, Lithospermum occidentale, Lobelia inflata, Lobelia siphilitica, Lonicera morrowii, Lonicera sempervirens, Lonicera tatarica, Lupinus perennis, Lupinus subcarnosus, Lycium carolineanum, Lysimachia ciliata, Lysimachia sp., Maackia amurensis, Maclura pomifera, Magnolia grandiflora, Malus baccata, Malus domestica, Malus sylvestris, Malva sp., Malvastrum sp., Malvaviscus arboreus var. drummondii, Malvella leprosa, Mammillaria sp., Mangifera indica

, *Manihot esculenta*, *Manilkara zapota*, *Matthiola incana*, *Medicago arabica*, *Medicago lupulina*, *Medicago polymorpha*, *Medicago sativa*, *Medicago truncatula*, *Melia azedarach*, *Melilotus albus var. annuus*, *Melilotus albus*, *Melilotus indicus*, *Melilotus officinalis*, *Mentzelia laevicaulis*, *Mimosa sp.*, *Mirabilis jalapa*, *Mirabilis nyctaginea*, *Mollugo verticillata*, *Morus alba*, *Mucuna deeringiana*, *Myrica cerifera*, *Nandina domestica*, *Nerium oleander*, *Nicandra physalodes*, *Nicotiana glauca*, *Nicotiana tabacum*, *Nyssa sp.*, *Oenothera gaura*, *Oenothera laciniata*, *Oenothera suffrutescens*, *Olea europaea*, *Oncoba spinosa*, *Osmanthus heterophyllus*, *Ostrya virginiana*, *Oxydendrum arboreum*, *Paeonia lactiflora*, *Parkinsonia florida*, *Parkinsonia sp.*, *Parthenium argentatum*, *Parthenocissus quinquefolia*, *Parthenocissus tricuspidata*, *Passiflora sp.*, *Pastinaca sativa*, *Paulownia tomentosa*, *Pavonia sp.*, *Penstemon cobaea*, *Persea americana*, *Persicaria lapathifolia*, *Persicaria maculosa*, *Petroselinum crispum*, *Phacelia sp.*, *Phaseolus acutifolius*, *Phaseolus lunatus*, *Phaseolus vulgaris*, *Philadelphus sp.*, *Phlox paniculata*, *Photinia serratifolia*, *Physalis sp.*, *Physocarpus sp.*, *Phytolacca americana*, *Picea engelmannii*, *Pilosella aurantiaca*, *Pimpinella anisum*, *Pinus echinata*, *Pinus nigra*, *Pistacia chinensis*, *Pistacia vera*, *Pisum sativum*, *Pittosporum sp.*, *Plantago aristata*, *Plantago lanceolata*, *Platanus occidentalis*, *Platanus wrightii*, *Platycladus orientalis*, *Platycodon grandiflorus*, *Plectocephalus americanus*, *Plumeria sp.*, *Polygonum aviculare*, *Populus alba*, *Populus deltoides*, *Populus fremontii*, *Populus nigra*, *Populus x canadensis*, *Portulaca grandiflora*, *Potentilla sp.*, *Primula obconica*, *Proboscidea louisianica*, *Prosopis sp.*, *Prunus americana*, *Prunus armeniaca*, *Prunus cerasus*, *Prunus domestica*, *Prunus dulcis*, *Prunus laurocerasus*, *Prunus munsoniana*, *Prunus persica*, *Prunus serotina*, *Pseudotsuga menziesii*, *Psidium guajava*, *Psoralea tenuiflora*, *Ptelea trifoliata*, *Pueraria montana var. lobata*, *Punica granatum*, *Pyracantha sp.*, *Pyrus communis*, *Quercus cerris*, *Quercus macrocarpa*, *Quercus palustris*, *Quercus phellos*, *Quercus prinus*, *Quercus suber*, *Quercus virginiana*, *Ranunculus repens*, *Raphanus sativus*, *Ratibida columnifera*, *Rheum rhaponticum*, *Rhododendron catawbiense*, *Rhus copallinum*, *Rhus glabra*, *Rhus trilobata*, *Rhus typhina*, *Ribes rubrum*, *Ribes sp.*, *Rivina humilis*, *Robinia hispida*, *Robinia pseudoacacia*, *Rosa sp.*, *Rubus idaeus var. strigosus*, *Rubus sp.*, *Rubus ulmifolius*, *Rubus x loganobaccus*, *Rudbeckia triloba*, *Rumex crispus*, *Salix babylonica*, *Salix nigra*, *Salsola kali*, *Salvia greggii*, *Salvia splendens*, *Sambucus canadensis*, *Sambucus racemosa subsp. pubens*, *Sapindus drummondii*, *Saponaria officinalis*, *Sassafras albidum*, *Scabiosa atropurpurea*, *Schinus molle*, *Schinus terebinthifolia*, *Scutellaria sp.*, *Senecio sp.*, *Senegalia greggii*, *Senna marilandica*, *Senna tora*, *Sequoia sempervirens*, *Sesbania herbacea*, *Sesbania vesicaria*, *Sesuvium portulacastrum*, *Shepherdia argentea*, *Sida rhombifolia*, *Sida spinosa*, *Sideroxylon lanuginosum*, *Silene antirrhina*, *Silene latifolia subsp. alba*, *Silphium sp.*, *Solanum carolinense*, *Solanum elaeagnifolium*, *Solanum lycopersicum*, *Solanum melongena*, *Solanum nigrum*, *Solanum rostratum*, *Solanum tuberosum*, *Solidago altissima*, *Sonchus asper*, *Sonchus oleraceus*, *Sophora davidii*, *Sophora secundiflora*, *Sorbus americana*, *Spergula arvensis*, *Sphaeralcea angustifolia*, *Spinacia oleracea*, *Spiraea sp.*, *Stellaria media*, *Stillingia linearifolia*, *Strophostyles helvola*, *Styphnolobium japonicum*, *Symplocos tinctoria*, *Syringa reticulata var. mandschurica*, *Syringa vulgaris*, *Syringa x chinensis*, *Tamarix sp.*, *Tanacetum cinerariifolium*, *Taraxacum officinale*, *Taxodium sp.*, *Tecoma stans*, *Tephrosia sp.*, *Thuja occidentalis*, *Tilia americana*, *Toxicodendron pubescens*, *Toxicodendron vernix*, *Tragia sp.*, *Tragopogon porrifolius*, *Triadica sebifera*, *Trifolium campestre*, *Trifolium incarnatum*, *Trifolium pratense*, *Trifolium repens*, *Triodanis perfoliata subsp. biflora*, *Tsuga diversifolia*, *Ulmus americana*, *Ulmus crassifolia*, *Ulmus parvifolia*, *Ulmus pumila*, *Ulmus thomasii*, *Ungnadia speciosa*, *Urtica dioica subsp. gracilis*, *Urtica dioica*, *Vaccinium arboreum*, *Vachellia farnesiana*, *Valerianella sp.*, *Verbascum blattaria*, *Verbascum thapsus*, *Verbena hybrids*, *Verbesina encelioides*, *Vernicia fordii*, *Vernonia sp.*, *Veronica arvensis*, *Veronica officinalis*, *Veronica peregrina*, *Veronicastrum virginicum*, *Vicia faba*, *Vicia sativa subsp. nigra*, *Vicia sativa*, *Vigna radiata*, *Vigna unguiculata subsp. unguiculata*, *Viguiera sp.*, *Vincetoxicum sp.*, *Viola odorata*, *Vitex agnus-castus*, *Vitis labrusca*, *Vitis rupestris*, *Vitis vinifera*, *Weigela sp.*, *Wisteria sp.*, *Xanthium orientale subsp. saccharatum*, *Zinnia elegans*, *Ziziphus jujuba*

GEOGRAPHICAL DISTRIBUTION

Phymatotrichopsis omnivora is widespread in the alkaline, calcareous soils of the Southwestern USA and Northern Mexico (Percy, 1983). The fungus is prevalent throughout much of the cotton-growing area of Texas (except for the Caprock escarpment of the Panhandle), and hence the disease is often referred to as ‘cotton root rot’ or ‘Texas root rot’. Other records include recent reports in Venezuela (Colmenares, 2016), as well as older records for the Dominican Republic, India, Libya, Malawi and Pakistan (Lyda, 1972; Mishra, 1953; Uppalapati *et al.*, 2010; Farr & Rossman, 2021). As *P. omnivora* is difficult to isolate and identify morphologically, previous reports of distribution outside of the USA and Mexico are considered doubtful and should be confirmed molecularly (Arif *et al.*, 2014).



North America: Mexico, United States of America (Arizona, Arkansas, California, Louisiana, Nevada, New Mexico, Oklahoma, Texas, Utah)

BIOLOGY

P. omnivora is not seedborne. The primary inoculum is sclerotia, or strands surviving on roots of host plants. The fungus spreads as fine mycelial strands which traverse the soil and infect other roots. Experiments have shown that strands did not survive for more than 1 year on roots of killed cotton plants remaining in the soil, and strands buried 25 cm deep in the rhizosphere of cotton plants in the field did not survive for more than 3 months. Strands require live cotton roots for overwintering as experiments have shown that strands have poor survival on dead cotton plants. Sclerotia, on the other hand, have been shown to survive for at least 5 years in soil. Strands and sclerotia have been found at depths of 2 m and 2.6 m, respectively (although most occur at 0.5-0.9 m), thus demonstrating that they can tolerate high levels of CO_2. The fungus was not eliminated in soil flooded for 120 days. After heavy summer rain, the fungus may come to the soil surface and form large tawny mycelial mats, 10-20 cm in diameter and 0.6 cm thick, on which conidia are borne. These spores probably play no part in dissemination as they rarely germinate. Nothing is known about the possible role of the teleomorph, but recent genome sequencing has shown that *P. omnivora* is a heterothallic fungus based on the presence of the mating type genes, MAT1-1-1 or MAT1-2-1, in an isolate (Mattupalli *et al.*, 2021), which indicates that *P. omnivora* may have a yet to be identified sexual cycle.

Temperature is an important factor in pathogen survival with relatively high winter temperatures being favourable (Wheeler & Hine, 1972). Rush *et al.* (1984a), analyzed the factors which affect symptom appearance and concluded that root rot is favoured by temperatures over 22°C and relatively high soil moisture. Jeger & Lyda (1986) looked for environmental factors correlating to disease incidence, and identified cumulative precipitation up to the end of the growing season and (inversely) temperatures above 34°C. A threshold criterion based on cumulative precipitation and mean maximum temperature during the preceding 10 days could be used to forecast annual disease incidence. Percy (1983) assessed soil base exchange capacity, pH, sodium content, calcium content and clay fraction, and mean annual air temperature, as factors limiting the occurrence of *P. omnivora*. A map of the potential distribution of the fungus in North America, based on this analysis, was mostly coterminous with the known distribution. In addition, the fungus cannot tolerate soil temperatures below freezing for any appreciable time. Thus, temperature and soil requirements appear to be the factors restricting the natural distribution of the pathogen.

For more information on the biology of the pathogen see Streets (1937) and Streets & Bloss (1973), Uppalapati *et al.* (2010).

DETECTION AND IDENTIFICATION

Symptoms

The disease on cotton appears in patches in the field and these areas do not necessarily produce a diseased crop the next year (Uppalapati *et al.*, 2010). The infection of the root system early in the season does not cause above-ground symptoms (Rush *et al.*, 1984c). Symptoms only become conspicuous during the summer, as a sudden wilting of the plant, with or without a prior chlorosis of the leaves. The foliage droops, turns brown and may remain hanging on the branches for a few days before dropping off to leave a bare, dead stalk. At this stage, the roots are dead and their surface is covered with a network of yellow-brown fungal strands. If there is abundant water, brown to black wart-like sclerotia are also seen on the surface roots. The cortex of the killed roots is soft and readily peels. The conidial stage develops on the ground, near the margin of the zone of dying plants in the form of cushion-like, creamy yellowish masses. These spore mats are not, however, often found in cotton fields.

In a perennial crop such as alfalfa, the disease will continue to spread throughout each sequential growing season, with up to 30% stand loss occurring over a single year (Mattupalli *et al.*, 2018). Surviving alfalfa plants compensated for damage or loss to the taproot through the development of more lateral and crown roots (Mattupalli *et al.*, 2019).

Morphology

Conidia unicellular, hyaline, globose (4.8-5.5 µm in diameter) or ovate (6-8 x 5-6 µm). Mycelial strands about 200 µm in diameter, bearing acicular hyphae, with distinctive cruciform branches emanating from the peripheral mycelium. Sclerotia irregular in shape, brown to black, 1-5 mm in diameter.

More detailed information is given by Streets (1937) and Streets & Bloss (1973).

Genome

Four isolates of *P. omnivora* have been sequenced (Mattupalli *et al.*, 2021). Interestingly, the draft genome assemblies of the four isolates sequenced revealed that *P. omnivora* genome is bigger than most other fungal genomes. The genome size among *P. omnivora* isolates ranged from 107 to 109 Mb. Approximately 38% to 40% of the genome of *P. omnivora* are repeat sequences.

Detection and inspection methods

In general, the yellow-brown parallel strands of mycelium visible with a hand-lens on rotted roots of host plants are characteristic. PCR- and real-time PCR-based methods have been developed to detect the pathogen in root tissues for ease of detection (Arif *et al.*, 2014; Mattupalli *et al.*, 2019).

PATHWAYS FOR MOVEMENT

Under natural conditions, as a soilborne pathogen, *P. omnivora* has low dispersal potential. It persists at certain locations where soil conditions are favourable and does not readily spread beyond the vicinity of the host plant. *P. omnivora* could be transported by human-assisted means, with soil or on roots of infected host plants. Locally, it may be spread with soil associated to agricultural machinery. In North America, internal quarantine measures have been applied to prevent spread into non-infested areas, but it is likely that the fungus has reached its natural limits in any case. The risk of intercontinental introduction is mainly with trade of hosts other than cotton since cotton plants are not usually moved in trade. Seeds are not a pathway as *P. omnivora* is not seed-borne, and traded seeds should be free from soil. There are no records of the fungus being intercepted in internationally traded consignments, at least in the EU (EFSA PHL *et al.*, 2019).

PEST SIGNIFICANCE

Economic impact

The fungus is most serious on cotton and on this host it kills plants before maturity, reduces yield and quality by killing partly developed bolls and reduces lint quality in plants which survive until harvest. Mulrean *et al.* (1984) have analysed the elements of yield loss in cotton. Each year, it is estimated that 2% of the cotton yield in Texas (USA) is lost to root rot (Watkins, 1981). Cotton cultivation has been abandoned in some cases on soils that are most favourable to the fungus. *P. omnivora* also causes significant economic losses to alfalfa cultivation in Southern Oklahoma and Northern Texas (Uppalapati *et al.*, 2010). Unlike cotton, alfalfa is a perennial crop, and the root rot disease persists year after year and the disease areas increase over time (Mattupalli *et al.*, 2018). Because of this disease, farmers are reluctant to grow alfalfa in affected areas of Oklahoma and Texas.

On sunflowers, *P. omnivora* delays seed germination, and this combined with late planting may result in significant losses (Orellana, 1973). The references to *P. omnivora* in the APS Compendia of Plant Diseases (Riggs 2001; Young *et al.*, 2014) give a partial view of the situation on other crops. Winter-grown annual crops (such as sugarbeet) escape disease. Apples, peaches, pecans, grapes, and in Mexico, mangoes and avocados, suffer significant losses. *P. omnivora* is a major constraint to apple cultivation in Texas. *Ulmus* spp. have been severely attacked. The disease is only minor on citrus, roses and Rhododendron. It is not damaging on sweet potatoes or groundnuts. In general, there is relatively little information on hosts other than cotton and alfalfa in the research literature, which suggests that, though many are attacked by the fungus, relatively few suffer significant economic loss.

Control

The disease occurs particularly on heavy calcareous soils.

Heavy nitrogenous manuring and deep cultivation reduce losses. The disease on cotton is mainly controlled by rotation with non-host plants (e.g. with sorghum) and cultural practices such as early planting, to allow the crop to establish and start boll formation before root rot becomes significant.

Chemicals can be used to control the fungus in the soil. The standard soil treatments have been reported to be effective as have drenches with fungicides such as the benzimidazoles. Such treatments would be too costly for field crops but might be suitable for land on which a high-value horticultural crop was to be grown. Only the soil directly treated is affected, and experience shows that after a certain time this soil is recontaminated by *P. omnivora* coming from deeper soil layers. Thus, it is doubtful whether such treatments would be effective enough to be used for eradication (Uppalapati *et al.*, 2010). Recently, flutriafol (triazole fungicide) has been used to successfully control *P. omnivora* in cotton fields in the USA (Chitrampalam & Olsen, 2014; Isakeit *et al.*, 2012; Norton *et al.*, 2014). This fungicide is applied in the furrows while planting cotton seeds (Isakeit *et al.*, 2012; Norton *et al.*, 2014; Yang, 2020). It has also been approved in 2020 for use in alfalfa in the USA. This is the only chemical active substance on the market labelled for management of *P. omnivora*.

Identification of varietal resistance has not been found in the major hosts. There is considerable research interest in antagonistic fungi which colonize and destroy *P. omnivora* sclerotia (e.g. Kenerley & Stack, 1987, Martínez-Escudero *et al*., 2016) but this is not yet applied in practice.

Phytosanitary risk

P. omnivora is a polyphagous pathogen which causes important damage on crops such as cotton, alfalfa, apple, peach and grapevine. It would be very difficult to control if introduced in the EPPO region. EFSA PHL Panel *et al*. (2019) concluded that it met the criteria to be a quarantine pest for the EU. In view of the temperature and soil factors which appear to limit the distribution of the pest in North America (see Biology), potential distribution in other continents would mainly be in the warmer wetter areas (South America, Africa, India). In the EPPO region, the cotton-growing countries of the Mediterranean basin would be more likely to be affected than the more continental areas e.g. of Central Asia. With respect to other host plants, the risk is much greater for North Africa and Southern Europe than for Northern or Eastern Europe.

PHYTOSANITARY MEASURES

It is recommended to prohibit the importation of soil from areas where *P. omnivora* occurs. This implies that no soil should accompany plants for planting imported from those areas. However, inorganic or sterilized growing media could, if necessary, be accepted, or other safeguards to ensure that there is no possibility that *P. omnivora* could be present in the growing medium. EPPO Standard PM 8/1 on potato notes that *P. omnivora* can be present in soil attached to potato tubers and recommends that tubers should be free from plant debris and from soil. This is also valid for bulbs and root vegetables.

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