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Phytophthora on *Quercus suber* L. (cork oak)

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants

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Importance of *Quercus suber*

Quercus suber is a typically Mediterranean species, endemic of Southern Europe and Northern Africa where the climate is characterized by summer drought and mildly cold winters (distribution map see http://www.discoverlife.org). It's an evergreen tree that grows up to 20 m in height, the stem diameter at breast height can reach more than 200 cm, the bark is up to 20 cm thick, porous and furrowed and the leaves are alternate, simple and with the margin entire or with 4-7 pairs of acute teeth. It grows well in various types of soil, with a preference for acidic soils (pH 5-7) and with low tolerance for calcarious and saline soils. Cork oak is an essential component in the agro-ecosystems of the Iberian Peninsula supporting rich wildlife populations and simultaneously used by farmers to grow cereals, graze animals and harvest cork. Portugal is the main producer and exporter of cork, as well as first in the industrial transformation and commercialization sectors.

Phytophthora species

From *Q. suber* trees, irrespective of the presence of decline symptoms, the following *Phytophthora* species have been isolated directly from the tissues or from the soil:

***Phytophthora* species**	**Disease symptoms**	**Reference**
cinnamomi	Canker, root rot	Brasier *et al.*, 1993; Tuset *et al.*, 1996; Robin *et al.*, 1998, Moreira & Martins, 2005; Caetano, 2007; Scanu *et al.*, 2012
citrophthora	Decline	Scanu *et al.*, 2012
cryptogea	Decline	Scanu *et al.*, 2012
psychrophila	Decline	Scanu *et al.*, 2012
quercina	Decline	Scanu *et al.*, 2012
ramorum	Stem canker	Moralejo *et al.*, 2009

In infection trials with detached leaves *Q. suber* showed consistently low susceptibility to *P. ramorum* infection (Denman *et al.,* 2005).

Disease symptoms (see figures)

Phytophthora species can attack different plant tissues and cause different disease symptoms on *Q. suber*. The most common symptoms are:

Crown: yellow leaves, reduction of leave size, epicormic shoots and defoliation (Moreira & Martins, 2005)

Stem: bleeding canker and tarry exudations (Moreira & Martins, 2005)

Roots: root rot

Possibility of Symptom Confusion

The disease symptoms presented in the previous chapter are not specific only for *Phytophthora* infection. The fungus *Biscogniauxia mediterranea*, the causal agent of the charcoal disease causes similar symptoms as *Phytophthora*, like yellowing of the leaves, defoliation, epicormic shoots and exudations, but it only affects trees that are already declining (Natividade, 1950). *Botryosphaeria* spp. can also cause canker on *Q. suber* branches. To specify the cause of the disease samples must be examined in the laboratory.

Disease development

The disease can develop rapidly or slowly. The slow decline (Fig. 1) can last for several years, with a gradual defoliation and the presence of branches partially or totally defoliated. In the rapid decline or sudden death (Fig. 2), trees show dried leaves attached to the branches and die from one season to another. The disease development depends on the susceptibility of the tree, soil and climatic conditions. Soils with low fertility and low mineral nutrient levels, particularly phosphorus, seem to favour infection. Sites facing south show higher occurrence of *P. cinnamomi*, which is also more frequent in slopes and valleys than on hilltops (Moreira & Martins, 2005).

Diagnosis

It is not possible to identify a *Phytophthora* infection only by disease symptoms. Different diagnostic techniques like direct isolation, molecular and serological methods help to identify *Phytophthora* as the cause of the tree disease and to specify the *Phytophthora* species. Information on *Phytophthora* diagnosis on trees or in general are given for example in htttp://forestphytophthoras.org/key-to-species, http://www.phytophthoradb.org, http://phytophthora-id.org/ and in Martin *et al*. (2012). Please contact your national authorities (see next chapter) for help with diagnosis.

What to do in case trees are suspected to be infected?

Contact your responsible national authorities, for example:

Austria:

- Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft (BWF)
  Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW)
  Seckendorff-Gudent-Weg 8, 1131 Vienna, Austria; http://www.bfw.ac.at/
- Österreichische Agentur für Gesundheit und Ernährungssicherheit
  Austrian Agency for Health and Food Safety, Institute for Sustainable Plant Production
  Spargelfeldstraße 191, 1220 Vienna; http://www.ages.at

Belgium:

- Département Sciences du Vivant, Centre Wallon de Recherches Agronomiques
  Life Sciences Department, Walloon Agricultural Research Centre
  Rue de Liroux 4, B-5030 Gembloux;
  Anne CHANDELIER | a.chandelier@cra.wallonie.be
- Instituut voor Landbouw- en Visserijonderzoek (ILVO), Eenheid Plant -Gewasbescherming
  Institute for Agricultural and Fisheries Research, Plant Sciences Unit – Crop Protection - Gewasbescherming
  Burg. van Gansberghelaan 96 bus 2, 9820 Merelbeke
  Kurt HEUNGENS | kurt.heungens@ilvo.vlaanderen.be

Bulgaria:

- Българска Агенция по безопастност на храните:
  Централна лаборатория по карантина на растенията
  plant protection regional services: http://www.babh.government.bg/en/labs.html
- Агробиоинститут, Селскостопанска Академия
  бул 8, Драган Цанков № 8, София 1164
  Biotic Stress Group, AgroBioInstitute, Agricultural Academy
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Květnové náměstí 391, Průhonice, 252 67, Praha západ
Matěj PANEK | panek@vukoz.cz

Denmark:

- NaturErhvevstyrelsen, Ministeriet for Fødevarer, Landbrug og Fiskeri
  The Danish AgriFish Agency, http://www.naturerhverv.fvm.dk
- Skov & Landskab, Det Biovidenskabelige Fakultet, Københavns Universitet
  Forest and Landscape, Faculty of Science, University of Copenhagen
  http://www.sl.life.ku.dk

Finland:

- Elintarviketurvallisuusvirasto Evira, Kasvinterveysyksikkö
  Finnish Food Safety Authority Evira, Plant Health
  Mustialankatu 3, FI-00790 Helsinki
  http://www.evira.fi/portal/fi/kasvit/viljely_ja_tuotanto/metsanviljely/valvonta/
- Metsäntutkimuslaitos
  Finnish Forest Research Institute
  P.O. Box 18, FI-01301 Vantaa
  Anna RYTKÖNEN | anna.rytkonen@metla.fi
- Maa- ja elintarviketalouden tutkimuskeskus MTT
  Agrifood Research, MTT
  FI-31600 Jokioinen
  Päivi PARIKKA | paivi.parikka@mtt.fi.

France:

- Services Régionaux de l'Alimentation (SRAL) des Directions Régionales de l'Alimentation, de l'Agriculture et de la Forêt (DRAAF)
  Regional Plant Protection services
  http://agriculture.gouv.fr/suivi-de-la-sante-des-forets
  http://agriculture.gouv.fr/services-deconcentres
- Laboratoire de Santé végétaux, unite de Mycologie, ANSES
  French Agency for Food, Environmental and Occupational Health & Safety (ANSES)- Plant Health Laboratory, unit of mycology
  Domaine de Pixérécourt Bat E., 54220 Malzéville, France; http://www.anses.fr/PNTC01.htm;
  Nathalie SCHENCK | Nathalie.schenck@anses.fr
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- Pôle interrégionaux du Département de la santé des forêts:
  Regional forest health survey organisation:
  http://agriculture.gouv.fr/departement-de-la-sante-des-forets

Germany:

- Pflanzenschutzdienstellen der Bundesländer, Adressenliste siehe:
  regional plant protection services, address list see: http://www.jki.bund.de/de/startseite/unser-service/linksammlung.html
- Julius Kühn Institut – Bundesforschungsanstalt für Kulturpflanzen (JKI), Institut für Pflanzenschutz in Gartenbau und Forst (JKI-GF)
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  Forest Research Institute, 570 06 Vassilika, Thessaloniki, Greece
  http://www.fri.gr, info@fri.gr
- Ινστιτούτο Μεσογειακών Δασικών Οικοσυστημάτων & Τεχνολογίας Δασικών Προϊόντων, Τέρμα Αλκμάνος, 115 28 Ιλίσια, Αθήνα, Ελλάς
  Institute of Mediterranean Forest Ecosystems & Forest Products Technology,
  Terma Alkmanos, 115 28 Ilisia, Athens, Greece
  http://fria.gr, tsop@fria.gr

Hungary:

- Megyei Kormányhivatalok Növény- és Talajvédelmi Igazgatóságai
  Regional offices of NFCSO, Directorate of Plant Protection and Soil Conservation
  http://www.nebih.gov.hu/elerhetosegek
- MTA ATK Növényvédelmi Intézet
  Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences
  Herman Ottó u. 15, H-1022 Budapest, Hungary;
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Ireland:

- Department of Agriculture, Food and the Marine, Horticulture and Plant Health Division
  Backweston Agri-Campus, Celbridge, Co. Kildare, Ireland
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Italy:

- COSVIR XI - Servizio fitosanitario centrale
  Italian Phytosanitary Service
  cosvir11@pec.politicheagricole.gov.it, http://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2341
- Dipartimento per la Innovazione nei sistemi Biologici, Agroalimentari e Forestali, Università degli Studi della Tuscia
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Latvia:

Valsts augu aizsardzības dienests
State Plant Protection Service http://www.vaad.gov.lv/english/contacts/departments.aspx

Netherlands:

Nationaal Referentie Centrum,
Nederlandse Voedsel- en Warenautoriteit (NVWA)
National Reference Centre, NPPO
Netherlands Food and Consumer Product Safety Authority
Ministry of Economic Affairs, Agriculture and Innovation
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Portugal:

- Instituto de Conservação da Natureza e das Florestas – ICNF
  Institute for Nature Conservation and Forestry - INCF
  http://www.icnf.pt/florestas
- Direcção de Serviços de Fitossanidade e de Materiais de Multiplicação de Plantas
  Directorate of Plant Health and Materials Multiplication of Plants
  Tapada da Ajuda, 1349-018 Lisboa
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Romania:

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  Institute of Forestry, Department of Forest Protection
  Kneza Višeslava 1
  11030 Belgrade, Serbia
  www.forest.org.rs
- Institut za nizijsko šumarstvo i životnu sredinu, Zaštita šuma
  Institute of Lowland Forestry and Environment, Forest Protection
  Antona Čehova 13, 21000 Novi Sad, Serbia
  www.ilfe.org

Slovenia:

Kmetijski inštitut Slovenije
Agricultural Institute of Slovenia
Hacquetova 17, 1001 Ljubljana, Slovenia
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Switzerland:
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL)
Competence Center of Forest Protection (WSL)
http://www.wsl.ch/dienstleistungen/waldschutz/index_EN

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- Çankırı Karatekin Üniversitesi, Fen Fakültesi, Biyoloji Bölümü, Çankırı, Türkiye
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- Tree Health Diagnostic & Advisory Service, Forest Research, Northern Research Station, Roslin, Midlothian EH25 9SY; ddas.nrs@forestry.gsi.gov.uk
- Tree Health Diagnostic & Advisory Service, Forest Research, Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH; ddas.ah@forestry.gsi.gov.uk

Management and control

All activities that involve movement of soil, water and plant material have the potential to cause the spread of *Phytophthora*. There are several management strategies to minimize the spread of *Phytophthora* such as:

- Modifying behaviour:
  - Plan activities in advance
  - Work in uninfested areas first before moving into infested areas
  - Postpone activities in wet conditions
  - Disturb the soil as little as possible
- Controlling access:
  - Restrict movement of people, vehicles and equipment
- Adopting hygiene procedures:
  - Washdown of vehicles, machinery and footwear
  - Travel only on designated roads and tracks
  - Ensure raw materials are free of *Phytophthora*
  - Ensure water and effluent does not drain towards vegetation
  - Do not remove water, soil or plant material from the infested area
  - Provision of washdown stations as appropriate
- Ensuring awareness of *Phytophthora*:
  - Erect signs as appropriate
  - Provide information on *Phytophthora* and its spread, as appropriate

Phosphite applications have been tested in *Quercus suber*. Spraying infected plants with low levels of phosphite during the active growth months may induce resistance against *Phytophthora*. Please contact your responsible authorities before you use any kind of chemicals for *Phytophthora* control.

EPPO quarantine recommendation

The European and Mediterranean Plant Protection Organisation (EPPO) considers *P. ramorum* as a dangerous organism. It is listed on the EPPO Alert List and is regulated (http://www.eppo.int/QUARANTINE/Alert_List/alert_list.htm).

Literature used

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Links to further information

Phytophthora in the Forests: http://forestphytophthoras.org/
P. ramorum: http://www.suddenoakdeath.org, http://rapra.csl.gov.uk/, http://www.eppo.org
P. cinnamomi: http://www.europe-aliens.org/speciesFactsheet.do?speciesId=50625
Phytophthora determination keys: http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-08-11-0636

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Disease symptoms of *Phytophthora* on *Quercus suber* (cork oak)

Figure 1: Disease symptoms of *Phytophthora cinnamomi* on *Quercus suber*
slow decline with a gradual defoliation and the presence of branches partially or totally defoliated

Figure 2: Disease symptoms of *Phytophthora cinnamomi* on *Quercus suber*
sudden death, showing dried leaves attached to the branches

Figure 3: **Disease symptoms of *Phytophthora cinnamomi* on *Quercus suber* plantules**
Left: control (not inoculated)
Right: infected with *Phytophthora cinnamomi*

Photos: Laboratório de Biotecnologia e Fitopatologia – FCT - UAlg