Plant Diseases and Diagnosis

Dina NEVES / Cristiana MAIA

Phytophthora on Quercus suber L. (cork oak)

JKI Data Sheets

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants
Imprint

The open access series „JKI Data Sheets – Plant Diseases and Diagnosis“ is a publication that publishes original papers, pathogen descriptions, findings and reports on biotic and abiotic causes of crop diseases and crop damage.

All manuscripts submitted for publication in the JKI Data Sheets are peer-reviewed by at least two independent referees while the anonymity of author(s) is preserved.

All contributions are made available under the Creative Commons licence. This allows you to use and distribute the whole work or parts of the work at no charge as long as you use it only for noncommercial purposes, name the author(s) and source(s) and do not modify the work.

Publisher/Editor-in-Chief:  
Dr. Georg F. Backhaus, Präsident und Professor  
Julius Kühn-Institut, Bundesforschungsanstalt für Kulturpflanzen  
Erwin-Baur-Str. 27  
D-06484 Quedlinburg  
Deutschland

Managing Editor:  
Dr. Olaf Hering, Informationszentrum und Bibliothek  
Julius Kühn-Institut  
Königin-Luise-Str. 19  
D-14195 Berlin  
Deutschland  
E-Mail: redaktion.datasheets@jki.bund.de

Submission of manuscripts:  
Please go to the journal's website at http://pub.jki.bund.de/

ISSN:  
2191-1398

DOI  
10.5073/jkidspdd.2013.085
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](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 calcareous 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:

<table>
<thead>
<tr>
<th>Phytophthora species</th>
<th>Disease symptoms</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>citrophthora</td>
<td>Decline</td>
<td>Scanu <em>et al.</em>, 2012</td>
</tr>
<tr>
<td>cryptogea</td>
<td>Decline</td>
<td>Scanu <em>et al.</em>, 2012</td>
</tr>
<tr>
<td>psychrophila</td>
<td>Decline</td>
<td>Scanu <em>et al.</em>, 2012</td>
</tr>
<tr>
<td>quercina</td>
<td>Decline</td>
<td>Scanu <em>et al.</em>, 2012</td>
</tr>
<tr>
<td>ramorum1</td>
<td>Stem canker</td>
<td>Moralejo <em>et al.</em>, 2009</td>
</tr>
</tbody>
</table>

1 - in the European Union *P. ramorum* is a regulated organism (see chapter 'Quarantine recommendation')

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 http://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/](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](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 - Gewas-
  bescherming
  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
- Агробиоинститут, Селскостопанска Академия бул 8, Драган Цанков № 8, София 1164
  Biotic Stress Group, AgroBioInstitute, Agricultural Academy
  8 Dragan Tsankov blvd., 1164 Sofia
  Славчо Славов, sbslavov@abi.bg
  Slavtcho SLAVOV | sbslavov@abi.bg

**Czech Republik:**
- Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, v.v.i
  The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Publ. Res. Institute
  Květnové náměstí 391, Průhonice, 252 67, Praha západ
  Matěj PANEK | panek@vukoz.cz

**Denmark:**
- NaturErhvervsryrelsen, Ministeriet for Fødevarer, Landbrug og Fiskeri
  The Danish AgriFish Agency, [http://www.naturenhrerv.fvm.dk](http://www.naturenhrerv.fvm.dk)
- Institut for Geovidenskab og Naturforvaltning, Det Natur- og Biovidenskabelige Fakultet,
  Københavns Universitet
  Department of Geosciences and Natural Resource Management, Faculty of Science, University of
  Copenhagen | [www.ign.ku.dk](http://www.ign.ku.dk)
Finland:
- Elintarviketurvallisuusvirasto Evira, Kasvinterveysysikkö
  Finnish Food Safety Authority Evira, Plant Health Mustialankatu 3, FI-00790 Helsinki
  http://www.evira.fi/portal/fi/kasvit/viljely_ja_tuotanto/metsanviljely/valvonta/
- Metsäanttimuslaitos
  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
  Renaud IOOS | renaud.ioos@anses.fr
- 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:
- Pflanzenschutzdiensten 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 Pflanzen schutz in Gartenbau und Forst (JKI-GF)
  Julius Kühn Institut - Federal Research Center for Cultivated Plants (JKI),
  Institute for Plant Protection in Horticulture and Forestry (JKI-GF)
  Messeweg 11/12, 38104 Braunschweig, Germany
  http://www.jki.bund.de
  Sabine WERRES | sabine.werres@jki.bund.de
Greece:
- Ινστιτούτο Δασικών Ερευνών, 570 06 Βασιλικά, Θεσσαλονίκη, Ελλάς
  Forest Research Institute, 570 06 Vassiliki, Thessaloniki, Greece
  http://www.fri.gr, Στέφανος ΔΙΑΜΑΝΤΗΣ | 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 Ilissia, Athens, Greece
  http://www.fria.gr, Παναγιώτης ΤΣΟΠΕΛΑΣ | tsop@fria.gr
- Γεωπονικό Πανεπιστήμιο Αθηνών, Εργαστήριο Φυτοπαθολογίας, Ιερά Οδός 75, 11855 Αθήνα
  Agricultural University of Athens, Laboratory of Plant Pathology, Iera Odos 75, 11855 Athens, Greece
  http://www.aua.gr/index.php, Επαμεινώνδας ΠΑΠΛΩΜΑΤΑ | epaplom@aua.gr
- Μπενάκειο Φυτοπαθολογικό Ινστιτούτο, Στεφάνου Δέλτα 8, Κηφισιά, Αθήνα, 14561
  Benaki Phytopathological Institute, 8 Stefanou Delta Street, Kifissia, Athens, 14561
  http://www.bpi.gr, Ειρήνη ΒΛΟΥΤΟΓΛΟΥ | Ivoutoglou@bpi.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;
  József BAKONYI | bakonyi.jozsef@agrarmta.hu

Ireland:
- Department of Agriculture, Food and the Marine, Horticulture and Plant Health Division
  Backweston Agri-Campus, Celbridge, Co. Kildare, Ireland
  oliver.mcevoy@agriculture.gov.ie

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
  DIBAF-Department for Innovation in Biological, Agro-food and Forest systems,
  University of Tuscia
  Via S. Camillo de Lellis snc
  01100 Viterbo- Italy
  Anna Maria VETTRAINO | vettrain@unitus.it
- Dipartimento di Gestione dei Sistemi Agroalimentari e Ambientali
  Sezione Patologia vegetale, Università di Catania
  Department of Agri-food and Environmental Systems Management, University of Catania
  Via Santa Sofia, 100 95123 Catania Italy
  Santa Olga CACCIOLA | olgacacciola@unict.it
Latvia:
Valsts augu aizsardzības dienests

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 Postbus 9102, 6700 Hc Wageningen, Nederland
Johan MEFFERT | j.p.meffert@minlnv.nl

Norway:
Bioforskn Plantehelset
Norwegian Institute for Agricultural and Environmental Research,
Plant Health and Plant Protection Division
Høgskoleveien 7, 1432 Ås, Norway;
Venche TALGØ | venche.talgo@bioforsk.no

Poland:
Instytut Ogrodnictwa
Research Institute of Horticulture, Dept. of Ornamental Plant Protection
Konstytucji 3 Maja 1/3, 96-100 Skierniewice
Leszek B. ORLIKOWSKI | leszek.orlikowski@inhort.pl

Portugal:
- Instituto Nacional de Investigação Agrária e Veterinária-UEIS-SAFSV
National Institute for Agrarian and Veterinarian Research
Quinta do Marquês, Av. da República, Nova Oeiras, 2780-505 Oeiras
Ana Cristina MOREIRA & Amélia LOPES | cristina.moreira@iniav.pt; amelia.lopes@iniav.pt
-Direção Geral de Alimentação e Veterinária
Directorate General of Food and Veterinary
Tapada da Ajuda, Ed. 1, 1349-018 Lisboa
Paula CARVALHO | pcarvalho@dgav.pt

Romania:
Institutul de Cercetari si Amenajari Silvice - ICAS,
Forest Research and Management Institute
Statiunea Brasov; Closca 13, 500040, Brasov, Romania,
Danut & Florentina CHIRA | florichr@yahoo.com, chira@rdsbv.ro
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.

Quarantine recommendation

The European and Mediterranean Plant Protection Organization (EPPO) considers P. ramorum to be a dangerous organism. It is listed on the EPPO Alert List. For details see http://www.eppo.int/QUARANTINE/Alert_List/alert_list.htm.

In the European Union P. ramorum is a regulated organism according to the Commission Decision 2002/757/EU.
Literature used


Links to further information

*Phytophthora* in the Forests: [http://forestphytophthoras.org/](http://forestphytophthoras.org/)


*P. cinnamomi*: [http://www.europe-aliens.org/speciesFactsheet.do?speciesId=50625](http://www.europe-aliens.org/speciesFactsheet.do?speciesId=50625)


Acknowledgement

The data sheet was prepared within the Working Group 1 of the European COST Action FP0801 [http://www.cost.eu/domains_actions/fps/Actions/FP0801](http://www.cost.eu/domains_actions/fps/Actions/FP0801).

Authors

Dina NEVES\(^1\) and Cristiana MAIA\(^2\)

Universidade do Algarve  
Campus de Gambelas – FCT  
Lab. Biotecnologia Molecular e Fitopatologia  
8005-139 Faro  
Portugal

\(^1\) dneves@ualg.pt; \(^2\) cris17couto@gmail.com
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*