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Plant Diseases and Diagnosis

Tamara CORCOBADO SÁNCHEZ

Phytophthora on *Quercus ilex* L. (holm oak)

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants

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Julius Kühn-Institut, Federal Research Centre for Cultivated Plants
Erwin-Baur-Str. 27
D-06484 Quedlinburg

Managing Editor:

Dr. Olaf Hering, Information Centre and Library
Julius Kühn-Institut
Königin-Luise-Str. 19
D-14195 Berlin
E-Mail: redaktion.datasheets@jki.bund.de

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Importance of *Quercus ilex*

Quercus ilex L. (holm oak) is a dominant tree within the Mediterranean basin and is used as a bio-indicator of Mediterranean-type ecosystems (Plieninger *et al*., 2004; distribution map for *Q. ilex* see http://www.discoverlife.org). *Q. ilex* is an evergreen tree which grows in four bioclimates (semiarid, subhumid, humid and perhumid) and is present in different soil types. It grows up to 25 m and has sclerophyllous, tomentose leaves with a shape ranging from round to longer leaves, with or without spines. It comprises two different subspecies: *Q. ilex* subsp. *ilex* and *Q. ilex* subsp. *ballota* (syn. *Q. rotundifolia*). In the Iberian Peninsula, its importance derives from its presence in the most widespread agroforestry system in Europe known as dehesa. Dehesas play a main role as an ecological, economical and social system. They are characterized by the rearing of livestock, the production of acorns for livestock feeding, firewood production and cereal cropping.

Phytophthora species

From *Q. ilex* 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 (most frequently isolated)	Defoliation, leaf discoloration and wilting, dead branches, exudations from bark, root rot	Brasier *et al.*, 1993 ; Sánchez *et al.*, 2002
cryptogea	Decline	Scanu *et al.*, 2012
gonapodyides	Defoliation, leaf discoloration and wilting, dead branches, root rot	Corcobado *et al.*, 2010
psychrophila	Defoliation, leaf discoloration and wilting, dead branches, root rot	Pérez-Sierra *et al.*, 2012, Scanu *et al.*, 2012
quercina	Defoliation, leaf discoloration and wilting, dead branches, root rot	Pérez-Sierra *et al.*, 2012, Scanu *et al.*, 2012
syringae	Defoliation, leaf discoloration and wilting, dead branches, root rot	Pérez-Sierra *et al.*, 2012

In nurseries, *Q. ilex* seedlings have been found to be infected with *P. cinnamomi*, *P. cryptogea*, *P. drechsleri*, *P. cambivora* and *P. gonapodyides* (Sánchez *et al.,* 2004; Jung, 2011).

Disease symptoms (see figures)

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

Crown: defoliation, leaf discoloration and wilting, branch dieback (Gallego *et al*., 1999)

Stem: bleeding canker (Gallego *et al*., 1999)

Roots: root necrosis (Corcobado *et al*., 2011)

Possibility of Symptom Confusion

The disease symptoms presented in the previous chapter are not specific only for *Phytophthora* infection. Oak decline mediated by drough can resemble those symptoms of *Phytophthora* infection such as defoliation and leaf discoloration and wilting. The fungus *Botryosphaeria* spp. can cause similar symptoms as *Phytophthora* infection, like cankers on branches and leaf yellowing and wilting (Sánchez *et al*., 2003). The fungus *Biscogniauxia mediterranea* only affects non vigorous *Q. ilex* trees, causing yellowing of the leaves, defoliation, epicormic shoots and exudations (Jiménez *et al*., 2005). To specify the cause of the disease, samples must be examined in the laboratory.

Disease development

The disease can develop in two different ways: i) with a sudden death of the tree where dried leaves keep attached to the branches or ii) with a slow decline characterized by a gradual crown defoliation where the foliage of the highest part of the tree is the first to wilt and eventually affecting to the whole crown (Gallego *et al*., 1999). The severity of the disease and its development depends on soil properties such as texture and pH, climatic conditions which influence water availability, tolerance of the tree and topographic position as valleys and slopes are associates with a higher incidence and severity of the decline.

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/
- 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
  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:

- 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
  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:

- 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)
  Julius Kühn Institut - Federal Research Center for Cultivated Plants (JKI), Institute for Plant Pro tection 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 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;
  József BAKONYI | bakonyi.jozsef@agrar.mta.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
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
Postbus 9102, 6700 Hc Wageningen, Nederland
Johan MEFFERT | j.p.meffert@minlnv.nl

Norway:

Bioforsk Plantehelse
Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Pro tection 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 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
  dsfmmp@dgadr.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

Serbia:

- Институт за шумарство, Одељење за заштиту шума
  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
Alenka MUNDA | alenka.munda@kis.si

Spain:
Grupo de Investigación en Hongos Fitopatógenos, Instituto Agroforestal Mediterráneo, Universitat Politècnica de València
Polytechnic University of Valencia (UPV), Mediterranean Agroforestal Institute (IAM), Research group on Plant Pathogenic fungi
Camino de Vera s/n, 46022 Valencia, Spain
Ana Mª PÉREZ-SIERRA | aperesi@eaf.upv.es

Sweden:
SLU, Institutionen för Skoglig Mykologi och Växtpatologi
Dept. of Forest Mycology and Plant Pathology
Box 7026, 750 07 Uppsala
Jan STENLID | Jan.Stenlid@slu.se

Switzerland:
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL)
Competence Center of Forest Protection (WSL)
http://www.wsl.ch/dienstleistungen/waldschutz/index_EN

Turkey:
- Çankırı Karatekin Üniversitesi, Fen Fakültesi, Biyoloji Bölümü, Çankırı, Türkiye
  Çankırı Karatekin University, Faculty of Science, Department of Biology, Çankırı, Turkey
  Seçil AKILLI | secilakilli@gmail.com
- Ankara Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü, 06100, Kalaba, Ankara, Türkiye
  Agricultural Faculty of Ankara University, Department of Plant Protection 06100, Kalaba, Ankara, Turkey
  Salih MADEN | salihmaden@hotmail.com

United Kingdom:
- 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

In order to limit the spread of *Phytophthora* and the severity of the disease, management and control practices are recommended. Among them, it can be highlighted the following ones:

- Activities to reduce *Phytophthora* inoculum and/or decrease *Phytophthora* disease severity on trees:
  - Soil biofumigation with brassicas (under-researched control practice; Morales-Rodríguez *et al*., 2012).
  - Calcium amendments (Serrano *et al*., 2012).
  - Application of phosphite by aerial, foliar or basal bark sprays and injections has been proven to prevent infection or reduce the severity of symptoms (Hardy *et al*., 2001). Before you use any kind of chemicals please contact your national authorities (e.g. plant protection services).
- Activities to reduce *Phytophthora* dispersal (McCabe, 2008):
  - Avoidance of people, livestock, vehicles and machinery movement from *Phytophthora* infested areas to non-infested areas, especially during the wet season.
  - Clean footwear, equipment and wheels of vehicles.
  - Installation of hygiene infrastructures.
  - Restrict travel to only roads and tracks.
  - Use of physical barriers to protect non-infested areas.
  - Restrict soil tilling.
  - Ensure good soil drainage to limit run-off.
  - Avoidance of high densities of livestock which increases soil compaction and run-off.
  - Replace herbaceous crops which host *Phytophthora spp.* with non-susceptible plants.
- *Phytophthora* disease awareness:
  - Design disease awareness programs.
  - Signposting of *Phytophthora* infested areas.

EPPO quarantine recommendation

The *Phytophthora* species associated with *Quercus ilex* are not listed on the European and Mediterranean Plant Protection Organisation (EPPO) lists (http://www.eppo.int/QUARANTINE/quarantine.htm).

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Links to further information

Phytophthora in the Forests: http://forestphytophthoras.org/

Phytophthora spp.: http://www.forestry.gov.uk/fr/INFD-737ESG, http://oregonstate.edu/instruct/dce/phytophthora/, http://www.europe-aliens.org/speciesFactsheet.do?speciesId=50625, www.eppo.org

Phytophthora determination keys: http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-08-11-0636

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Authors

Tamara CORCOBADO SÁNCHEZ
Universidad de Extremadura
Ingeniería Forestal y del Medio Natural
Avenida Virgen del Puerto 2, 10600, Plasencia, Spain
tamicorsa@hotmail.com, asolla@unex.es

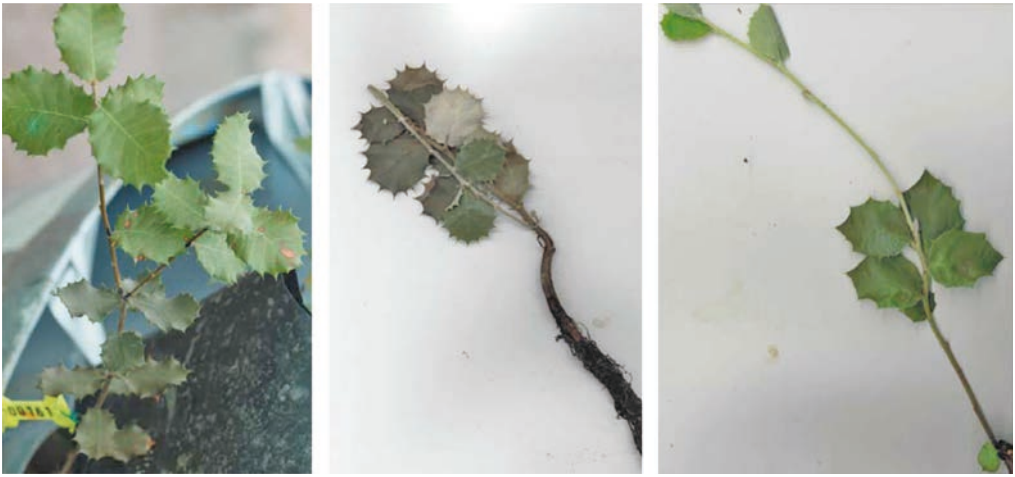
Disease symptoms of *Phytophthora* on *Quercus ilex* (holm oak)

Crown symptoms on *Quercus ilex*

Left: slow decline with a gradual defoliation caused by *P. cinnamomi*
Right: sudden death, showing wilted leaves attached to the branches, caused by *P. cinnamomi*

Trunk symptoms on *Quercus ilex*

bleeding canker



Above-ground symptoms on seedlings of *Quercus ilex*
defoliation and leaf discoloration caused by *P. cinnamomi* (left), *P. gonapodyides* (center) and *P. quercina* (right)

Root symptoms on seedlings of *Quercus ilex*
Left: Root rot characterized by the lost of lateral and fine roots, caused by *P. cinnamomi*
Center: Root rot caused by *P. gonapodyides*
Right: Root rot caused by *P. quercina*

Photos: T. CORCOBADO SÁNCHEZ