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Benoit MARÇAIS / Claude HUSSON

Phytophthora on *Alnus* spp. (alders)



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Importance of *Alnus* sp.

The genus *Alnus* (*Betulaceae*) includes thirty-five species distributed across northern hemisphere (<http://www.discoverlife.org>). There are four species native to Europe: *A. incana* (grey alder), *A. cordata* (Italian or Corsica alder), *A. glutinosa* (common or black alder) and *A. viridis* (green alder). In addition, *A. rubra* native to North America has been extensively planted in some European countries (Claessens, 2003). *Alnus* sp. plays important ecological roles. It is a pioneer genus, tolerant of high ground water levels and periodic flooding. *A. glutinosa* is the most common species and is present throughout Europe up to 1800 m.

It is well adapted to wet sites and plays a vital role in riparian ecosystems as the root system helps to stabilise riverbanks reducing the effect of erosion (Webber *et al.*, 2004). Black alder has a beneficial effect on soil (porosity, symbiosis with *Frankia*), on water quality (filtration, purification) and also on fauna. It contributes to increase the biodiversity of birds and insects and its root system allows fish to shelter. *Alnus incana* is widely distributed in central and eastern Europe. In the south, it grows mainly in mountain areas. As it is a root sprout pioneer that tolerates both dry conditions and flooding, *A. incana* is very important for improving the stability of slopes and riverbanks (Jung & Blaschke, 2004). *A. cordata* and *A. viridis* are much less frequent species and are native to Corsica-Italy and mountains of central Europe, respectively (Claessens, 2003).

Phytophthora species

The *Phytophthora* species attacking alders are mainly of the *P. alni* complex, i.e. *P. alni* subsp. *alni*, *P. alni* subsp. *multiformis* and *P. alni* subsp. *uniformis*. It has been shown that *P. alni* subsp. *alni* is a hybrid between *P. alni* subsp. *multiformis* and *P. alni* subsp. *uniformis* (Brasier *et al.*, 2004; loos *et al.*, 2006). *P. alni* subsp. *alni* is the most common species while both parental taxons are far less commonly isolated on declining alders (Streito, 2003; Jung & Blaschke, 2004; Aguayo *et al.*, 2012). Moreover, the *P. alni* complex is specific to the *Alnus* genus (in particular *A. cordata* and *A. glutinosa*) and the hybrid species shows a higher aggressiveness than both parental species (Brasier & Kirk, 2001; Santini *et al.*, 2003).

Moreover, there have been a few records of other *Phytophthora* species on *A. glutinosa* in Europe. The most frequently recorded are *P. citricola*, *P. cactorum* and *P. gonapodyides* and rarely *P. megasperma* and *P. pseudosyringae*. These species have been isolated from stem base, main roots or fine roots (Streito, 2003). However, it is usually considered that these species are not the causal agent of the alder decline.

Disease symptoms (see figures)

Phytophthora alni can attack fine and major roots or tree collar. The most common symptoms are (Streito, 2003):

- Crown:** small leaves, yellow discoloration of the leaves, sparse foliage, dieback of the crown, early and often excessive fructification. Usually the whole crown shows the disease symptoms.
- Stem base:** tarry or rusty spots necroses on the surface of the bark with occasional bleeding. Flame-shaped inner bark lesions mainly at the stem base; similar lesions or necroses can be observed on major roots.

Stem and fine roots are directly infected by *P. alni*. Then, the fine-root system is partially reduced by the pathogen that leads to a dieback of the crown.

Possibility of Symptom Confusion

The disease symptoms on the stem base or roots presented in the previous chapter are not specific only for *P. alni* infection. *Phytophthora* sp. cited above, *Armillaria* sp., other fungi like *Dia-porales* or *Hypoxydon* sp., bacteria (*Erwinia alni*), insects (*Cryptorhynchus lapathi*) or frost-cracks can induce similar symptoms (stem base lesion, necrotic roots, tarry spots with dark bleeding (Cech & Hendry, 2003).

It is considered that these micro-organisms or insects affect alders as secondary pathogen. In addition, abiotic damage as wounds due to fencing wire girdling the trunk of alder or drought periods can affect the crown leading to appearance of small yellowish leaves and sparse foliage (Cech & Hendry, 2003).

Disease development

Disease development strongly depends on the alder size. Survival analysis was performed from a 10-years survey of *A. glutinosa* population from a section of river in eastern France (Elegbede *et al.*, 2010; Marçais, unpublished results). The study shows that seedlings (less than 1 cm diameter at breast (dbh) high) are quickly killed: the median time from recruitment into the study (when seedling reached 1.3 m high) and first sign of infection (either canker or crown decline) was of 2 years and the median time between first infection and death was of 4 years.

By contrast, the decline is much more progressive for larger trees, with median time between infection and death of more than 10 years. Mortality of large trees occurs but is not really frequent (only 2-5% of trees over 0.5 m² dbh died in a 10 year period). Recovery of strongly infected alder trees is been frequently observed and appears to be linked with poor pathogen winter survival. Indeed, *P. alni* subsp. *alni* lacks viable survival spores such as chlamydospores or oospores and may thus suffer severe population crash during cold winters.

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?

If *P. alni* has already been detected on alders or in soil, we can consider that all typical symptomatic trees located in the same stand are infected by *P. alni* without performing new diagnosis. If not, fresh active inner bark necroses have to be collected at the margin of the lesions. Pieces of bark are stored in a plastic bag containing sterile water or river water. Samples can also be wrapped in damp paper during storage. Then, the material has to be quickly sent to the laboratory for analysis. Isolation success greatly depends on the age of the lesions and on the storage conditions (Streito, 2003).

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 безопасност 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:

- NaturErhvervstyrelsen, 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:

- Pflanzenschutzdienststellen der Bundesländer, Adressenliste siehe:
regional plant protection services, address list see: <http://www.jki.bund.de/de/startseite/unsere-service/linksammlung.html>
- Julius Kühn Institut – Bundesforschungsanstalt für Kulturpflanzen (JKI), Institut für Pflanzenschutz in Gartenbau und Forst (JKI-GF)
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Greece:

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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
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 Toscana
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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
Postbus 9102, 6700 Hc Wageningen, Nederland
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Norway:

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Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division
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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>
- Direção 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,
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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
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Slovenia:

Kmetijski inštitut Slovenije
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Hacquetova 17, 1001 Ljubljana, Slovenia
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Switzerland:

Edig. 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
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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

Operations to manage the disease or to restore riparian ecosystem have to be carefully conducted in order to avoid any contamination from diseased trees or soil toward healthy stands. The felling or winching out of affected trees are not recommended as such approaches are highly destructive to riparian habitat or riverbanks and are undoubtedly ineffective (Gibbs, 2003). Indeed, severe declining trees produce far less inoculum than moderate declining or asymptomatic but infected trees (Elegbede *et al.*, 2010). Coppicing is a traditional method of managing riparian alder. It en-

courages the regeneration of new growth (Gibbs, 2003; Webber *et al.*, 2004). The number and health status of shoots depend on the conditions of trees at the time of coppicing. Not surprisingly, more vigorous shoots regenerate from the stumps of healthy trees compared with diseased trees (Webber *et al.*, 2004).

Few data are available on the effectiveness of chemical treatment. However, given the location of the host population (riparian ecosystem), fungicides cannot be used as a sustainable solution (Gibbs, 2003).

No consistent evidence of variation in host resistance to *P. alni* was observed on 15 European provenances of *A. glutinosa* (Webber *et al.*, 2004). Despite these results, a search for resistant individuals is to be commended (Gibbs, 2003). Host resistance programs are in progress in Belgium on hundreds of trees (Chandelier, unpublished data). Finally, survival analysis on larger alders and recovery rate of strongly affected mature alders show encouraging results for the maintenance of the species (see chapter Disease development).

EPPO quarantine recommendation

The *P. alni* complex is not listed in the European and Mediterranean Plant Protection Organisation (EPPO) lists (<http://www.eppo.int/QUARANTINE/quarantine.htm>).

Literature used

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Links to further information

Alnus spp.: <http://en.wikipedia.org/wiki/Alnus>

Phytophthora alni: http://en.wikipedia.org/wiki/Phytophthora_alni

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

Phytophthora database: <http://www.phytophthoradb.org/>

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

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Disease symptoms of *Phytophthora alni* on *Alnus glutinosa*



Left: Diseased coppice of alder along a river

Central: Declining alder surrounded by healthy trees

Right: Small yellowish leaves



Left: stem base necroses on mature tree with tarry exudate

Central: Tarry or rusty spots at the stem base

Left: Flame-shaped inner bark lesion