

Express PRA for *Peronospora aquilegiicola*

– Occurrence –

Prepared by: Julius Kühn-Institute, Institute for national and international Plant Health; prepared by:
Dr. Anne Wilstermann; on: 07-05-2020 (translated by: Elke Vogt-Arndt)

Initiation: Occurrence on *Aquilegia* sp. in a private garden in the Federal State Lower Saxony

Express PRA	<i>Peronospora aquilegiicola</i> Thines, Denton & Choi, 2019		
Phytosanitary risk for Germany	high <input type="checkbox"/>	medium <input checked="" type="checkbox"/>	low <input type="checkbox"/>
Phytosanitary risk for EU-Member States	high <input type="checkbox"/>	medium <input checked="" type="checkbox"/>	low <input type="checkbox"/>
Certainty of the assessment	high <input type="checkbox"/>	medium <input checked="" type="checkbox"/>	low <input type="checkbox"/>
Conclusion	<p>The oomycete <i>Peronospora aquilegiicola</i>, presumably endemic to East Asia, was previously not found in Germany. It has not yet been detected in other Member States. To date, it is listed neither in the Annexes of Regulation (EU) 2019/2072 nor by EPPO.</p> <p><i>Peronospora aquilegiicola</i> infects columbine and presumably, false columbine, too.</p> <p>Currently, it is assumed that <i>P. aquilegiicola</i> can establish outdoors and under protected conditions in Germany and in the EU, wherever host plants are available.</p> <p>Due to its high damage potential for columbines, <i>P. aquilegiicola</i> poses a medium phytosanitary risk to Germany and other EU-Member States.</p> <p>Based on this risk analysis, it is assumed that the pest can establish in Germany or another Member State and cause significant damage. Thus, measures for the prevention of this potential quarantine pest according to Article 29 of Regulation (EU) 2016/2031 should be met. The infection has to be controlled.</p>		
Taxonomy²⁾	<p>Kingdom: Chromista; Phylum: Pseudofungi; Class: Oomycetes; Order: Peronosporales; Family: Peronosporaceae; Species: <i>Peronospora aquilegiicola</i> sp. nov. Thines, Denton & Choi, 2019</p>		
Common name	Aquilegia downy mildew		
Synonyms	--		
EPPO Code	PEROAQ		
Does a relevant earlier PRA exist?	No		
Biology	<p><i>P. aquilegiicola</i> infests the plants on the surface or systemically. The mycelium can be present in leaves, shoots and roots. The ramified conidiophores (the cells that carry conidia) stick out of the</p>		

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	stomata on the bottom side of infected leaves. Under damp conditions, large quantities of conidia (asexual propagation units) are developed. Via water splashes or the wind, the conidia are carried to new host plants where they germinate immediately. To outlive long-term unfavourable conditions and to hibernate, <i>P. aquilegiicola</i> produces oospores (fertilised egg cells with clearly thickened cell wall) that can be found in the plant roots and in rotting plant debris (DENTON <i>et al.</i> , 2015). It is known from other <i>Peronospora</i> sp. that a transmission via seed is possible (e.g. <i>Peronospora belbahrii</i> , downy mildew on basil). <i>Peronospora</i> -DNA was detected in PCR-Tests of seeds of <i>Aquilegia</i> . So far, there is no proof of the transmission via seeds (THINES <i>et al.</i> , 2019).
Is the pest a vector? ³⁾	No
Is a vector needed? ⁴⁾	No
Host plants	So far, only columbine (<i>Aquilegia</i> sp.; <i>A. alpina</i> , <i>A. buergeriana</i> , <i>A. flabellata</i> , <i>A. viridiflora</i> , <i>A. vulgaris</i>) and presumably, false columbine (<i>Semiaquilegia</i> sp.; <i>S. adoxoides</i>) are documented as host plants (THINES <i>et al.</i> , 2019).
Symptoms ⁵⁾	Infested leaves initially turn yellow or get chlorotic. Later, they turn to dark purple. Unless the fungus is already growing systemically in the leaf, the leaf spots are limited by the leaf veins. This leads to a mosaic design on the leaves. Mainly under damp conditions, on the underside of the leaf a felt of conidia is produced, coloured beige to purple, (DENTON <i>et al.</i> , 2015). Systemic infections show up as more uniform lesions (THINES <i>et al.</i> , 2019). The lesions may become necrotic (DENTON <i>et al.</i> , 2015). Often, the leaf edges of infected leaves curl. The flowers of the plants saturate with water, deform and turn brown. The complete development of the flowers is reduced (THINES <i>et al.</i> , 2019). Flower stems often are brown or purple, they develop spots and occasionally, kinks. In case that the infection occurs after flowering, brown spots develop on the seed buds and partly, the development of seeds is not possible. Mostly, the roots of the plants seem to be healthy after the dieback of the plant parts above ground (winter) and growth is dormant. However, in the upper root section depressions are visible beneath the surface of which dark lesions are hidden. Systemic infections result in dwarf growth with smaller plants and small, often curled leaves. The dieback of the plants occurs after one or two growing seasons (DENTON <i>et al.</i> , 2015). In the framework of this risk analysis, it could not be determined whether the plants always die.
Presence of the host plants in Germany ⁶⁾	Species of the genera <i>Aquilegia</i> and <i>Semiaquilegia</i> are popular ornamentals in gardens and parks. The endemic species of the genus <i>Aquilegia</i> like the rare <i>A. einseleana</i> or <i>A. atrata</i> are specially protected in Germany (BfN, undated).
Presence of the host plants in the Member States ⁷⁾	Species of the genus <i>Aquilegia</i> are present as wild flowers and ornamentals in all EU Member States.
Known infested areas ⁸⁾	In 2013, columbines that were infected with downy mildew were detected in England and in Wales. Since then, the pest spreads

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	rapidly in Great Britain (DENTON <i>et al.</i> , 2015), but was not found in Central Europe (THINES <i>et al.</i> , 2019). Molecular genetic examination showed a high genetic similarity with a former sample from South Korea on <i>Semiaquilegia adoxoides</i> . In 1998, downy mildew on <i>S. adoxoides</i> was described in China. The morphologic description from China is similar to <i>P. aquilegiicola</i> , but the occurrence in China has not yet been proven (THINES <i>et al.</i> , 2019).
Pathways⁹⁾	Infected plant material. The oomycete is systemically present in the plant and can be transmitted by any plant material. The transmission via infected seeds seems possible but has not yet been proven (DENTON <i>et al.</i> , 2015).
Natural spread¹⁰⁾	Locally, <i>P. aquilegiicola</i> is spread via conidia through splash water during rain or wind, possibly over longer distances, too (DENTON <i>et al.</i> , 2015).
Establishment and spread to be expected in Germany¹¹⁾	On outdoor columbines e.g. in gardens and parks and wild habitats of the endemic species. In ornamental companies and in protected cultivation.
Establishment and spread to be expected in the Member States¹²⁾	It is assumed that the pest can establish outdoors and in protected cultivation where host plants are present.
Known damage in infested areas¹³⁾	Severe damage on columbine was observed in gardens and ornamentals in Great Britain (DENTON <i>et al.</i> , 2015).
Limitation of the endangered area in Germany	Locations with columbine, outdoors and in protected cultivation, in gardens, nurseries for ornamentals, wild stands.
Damage to be expected in endangered area in Germany¹⁴⁾	The infection with <i>P. aquilegiicola</i> is described as very aggressive. It causes dieback of plants. Columbines are popular ornamental plants in gardens and are cultivated commercially. Furthermore, the infection of endemic species is expected. In case of the distribution of the pest, the damage to be expected on columbines is estimated as very high. Furthermore, the infection of endemic species has to be expected. In case of a further spread of the pest, the damage being expected on columbines is estimated as very high.
Damage to be expected in endangered area in Member States¹⁵⁾	See above
Control feasibility and measures¹⁶⁾	<p>The use of healthy planting material (plants, rhizomes, seeds) serves as a precautionary measure.</p> <p>The spore production is favoured by damp conditions. That is why columbines should not be placed in close plantings to ensure sufficient aeration. Extensive nitrogen fertilization increases the susceptibility of the plants. Infected plants should be removed and</p>

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	<p>eradicated immediately. For eradication, it is possible to bury the plants in a depth of at least 50 cm or to burn them (RHS, 2020). No new host plants should be planted for at least one or better, several growing seasons in locations where infected host plants have been grown before (RHS, 2020). To date, it is not known how long the oospores of <i>P. aquilegiicola</i> may survive in the soil. For related species, the survivability is several years to decades (VAN DER GAAG, 1997). Plant pots of infected plants should be disinfected. So far, no resistant cultivated species of <i>Aquilegia</i> sp. are known and no chemical control agents for the use in gardens are available (RHS, 2020). No information was found on the efficacy of common crop-protection products against <i>P. aquilegiicola</i> in gardening.</p>
Detection and diagnosis ¹⁷⁾	<p>Molecular identification is possible via PCR-amplification and sequencing. Morphological identification is possible, too (THINES <i>et al.</i>, 2019).</p>
Remarks	<p>The oomycete was described only recently. Thus, there is uncertainty about the actual distribution of the pest.</p>
Literature	<p>BFN, undated.: FloraWeb - Daten und Informationen zu Wildpflanzen und zur Vegetation Deutschlands. Bundesamt für Naturschutz. http://www.floraweb.de/index.html</p> <p>DENTON, J. D., E. J. BEAL, A. KILTY, J. O. DENTON, Y.-J. CHOI, M. THINES, 2015: Characterisation and risk assessment of the emerging <i>Peronospora</i> disease on <i>Aquilegia</i>. Mycol Progress 14(69), 10S. DOI 10.1007/s11557-015-1092-5</p> <p>ELLIS, W. N., 2020: <i>Peronosporia aquilegiicola</i> Thines, denton & Choi, 2019. Plant Parasites of Europe, Amsterdam, Netherlands. https://bladmineerders.nl/parasites/heterokonta/oomycota/peronosporales/peronosporaceae/peronospora/peronospora-aquilegiicola/</p> <p>RHS, 2020: Aquilegia downy mildew. Royal Horticultural Society. https://www.rhs.org.uk/advice/profile?pid=866</p> <p>THINES, M., G. J. DENTON, E. J. BEAL, A. KILTY, J. O. DENTON, H.-D. SHIN, Y.-J. CHOI, 2019: <i>Peronospora aquilegiicola</i> sp. nov., the downy mildew affecting columbines in the UK is an invasive species from East Asia. Eur J Plant Pathol 155, 515-525. https://doi.org/10.1007/s10658-019-01787-y</p> <p>VAN DER GAAG, D. J., 1997: Oospore populations of <i>Peronospora viciae</i>: quantification, germinability and survival. Dissertation at the University Wageningen, ISBN 90-5485-664-5, 136 p.</p>