Phytoprotection

First report of stripe rust (*Puccinia striiformis* f. sp. *tritici*) on wheat in Quebec, Canada
Un premier signalement de rouille jaune (*Puccinia striiformis* f. sp. *tritici*) chez le blé au Québec, Canada

Sylvie Rioux, Benjamin Mimee, Annie-Ève Gagnon et Sarah Hambleton

Volume 95, numéro 1, 2015

URI : https://id.erudit.org/iderudit/1028400ar
DOI : https://doi.org/10.7202/1028400ar

Aller au sommaire du numéro

Éditeur(s)

Société de protection des plantes du Québec (SPPQ)

ISSN

1710-1603 (numérique)

Découvrir la revue

Citer cet article

Rioux, S., Mimee, B., Gagnon, A.-È. & Hambleton, S. (2015). First report of stripe rust (*Puccinia striiformis* f. sp. *tritici*) on wheat in Quebec, Canada. *Phytoprotection*, *95*(1), 7–9. https://doi.org/10.7202/1028400ar

Résumé de l'article

La rouille jaune du blé, *Puccinia striiformis* f. sp. *tritici*, représente une des maladies du blé les plus importantes à travers le monde. Au Canada, la rouille jaune du blé se retrouve principalement dans les provinces de l'Ouest (Colombie-Britannique, Alberta et Saskatchewan) et, plus récemment, dans les provinces du Manitoba et de l'Ontario. Nous rapportons ici la première détection de la rouille jaune du blé dans la province de Québec, Canada. Des feuilles présentant des sporulations jaunâtres disposées en bandes étroites ont été retrouvées dans des essais de performance de blé à la station de recherche de l'Université Laval, à Saint-Augustin-de-Desmaures. Des analyses moléculaires ciblant des séquences génomiques spécifiques de même qu'un segment d'un gène d'ADNr (ITS2/28S) ont confirmé l'identification visuelle.

First report of stripe rust (*Puccinia striiformis* f. sp. *tritici*) on wheat in Quebec, Canada

Sylvie Rioux[1]✉, Benjamin Mimee[2], Annie-Ève Gagnon[3], and Sarah Hambleton[4]

Received on 2014-05-13; accepted on 2014-09-23

PHYTOPROTECTION 95 : 7-9

Stripe rust, *Puccinia striiformis* f. sp. *tritici*, is one of the world's most important diseases of wheat. In Canada, stripe rust is found mainly in the western provinces (British Columbia, Alberta and Saskatchewan) and, more recently, in the provinces of Manitoba and Ontario. Here, we report the first detection of stripe rust on wheat in the province of Quebec, Canada. Leaves showing yellowish sporulation arranged in narrow stripes were found in wheat performance trials at the research station of Université Laval, in Saint-Augustin-de-Desmaures. Morphological identification was confirmed by several PCR assays targeting specific genomic sequences and a rDNA gene segment (ITS2/28S).

Keywords: Stripe rust, *Puccinia striiformis* f. sp. *tritici*, wheat, *Triticum aestivum*

[Un premier signalement de rouille jaune (*Puccinia striiformis* f. sp. *tritici*) chez le blé au Québec, Canada]

La rouille jaune du blé, *Puccinia striiformis* f. sp. *tritici*, représente une des maladies du blé les plus importantes à travers le monde. Au Canada, la rouille jaune du blé se retrouve principalement dans les provinces de l'Ouest (Colombie-Britannique, Alberta et Saskatchewan) et, plus récemment, dans les provinces du Manitoba et de l'Ontario. Nous rapportons ici la première détection de la rouille jaune du blé dans la province de Québec, Canada. Des feuilles présentant des sporulations jaunâtres disposées en bandes étroites ont été retrouvées dans des essais de performance de blé à la station de recherche de l'Université Laval, à Saint-Augustin-de-Desmaures. Des analyses moléculaires ciblant des séquences génomiques spécifiques de même qu'un segment d'un gène d'ADNr (ITS2/28S) ont confirmé l'identification visuelle.

Mots-clés : rouille jaune, *Puccinia striiformis* f. sp. *tritici*, blé, *Triticum aestivum*

Stripe rust, *Puccinia striiformis* Westend. f. sp. *tritici*, is one of the most important diseases of wheat (*Triticum aestivum* L.) that can be found around the world. In Canada, stripe rust was first discovered on a wild grass in Alberta, in 1918, and few years later on barley (*Hordeum vulgare* L.) and on wheat (Newton and Johnson 1936). Since that time, the disease has been observed mostly in the Prairies and in British Columbia. Stripe rust can cause between 10% and 70% yield loss, depending on factors such as cultivar susceptibility and timing of infection initiation (Baily *et al.* 2003; Chen 2005). Since 2000, the disease has also been reported in Ontario but yield has not been affected (OMAFRA 2009). In Ontario, stripe rust occurrence appears to be associated with early spring conditions or a prolonged cool period (between 10°C and 15°C with increased leaf wetness) (Chen 2005). An alternate host for the pathogen was not known until Jin *et al.* (2010) demonstrated that wheat inoculated with aeciospores collected from *Berberis chinensis* Poir. resulted in the formation of uredinia. Later, Wang and Chen (2013) reported that Oregon grape (*Mahonia aquifolium* (Pursh) Nutt.) also was an alternate host. These discoveries indicate that the pathogen inoculum could be aeciospores coming from local alternate hosts along with urediniospores carried by air currents from the southern United States, where the pathogen overwinters on native grasses and winter wheat (Bailey *et al.* 2003).

1. Centre de recherche sur les grains, 2700 rue Einstein, Québec (Québec), Canada G1P 3W8; corresponding author e-mail: sylvie.rioux@cerom.qc.ca
2. Horticulture Research and Development Centre, Agriculture and Agri-Food Canada, 430 boul. Gouin, Saint-Jean-sur-Richelieu (Québec), Canada J3B 3E6
3. Centre de recherche sur les grains, 740 chemin Trudeau, Saint-Mathieu-de-Beloeil (Québec), Canada J3G 0E2
4. Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, K.W. Neatby Building, 960 Carling Avenue, Ottawa (Ontario), Canada K1A 0C6

On 26 July 2013, stripe rust was found on the upper leaves of six wheat lines and three cultivars grown in experimental performance trials at the Université Laval research station in Saint-Augustin-de-Desmaures (46°43′56.6′′N, 71°31′04.6′′W, QC, Canada). To our knowledge, this is the first report of *P. striiformis* f. sp. *tritici* in the province of Quebec. Several dried infected leaves have been deposited in the National Mycological Herbarium (maintained by Agriculture and Agri-Food Canada in Ottawa) with accession number DAOM 243003. Uredinia occurred on the upper leaf surfaces only. None were observed on the leaf sheath. These sori were yellow and arranged in narrow stripes lined up along the length of leaf blades. The stripes were 3-12 mm long and spaced 0-5 mm apart. The number of stripes on a leaf was low, ranging from 4 to 20. Pustules were elongated to oval, measuring 0.31-0.58 x 0.13-0.19 mm. Urediniospores were egg-shaped to spherical, yellow, and measured 25-30 x 20-28 µm. DNA was extracted from urediniospores and amplified by PCR or real-time PCR (qPCR) using several sets of specific primers: Pst1 and Pst2 (Wang *et al.* 2008), Nesta (Wang *et al.* 2009), and two qPCR assays (Liu *et al.* in press) targeting short fragments within the RPB2 and BT gene regions analyzed by Liu and Hambleton (2010, 2013). Relative to the phylogeny published by Liu and Hambleton (2010), the BT fragment is diagnostic for *Puccinia* Series *Striiformis*, comprising four species of which three were formerly included in the broadly-defined *P. striiformis* species complex, while the RPB2 fragment is specific for *P. striiformis sensu stricto*. The sequences underlying the BT assay differentiate the four species (*P. striiformis, P. striiformoides, P. pseudostriiformis* and *P. gansensis*) in pairwise comparisons at up to four nucleotide positions. The qPCR positive reactions were direct-sequenced for additional validation. A sequence for the internal transcribed spacer region 2 and partial 28S ribosomal RNA gene was also determined using the primers Rust2inv (Aime 2006) and ITS4Ru1 (5′-GCCTTAGATGGAATTTACCACCC-3′). All results were consistent with the morphometric identification of *P. striiformis* f. sp. *tritici*. The sequences were deposited in GenBank as KM679359 (ITS2/28S, 541 bp), KM105961 (BT, 136 bp) and KM105962 (RPB2, 306 bp). The BT and RPB2 data were a 100% match to three and two sequences of wheat stripe rust, respectively, found in the NCBI nr database (July 2014).

As sporulation generally starts 12 to 14 days after infection (Chen *et al.* 2014), infections could have occurred around 11-14 July 2013. Indeed, on 12-13 July, the minimum temperatures recorded at the closest Environment Canada station, the Quebec Jean-Lesage International Airport, were 11°C and 9°C, respectively; these correspond to optimal temperatures for infection (7-12°C according to Chen *et al.* 2014). Such temperatures also occurred on 1 July and 21-27 July 2013. However, average day temperatures between 1-24 July 2013, with the exception of 21 July, were higher than the optimal temperatures (10-15°C) reported for the latent period, from the infection to the sporulation (Chen *et al.* 2014). It is possible that we are in the presence of high temperature strains that emerged a few years ago in southeastern United States (Markell and Milus 2008). This means that stripe rust could occur again in Quebec and thus deserves to be followed more closely, especially as two *Berberis* species, *B. thunbergii* DC. and *B. vulgaris* L., were reported in this region (Romain Néron, Herbier du Québec, pers. comm.). The presence of alternate hosts raises the concern of early-season infection, which could potentially lead to higher yield losses and the possible occurrence of new virulence phenotypes since the pathogen can complete its sexual cycle.

ACKNOWLEDGEMENTS

The authors thank Nicole Bourget (Centre de recherche sur les grains), Pierre-Yves Véronneau (Horticulture Research and Development Centre, Agriculture and Agri-Food Canada), and Tara Edwards (Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada) for their technical assistance. We are also grateful to the Canadian Safety and Security Program (CSSP) in supporting the development of primers for the BT and RPB2 genes used in the present work.

REFERENCES

Aime, M.C. 2006. Toward resolving family-level relationships in rust fungi (Uredinales). Mycoscience 47 : 112-122.

Bailey, K.L., B.D. Gossen, R.K. Gugel, and R.A.A. Morrall. 2003. Diseases of Field Crops in Canada, 3rd ed. The Canadian Phytopathological Society, Saskatoon, SK.

Chen, X.M. 2005. Epidemiology and control of stripe rust (*Puccinia striiformis* f. sp. *tritici*) on wheat. Can. J. Plant Pathol. 27 : 314-337.

Chen, W., C. Wellings, X. Chen, Z. Kang, and T. Liu. 2014. Wheat stripe (yellow) rust caused by *Puccinia striiformis* f. sp. *tritici*. Mol. Plant Pathol. 15 : 433-446.

Jin, Y., L.J. Szabo, and M. Carson. 2010. Century-old mystery of *Puccinia striiformis* life history solved with the identification of *Berberis* as an alternate host. Phytopathology 100 : 432-435.

Liu, M., and S. Hambleton. 2010. Taxonomic study of stripe rust, *Puccinia striiformis sensu lato*, based on molecular and morphological evidence. Fungal Biol. 114 : 881-899.

Liu, M., and S. Hambleton. 2013. Laying the foundation for a taxonomic review of *Puccinia coronata* s.l. in a phylogenetic context. Mycol. Prog. 12 : 63-89.

Liu, M., E. McCabe, J.T. Chapados, J. Carey, R. Tropiano, S.K. Wilson, S. Redhead, C.A. Levesque, and S. Hambleton. Detection and identification of selected cereal rust pathogens by TaqMan® real-time PCR. Can. J. Plant Pathol. (*In press*).

Markell, S.G., and E.A. Milus. 2008. Emergence of a novel population of *Puccinia striiformis* f. sp. *tritici* in eastern United States. Phytopathology 98 : 632-639.

Newton, M., and T. Johnson. 1936. Stripe rust, *Puccinia glumarum*, in Canada. Can. J. Res. 14 : 89-108.

OMAFRA. 2009. Agronomy guide for field crops. Publication No. 811, Ontario Ministry of Agriculture, Food and Rural Affairs. Available at: www.omafra.gov.on.ca/english/crops/pub811/p811toc.html (Accessed on March 11, 2014).

Wang, M.N., and X.M. Chen. 2013. First report of Oregon grape (*Mahonia aquifolium*) as an alternate host for the wheat stripe rust pathogen (*Puccinia striiformis* f. sp. *tritici*) under artificial inoculation. Plant Dis. 97 : 839.

Wang, X., W. Zheng, H. Buchenauer, J. Zhao, Q. Han, L. Huang, and Z. Kang. 2008. The development of a PCR-based method for detecting *Puccinia striiformis* latent infections in wheat leaves. Eur. J. Plant Pathol. 120 : 241-247.

Wang, X., C. Tang, J. Chen, H. Buchenauer, J. Zhao, Q. Han, L. Huang, and Z. Kang. 2009. Detection of *Puccinia striiformis* in latently infected wheat leaves by nested polymerase chain reaction. J. Phytopathol. 157 : 490-493.