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Septoria tritici blotch in wheat: identification of a broad spectrum resistance gene

Septoria tritici blotch (STB) in wheat, caused by the fungus *Zymoseptoria tritici*, is one of the major diseases affecting wheat worldwide. In France, it causes between 350 and 700 million euros of losses for the industry each year. INRAE has been studying alternatives to the fungicides used to fight this disease for many years, in particular by developing resistant wheat varieties. INRAE, Wageningen University (the Netherlands), USDA (United States) and the Swiss Federal Institute of Technology in Zurich (ETH), in collaboration with Florimond-Desprez, has identified and characterized a gene that provides resistance to many isolates of *Zymoseptoria tritici*. Their results, published on 19 January in *Nature Communications*, open up new perspectives for the development of STB resistant wheat varieties.

Septoria tritici blotch caused by the fungus *Zymoseptoria tritici* and resulting in leaf necrosis is one of the main diseases affecting wheat crops throughout the world. In the most extreme cases, it can cause yield losses of up to 55%. At present, this disease is controlled mainly by the use of fungicides. The development of fungal resistance to phytosanitary products and the need to reduce the use of pesticides (directive of certain European Union countries to reduce the use of pesticides by 50%) to develop sustainable agriculture, mean that the research community has been working on various alternatives such as biocontrol or the development of resistant varieties for several years. Likewise, plant breeders consider wheat resistance to STB as a high priority. An international research programme jointly led by INRAE and Florimond-Desprez in partnership with the University of Wageningen and the USDA began in 2012 with the aim of identifying and studying the major STB resistance gene, *Stb16q*.

Broad spectrum resistance gene to *Zymoseptoria tritici*

Zymoseptoria tritici, the fungus responsible for STB in wheat, is a pathogen with a strong evolutionary potential. It is thus capable of developing resistance to fungicides and also of bypassing the defences present in certain wheat varieties. In addition, the small number of resistance genes known in wheat limits the selection of plants which present long-lasting resistance to this fungus. In 2018, the research team had already characterized a resistance gene to STB in common wheat, *Stb6*, which confers resistance against part of the population of this (press release of 2018). In this study, the researchers have identified and characterized a new resistance gene against the fungus: *Stb16q*.

This gene[2] stops the development of the fungus from the onset of infection, when it enters plant tissue. The screening[3] of 805 cultivated and wild varieties of wheat from very diverse origins shows that the *Stb16q* gene is only found in 6 varieties. The pathogenic fungus has received very little exposure to *Stb16q*, so it has not had time to develop resistance.

The team has also concurrently developed diagnostic markers which are available to breeders to monitor this gene throughout the different stages of wheat breeding programmes. Recently introduced in cultivated wheat varieties, this

gene considerably slows down the penetration and development of the fungus in plant tissues. However, the introduction of this resistance gene into wheat varieties must be carried out with caution and combined with other STB resistances.

The identification and characterization of genes which confer resistance to diseases such as STB open up new perspectives for wheat breeding. The development of wheat varieties resistant to STB would make it possible, in association with other levers such as biocontrol, to reduce the use of pesticides in field crops and develop more sustainable forms of agriculture.

[1] The following were involved at INRAE: Joint Research Unit for Genetics, Diversity and Ecophysiology of Cereals (GDEC), the National Plant Genomic Resource Centre (CNRGV) and the Institut Sophia Agrobiotech (ISA).

[2] This gene encodes a cysteine-rich receptor-like kinase (CRK) activity located on the plasma membrane of plant cells.

[3] Selection carried out within a population in order to isolate the individuals with specific traits.

Reference

Cyrille Saintenac, Florence Cambon, Lamia Aouini, Els Verstappen, Seyed Mahmoud Tabib Ghaffary, Théo Poucet, William Marande, Hélène Berges, Steven Xu, Maëlle Jaouannet, Bruno Favery, Julien Alassimone, Andrea Sanchez-Vallet, Justin Faris, Gert Kema, Oliver Robert and Thierry Langin, *A wheat cysteine-rich receptor-like kinase confers broad-spectrum resistance against Septoria tritici blotch,* Nature Communications DOI: 10.1038/s41467-020-20685-0

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