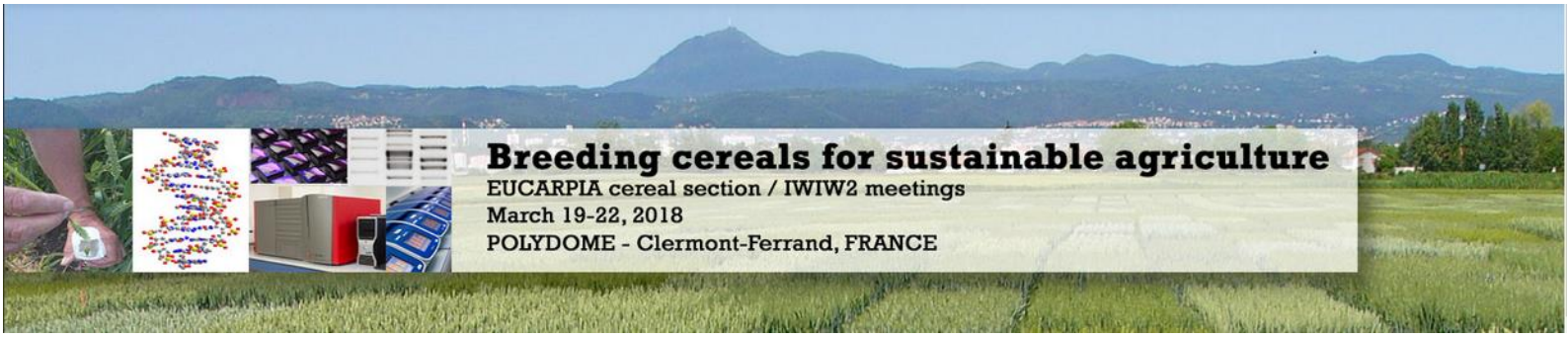

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PIV-58 - Christophe GIGOT - Using crop-pathogen modeling to identify plant traits to control *Zymoseptoria tritici* epidemics on wheat

Using crop-pathogen modeling to identify plant traits to control *Zymoseptoria tritici* epidemics on wheat

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Diversification in pathogen control methods to reduce the severity of economically important foliar diseases such as *Zymoseptoria tritici* on wheat is needed. One way is to identify plant physiological and architectural traits that influence disease development and that can be selected in the process of crop breeding. Such traits may be used for improving tolerance or disease escape. Traits favoring disease escape, the focus of our work, may significantly decrease crop epidemics (Robert et al., 2018). However, understanding the role of such traits in crop-pathogen interactions is a daunting task because the interactions are multiple and dynamic in time. To characterize and quantify crop-pathogen interactions, an innovative trait-based and resource-based modeling framework was developed (Precigout et al., 2017). In this framework, the pathosystem is assumed to respond dynamically to both architecture and physiological status of the host canopy. A canopy consists of plenty of small patches, i.e. small functional and infectable units of leaf tissue. Production of new patches, for canopy growth and renewal of photosynthetically active plant tissues, is a function of the available resources produced by the other patches. Pathogen spores can contaminate nearby healthy patches. The definition of patch proximity depends on dispersal abilities of the pathogen and canopy architecture. We used and adapted this modeling framework to quantify the effects of several plant traits on *Zymoseptoria tritici* epidemics for varied climate scenarios. The complex infection cycle of *Z. tritici* characterized by a long symptomless incubation period was implemented in the model. We studied plant architectural traits such as leaf size or stem height, and plant physiological traits such as leaf lifespan or leaf metabolite contents. In our simulations, these traits impacted the epidemics dynamics though their effects on pathogen dispersal and on the amount of resources available for the pathogen. Sensitivity analyses showed how disease severity depended on plant traits and pathogen virulence. The importance of several plant and pathogen traits could be linked to the pathogen's ability to manage the race for the colonization of the canopy in the face of canopy growth. Playing on host traits also made it possible to simulate different wheat varieties - with contrasted heights, pathogen resistance or precocity - to characterize the behavior of the pathosystem of interest for different host ideotypes. We argue that this kind of trait-based modeling approach is a valuable tool to identify plant traits promoting more resilient agroecosystems in particular for crop breeding in a context of innovative and sustainable crop protection.

Related publication:

Précigout P-A, Claessen D, Robert C. 2017. Crop fertilization impacts epidemics and optimal latent period of biotrophic fungal pathogens. Phytopathology 107, 1256-1267.

Robert C, Garin G, Abichou M, Houlès V, Pradal C, Fournier C. 2018. Plant architecture and foliar senescence impact the race between wheat growth and *Zymoseptoria tritici* epidemics. Annals of Botany (in press).

Keywords: *Septoria tritici* blotch, *Zymoseptoria tritici*, wheat, fertilization, epidemiology, tolerance, trait-based modeling, virulence, consumer-resource dynamics, disease-escaping traits

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