2016 IEEE International Conference on Functional-Structural Plant Growth Modeling, Simulation, Visualization and Applications (FSPMA 2016)

Using combined virtual plant – pathogen models to compare the influence of wheat architecture on epidemics of two contrasted foliar fungi

Guillaume Garin, Christian Fournier, Christophe Pradal, Vianney Houlès, Corinne Robert
guillaume.garin@itk.fr

It is urgent for agriculture to adopt new methods of crop protection that use less pesticide. In the perspective of agroecology, a solution is to regulate the pathogen populations via the properties of plant canopies. Here, we focus on the effects of plant architecture on foliar fungal epidemics. Combined FSPM-epidemic models are potential good tools to simulate these effects and to identify the most influential plant traits on epidemics. In wheat, the main fungal foliar diseases are septoria and brown rust. Both diseases develop lesions on leaves but the symptoms, the infection cycles and the dispersal types are different. Zymoseptoria tritici is a hemi-biotrophic fungus with sporulation occurring on necrotic leaf tissue after a biotrophic colonization phase, and it is mainly dispersed by rain-splash. Puccinia triticina is a strictly biotrophic fungus that grows and sporulates only on living tissues and spores are mainly dispersed by wind. The effects of architecture may depend on the dispersal strategy and infection cycle. This raises questions on the influence of plant architecture on these varied types of foliar fungi: do architectural traits impact their epidemics in the same way? Are there plant traits with opposite effects on the diseases? Answering these questions is crucial in the perspective of controlling fungi complexes on the same host. Several wheat architectural traits, such as stem height and plant development rate, are known to influence septoria. However, only very few studies are available on leaf rust. Our objective is to compare the effects of wheat architecture on epidemics of septoria and brown rust. For this, two FSPM models (Wheat-septoria and Wheat-brown rust) were developed and used to compare the effects of wheat properties on epidemics. The tested plant traits are phenology, organ growth rates (stems and leaves), organ dimensions, leaf curvature, and timing of leaf senescence. The outputs compared are the disease severity on each leaf rank of the canopy. The analysis is done for different climates. The results show that the two pathogens are impacted differently by plant architectural traits, even if they are both very sensitive to leaf green life span. The interaction with climate is also different. This work is an important step in developing methods to study varied pathosystems using FSPMs. This is also a first step to establish a more generic understanding of how different types of fungus are influenced by plant architecture.