

Modeling and simulating the distribution of fungicide among leaves in wheat

Christian Fournier^{1,2}, Anne Danthony³, Stéphanie Pointet^{1,2,4}, Benjamin Perriot³,
Mariem Abichou⁴, Samuel Poidevin³, Jessica Da Costa³, Eric Cotteux⁵, Bruno
Andrieu⁴, Sébastien Saint-Jean⁴ and Corinne Robert⁴

¹*INRA, UMR759 LEPSE, 34060, Montpellier, France*

²*INRIA project-team Virtual Plants, 34095 Montpellier France*

³*ARVALIS Institut du végétal, F-91720 Boigneville, France*

⁴*UMR ECOSYS, INRA, AgroParisTech, Université Paris-Saclay, 78850,
Thiverval-Grignon, France*

⁵*UMR ITAP, IRSTEA, F-34196 Montpellier, France*

Christian.Fournier@supagro.inra.fr

The upper leaves of wheat are the main sources of assimilate for grain production. As such, they are a specific target for fungicide treatments. The efficacy of a treatment can be assessed by the quantity of fungicide deposited on target leaves relative to the spraying application rate per unit area. For a given spraying system and under favorable meteorological conditions, foliar deposit depends on the individual areas and spatial arrangement of leaves within the canopy, which determine the interception of the spray; and on the physio-chemical characteristics of the product, which determine its fate on leaf surfaces. The objectives of this study are to model the deposition of pesticide on the upper leaves of wheat and to identify the plant architectural traits that influence the foliar deposit as the plant develops. For this we couple a 3D architectural model of wheat (ADEL-Wheat), which captures the dynamics of the spatial arrangement of individual leaves at different stages of plant development, with the projection algorithm of the Caribu light interception model that allows estimating the deposit of fungicide within the canopy. A three-year experiment was performed (ECHAP project), with detailed assessments of plant architecture for three genotypes, and of tracer-deposit (tartrazine) on the four upper leaves, for two spraying dates. The architectural measurements were used to calibrate the wheat model that was tested against the foliar deposit data. We used the model to further analyse the origin of the differences of deposit between leaves and between treatment dates observed in the experiments. The analyses reveal that the dynamics of leaf bending, assumed to be a function of leaf age, has a strong influence in spraying efficacy, especially for the upper two leaves. We therefore propose that optimal application strategy could be reasoned not only by considering the degree of expansion of targeted leaves, but also their dynamic of bending.