Assessment of quantitative resistance level impact on durability of associated qualitative resistance using model simulations. Example of phoma stem canker

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Background
In oilseed rape, genetic control is a major lever to prevent phoma stem canker of winter oilseed rape, a worldwide disease responsible for high yield losses, caused by Leptosphaeria maculans. Qualitative resistance (QLR) prevents infection by incompatible isolates, whereas quantitative resistance (QTR) reduces disease severity. When used at large scale, QLR can quickly loose efficacy (Rouxel et al., 2003) but field experiments have indicated that efficacy duration of QLR is prolonged when used in QLR+QTR-lines, compared with QLR-only lines (Brun et al., 2010). However, consequences of different QTR levels on QLR durability remain to be determined.

Objectives
Using the case study of the new Rlm7-QLR to phoma stem canker of winter oilseed rape in a small region of 16 km^2 located in region Centre, France, we aimed at documenting the relationship between associated QTR level and QLR efficacy duration under pre-set cropping systems and environmental conditions (including landscape characteristics, e.g. field size).

Methods
SIPPOM-WOSR (Lo-Pelzer et al., 2010) model simulations were performed, using initial model parameters and initial model values for 1st year-simulation pathogen population size and structure. Landscape characteristics and climatic conditions of the region under study are used. In SIPPOM-WOSR, QTR is modeled as a limiting factor for Disease Index. Several QTR levels (associated with the Rlm7 QLR) were tested under three different crop managements (intensive vs. integrated for all cultivars vs. intensive for non Rlm7 cultivars/ integrated for Rlm7 cultivars). Integrated crop management intends to manage phoma stem canker: no organic nitrogen supply before sowing, early sowing date, low sowing density and ploughing after oilseed rape harvest. Attribution of cultivars to fields within the landscape was performed using LandsFacts (Castellazzi et al., 2008). To cope with potential effects of initial cultivar distributions, several distributions were used for each QTR level*crop management simulation. The estimator chosen for QLR efficacy duration is the time-span from Rlm7 cultivar introduction (1st year of simulation) to the time when 90% of pathogen population is virulent on this cultivar (Van den Bosch & Gilligan, 2003).

Results
Whatever the associated crop management, QLR efficacy duration is very sensitive to QTR level. However, QTR threshold allowing long QLR efficacy duration strongly depends on crop management, illustrating the interaction between genetic and cultural control methods.

Conclusion
QTR is a major lever to delay QLR loss of efficacy, which may be due to a decrease in virulent pathogen population transmission. Simulation studies could be used to assess potential durability of new QLR (depending of associated QTR level and crop management) and thus help seed companies to decide on new cultivar commercial release.

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