

Injury profile simulator (IPSIM), a modelling platform to design qualitative models predicting injury profiles as a function of cropping practices and production situations. Application to the wheat brown rust

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In order to reduce the reliance of agriculture on pesticides, there is a need for tools to help design agroecological management strategies of pests. In particular, the “vertical integration” (combination of several control methods) and the “horizontal integration” (simultaneous management of several pests) embedded in the Integrated Pest Management concept, require methodological developments to be successfully implemented. We propose an innovative modelling framework in order to help design qualitative models to represent the impact of cropping practices, soil, weather and field environment on injury profiles caused by multiple pests (plant pathogens, weeds and animal pests). This communication presents the basic principles of the approach and an application to wheat, the main arable crop in Europe in terms of cultivated area and to a major disease of wheat worldwide, leaf or brown rust.

IPSIM is a simple generic hierarchical qualitative modeling platform based on the DEXi software. The main assumption of IPSIM is that each injury profile that can be observed in a given field only depends on the associated cropping system and part of the production situation (described in terms of soil, climate and field environment). DEXi is thus used to easily design hierarchical deterministic Bayesian networks (i.e. with probabilities only equal to 0 or 1) based on nominal and ordinal attributes describing agroecosystems. The structure of the model and the way attributes are aggregated together are determined using expert knowledge, along with technical and scientific literature.

This platform was used successfully to develop IPSIM-Wheat-brown rust, a model that predicts brown rust severity, an important foliar disease caused by *Puccinia triticina*, as a function of cropping practices, soil, weather and field environment (Figure 1). IPSIM-Wheat-brown rust, a sub-model of IPSIM-Wheat, was designed and its predictive quality was assessed on a large dataset (1739 observed fields, over 19 regions in France and 15 years). The model proved to have a good predictive quality: 0.68 weighted

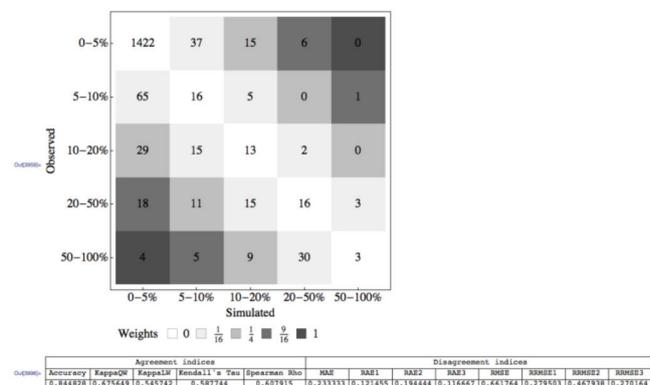
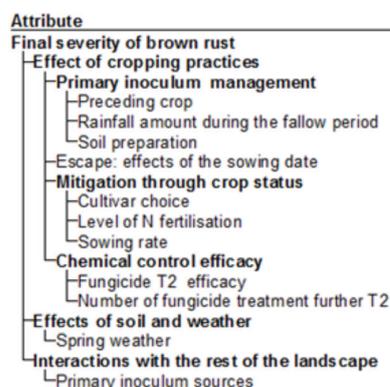


Figure 1. Structure of the IPSIM-Wheat-brown rust.

Figure 2. Confusion matrix of the IPSIM-Wheat-brown rust model and marginal distributions.

Kappa; 84.7% of the simulated classes encompassed the observed values and 94.5% had at most a difference of one class only (Efficiency = 0.41, Root Mean Square Error of Prediction = 11%; bias = 0.84%) (Figure 2). It is remarkable that these performances were obtained without any calibration.

IPSIM-Wheat-Brown rust does not aim to precisely predict the incidence of brown rust on wheat. It rather aims to rank cropping systems with regard to the risk of brown rust on wheat in a given production situation through *ex ante* evaluations. IPSIM-Wheat-brown rust can also help perform diagnoses of commercial wheat fields. Its structure is simple and combines available knowledge from the scientific literature (data and models already available) and expert knowledge. IPSIM-Wheat brown rust is now available to help design cropping systems with a low risk of brown rust on wheat and less reliant on pesticides, in a wide range of production situations. IPSIM-Wheat-brown rust is one of the sub-models of IPSIM-Wheat, a future model that will predict injury profile on wheat as a function of cropping practices and the production situation.