Recent advances in intercropping modelling: the new version of the STICS soil-crop model simulates consistently a wide range of bi-specific annual intercrops.

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ABSTRACT

STICS is a dynamic soil-crop model capable of simulating diverse crop rotations over short and long-term (Brisson et al., 2003). Intercropping increases the complexity of the system by adding inter-species competition. Crop models are useful tools for analyzing complex systems, as they allow the user far more control over individual variables than is possible in field experiments. An initial version of the STICS intercrop model was created by Brisson et al. (2004) from the standard version (Brisson et al., 2003). Recently Vezy et al. (2020) improved this initial version [STICS-Intercrop_v2020] by adding new formalisms and replacing some equations which were not found relevant during the first step of testing with our database. The aim of paper is to present the STICS-Intercrop_v2020 functions and to show the quality of simulations obtained for a wide range of winter and spring intercrop mixtures of durum wheat - winter pea and barley - spring pea. STICS-Intercrop_v2020 was tested for two sites in France using various plant densities and N-fertilizer rates in order to determine its relevance and validity domain for simulating intercropping. This research work was done in 3 main steps: 1) improving the existing formalisms and introducing new equations in the model algorithm for improving the light sharing and nitrogen competition between the two species, and then creating the new version STICS-Intercrop_v2020; 2) parameterising the model for sole crops only; and 3) independently evaluating the quality of predictions for intercrops without any re-parametrisation. The results of parametrisation were satisfactory with low Root Mean Square Errors and high Model Efficiencies, illustrating the robustness and accuracy for sole crops, as already shown for many crops, pedoclimatioc conditions and agronomic managements (Brisson et al., 2003). STICS-Intercrop_v2020 was reliably and efficient to simulate inter-specific interactions, development and growth variables, and provided coherent results for predicting yield and grain protein content for the two species, in winter and spring bi-specific cereal-legume intercrops, without any specific parameterization for intercropping. This illustrates the relevance of the formalisms to simulate dynamically both intra and inter-specific plant interactions. These results are very encouraging for using the STICS-intercrop model for future work where virtual experiments will help us to analyse the performance (LER, level of production in low inputs systems, etc.) and resilience of sole crops versus intercrops according to management practices, pedoclimatic variability and climate change scenarios. This work was part of the ReMIX project funded by EU H2020 program.

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