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Development, Calibration, and Validation of an Intercropping Model

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Abstract

Intercropping is an agricultural practice of cultivating two or more crop species simultaneously in the same field. Compared to sole cropping, main advantages of intercropping are an increase of the interception of solar radiation and increased nutrient supply when legumes are integrated into the intercropping system, resulting in increasing crop growth. Intercropping is presently used in many tropical and subtropical regions. However, due to the spatial heterogeneity of the intercropping system and complexity of belowground competition for water and nutrients, it is challenging to dynamically simulate intercropping. Here we present a new intercropping model that was developed by integrating different modules such as light interception, belowground allocation, soil water movement and crop growth using the Scientific Impact assessment and Modelling PLatform for Advanced Crop and Ecosystem management (SIMPLACE) framework. We firstly checked the plausibility of three different approaches and selected the optimal one to describe light interception between two intercrops, then proposed an allocation strategy for belowground resources considering both alive root length density and crop water demand. The model advances previous attempts of intercropping modelling by simultaneously considering aboveground competition for light and belowground competition for water and nutrients together of different intercropping arrangements. Field experiments including five different intercropping arrangements were conducted in Dassari, Burkina Faso in 2015 and 2016 and used to calibrate and validate the model. The results indicate that our model performs accurate simulations for both biomass and plant height in intercropping arrangements without legumes (e.g. sorghum-maize) in both 2015 and 2016. The accuracy for arrangements including legumes (e.g. cowpea) should be further improved by a better representation of dynamics in symbiotic N-fixation.

Keywords: Competition, intercrops, Lintul 5, modelling, SIMPLACE

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