Calibration and Evaluation of the STICS Intercrop Model for Two Cereal-Legume Mixtures

Kirsten Paff, Sebastian Munz, Rémi Vezy, Noémie Gaudio, Laurent Bedoussac, Eric Justes

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Background

- Intercropping, i.e. multiple species grown simultaneously on the same field, used as a way of ecological intensification
- Especially mixtures of leguminous and non-leguminous crops could reduce inputs and potential environmental damage through N losses
- Intercropping increases system complexity

➢ The aim of this study was to calibrate and evaluate the improved STICS-Intercrop model (Vezy et al., 2020) by simulating two types of cereal-legume mixtures (winter and spring intercrops)

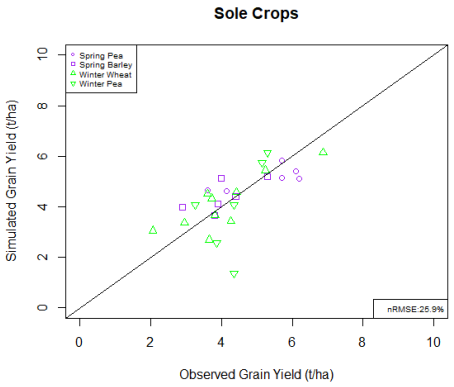
Materials and Methods

- French data sets comprised of 4 years of winter wheat (*Triticum turgidum* L.) and pea (*Pisum sativum* L.) (Bedoussac, 2009; Kammoun, 2015), and 4 years of spring barley (*Hordeum vulgare* L.) and pea (Corre-Hellou, 2005) including different N levels and plant densities (Table 1)
- 3-step Approach: 1) Calibration of species and cultivar parameters with sole crop data ; 2) Calibration of two intercrops parameters ; 3) Evaluation for intercrop data, in order to determine the validity domain.
- Step 1 of calibration followed the order: phenology, leaf area, biomass, nitrogen uptake/fixation, and grain yield
- The species and cultivar parameters calibrated in step 1 are used again for intercrop simulations in step 2

Table 1: Description of the observed field data.

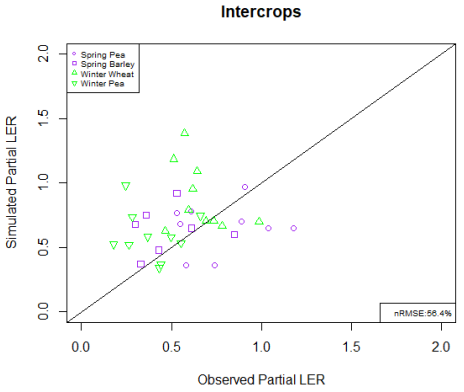
	Winter Wheat	Winter Pea	Spring Barley	Spring Pea
Location	Auzeville, France	Auzeville, France	Angers, France	Angers, France
Years	4	4	4	4
N Levels	4	2	2	2
Densities	2	2	2	2

Results and Discussion



- Largest source of error was winter pea (nRMSE=40.0 %)
- All other crops had a nRMSE<17.0 %
- Simulated winter pea reached max LAI too early, possibly a result of limited observed phenology data → further research needed

Figure 1: Comparison of simulated observed grain yield for sole crop winter wheat, winter pea, spring barley, and spring pea.



- Largest source of error was winter pea (nRMSE=80.9 %)
- High nRMSE for all other crops (37.4 to 60.3 %)
- Winter wheat crop height increased too quickly in simulations, causing overestimation of biomass and grain yield→ further revision of height simulation formalisms needed to avoid bias

Figure 2: Comparison of simulated and observed partial land equivalent ratio (LER) for intercropped winter wheat/winter pea and spring barley/spring pea.

Conclusion

- Based on the sole crop calibration, some intercrop situations could be correctly simulated
- Further analysis of the model's simulation of interspecific competition is necessary to better capture the large variation in observed data and to improve model accuracy

➢ With these future improvements, the STICS intercrop model can be a useful tool for better understanding the biological functions of intercropping systems to and assist in optimizing their management

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