Exploring management scenarios for intercroppong winter wheat and red fescue as cover crop using STICS model

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EXPLORING MANAGEMENT SCENARIOS FOR INTERCROPPING WINTER WHEAT AND RED FESCUE AS COVER CROP USING STICS-MODEL

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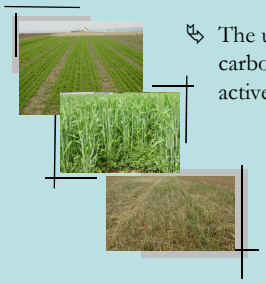
Introduction



- The use of a living cover crops in cropping system may help to preserve biodiversity, increase soil organic matter content, carbon sequestration and provide other ecosystem services such as natural pest regulation or nutrient recycling by maintaining actively growing vegetation during the whole year.
- But competition for light, water or nutrients between cover crop and commercial crop may decrease cash crop yield and returns
- Very few studies have been carried out to analyse the impact of various ways for managing this intercropping system.

Objectives

- To study four management scenarios of the system using STICS-crop model, to analyze the impact of the timing of the fescue cycle on the agronomic and environmental performance of the system.
- To find the best compromise between competitive effects and facilitative effect in intercropping winter wheat and red-fescue as cover crop (biomass accumulation and radiation interception).

Materials and methods

Model used: STICS-CROP MODEL (Brisson *et al.*, 2009)

STICS was parameterized and evaluated using data obtained in two field experiments at the INRA Grignon experimental station (Picard *et al.*, 2009) involving winter wheat and red-fescue grown alone and winter wheat intercropped with red fescue. The results of model evaluation are detailed in Shili-Touzi *et al.* (2010).

The scenarios simulated:

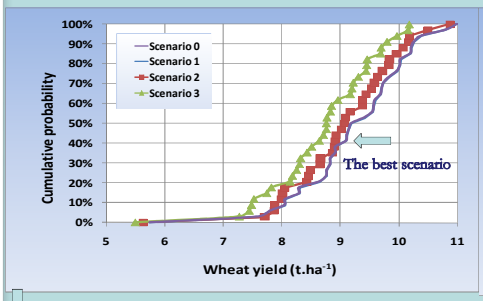
The wheat/red-fescue model was used to compare **four** management scenarios:

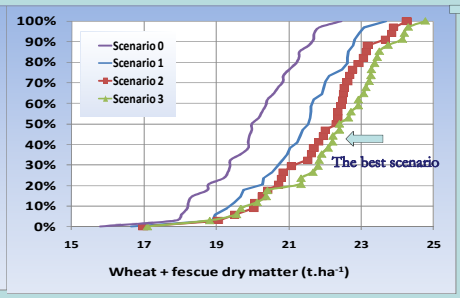
- **Scenario 0 :** wheat grown as **sole crop** (reference scenario).
- **Scenario 1 :** fescue emergence one week after the harvest of the wheat crop, corresponding to a **double-cropping system**.
- **Scenario 2 : f**escue emergence in the spring (18 March), corresponding to **relay intercropping**:, wheat grown as a sole crop from October to March and then intercropped with fescue.
- **Scenario 3 :** simultaneous emergence of wheat and fescue (10 October), corresponding to **full intercropping.**

For scenarios 2 and 3, fescue remainis alive after wheat harvest.

These simulations were run over 35 years of climatic data (1970-2004) from Versailles (48°48'N, 2°04'E), to enable us to take climate variability into account in the scenarios assessment.

Results



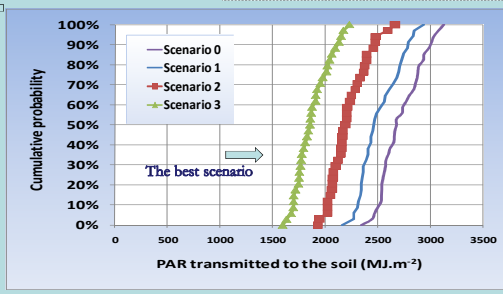


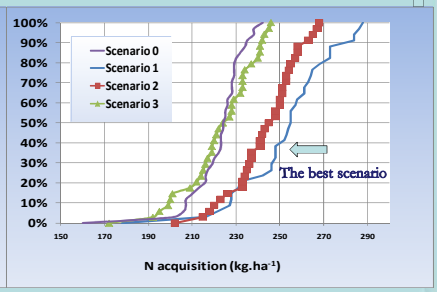
- the system was highly sensitive to the position of the fescue growth cycle, particularly in terms of dry matter production : overall dry matter production (wheat plus fescue) was greater than for sole-crop by 1.26, 1.84 and 2.19 t ha^{-1} on average for scenarios 1, 2 and 3, respectively.
- The difference between the scenarios is linked to differences in the timing of fescue dry matter production.

- Simulation results showed that wheat yield was not overly affected by fescue development in the intercropping system (Sc 2 and 3) in comparison with sole wheat yield (Sc 0 and 1).
- Yield variability over time was similar for all four scenarios.

- Over the 35-year period, an increase in N acquisition by both crops was possible only in scenarios 1 and 2 , for which intercropping increased total N acquisition.
- At the end of the simulated period (31 December), regardless of the scenario considered, intercropping with fescue resulted in lower soil inorganic N content than leaving the soil bare after the wheat harvest .

- The simulated PAR reaching ground level over the entire simulated period showed that intercropping system (Sc 2 and 3) decreased radiation transmission in comparison with sole wheat (Sc 0 and 1)
- It has a direct effect on the reduction of radiation available for weed growth corresponding of 7%, 18% and 31%for scenarios 1, 2 and 3 , respectively.





Conclusions

Advancing the sowing date of the fescue increases both competition effects (decreasing wheat biomass and yield) and facilitation effects (increasing total biomass and soil cover, decreasing the amount of solar radiation reaching the soil). It also increases the efficiency of radiation and nitrogen use. In most climatic scenarios the emergence of the fescue crop during the late tillering phase of the wheat crop gave the best results.

Brisson N., Launay M., Mary B., Beaudoin N., 2009. Conceptual basis, formalisations and parameterization of the STICS crop model. Quae, Paris, 304 p.
Picard D., Ghiloufi M., Saulas P., de Tourdonnet S 2009. Does undersowing winter wheat with a cover crop increase competition for resources and is it compatible with high yield? Field Crops Res.
Shili-Touzi I., De Tourdonnet S., Launay M., Doré T. 2010. Does intercropping winter wheat (Triticum aestivum) with red fescue (Festuca rubra) as a cover crop improve agronomic and environmental performance? A modeling approach. . Field Crops Res.