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REAL-TIME MONITORING OF ENVIRONMENTAL FACTORS TO MODEL WHEAT YIELD PRODUCTION

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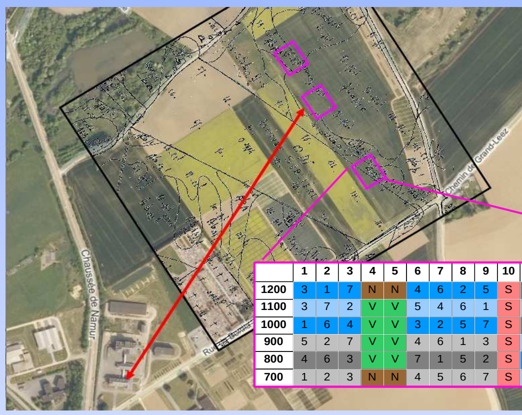
INTRODUCTION

Precision farming has been defined as a knowledge-based technical management system that can optimise profits and minimize agricultural impacts on the environment (Wright et al., 2009). Precision agriculture should always be linked with the development of new tools and methods to control and optimize the management of farm inputs, as the nitrogen management. Distributed soil crop models appear as a promising approach to estimate the nitrogen fertiliser requirements to improve yields (Houlès et al., 2004) and to minimize environmental impacts (Beaudoin et al., 2008). This study aims to assess the performances and robustness of a dynamic crop growth model (*STICS*, INRA-France) based on real time data acquired by environmental wireless microsensors.

METHODS

Data come from seven different nitrogen applications rates trials (0 to 240 kgN/ha) carried out on a Belgian wheat crop culture (Triticum aestivum L., cultivar Julius) implemented on three different soil types (silty, loamy and sandy loam) in Gembloux (BE). The soil profiles were initialy described, while the soil nitrogen concentrations (NO3- and NH4+) were regularly measured during the growing seasons. The plant characteristics (LAI, biomass/grain yields and protein content) were also followed during all the experimental period.

The wireless monitoring system (eKo pro series - Crossbow) was extended to cover the field spatial heterogeneity. Suction, water content and temperature of the soil were measured at two different depths, while atmospheric temperature and humidity, solar radiation, wind and rain data were collected at crop level and 2m height.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1200	3	1	7	N	N	4	6	2	5	S	3	4	5	N	N	6	1	7	2
1100	3	7	2	V	V	5	4	6	1	S	4	7	3	V	V	1	5	6	2
1000	1	6	4	V	V	3	2	5	7	S	6	5	2	V	V	3	1	7	4
900	5	2	7	V	V	4	6	1	3	S	3	7	5	V	V	6	1	2	4
800	4	6	3	V	V	7	1	5	2	S	6	3	1	V	V	2	4	7	5
700	1	2	3	N	N	4	5	6	7	S	7	5	6	N	N	1	2	3	4

Figure 1 : Experimental site : Spatial position of the field towards the buildings – Red line : the 800 meters distance to be covered by the wireless network – Magenta : splitplot experiments (Seven N rates (1-7), naked soil (N), biomass samples (V) and sensors position (S))

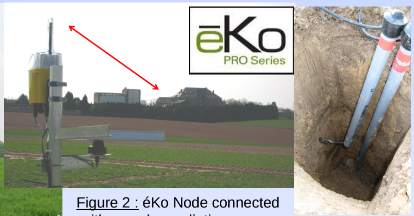
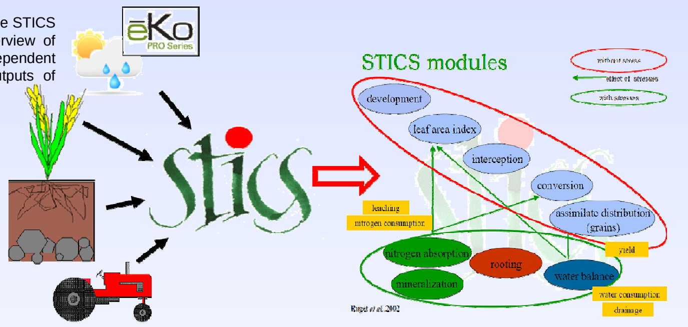


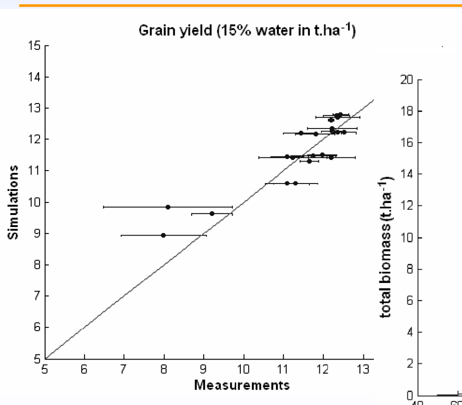
Figure 2 : éKo Node connected with a solar radiation sensor and two temperature and humidity sensors (under shelters) – éKo node communicating with the éKo base station (red) – Installation of the VWC sensor Decagon EC-5 at 30 and 60 cm depth

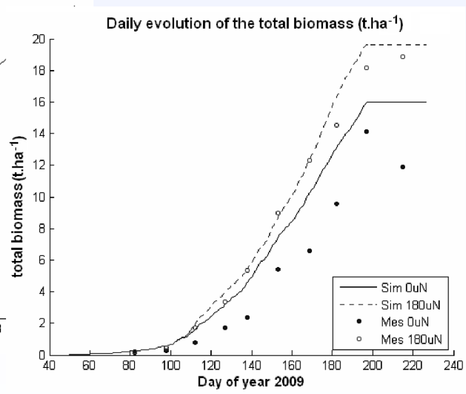
The crop model *STICS* (INRA-France) provides insight into the mechanisms of plant development, taking into account the cultivation techniques, the climatic data, and being able of working with readily available spatialized inputs (Brison et al., 1998). The daily microclimatic measurements were used to conduct the crop growth model at daily time step, while the biophysical variables (yields and biomass) were devoted to calibrate the model.

Figure 3 : Inputs of the STICS crop model and overview of the inner and interdependent mechanisms and outputs of the simulation model.



The model was first calibrated to the Julius wheat cultivar. To achieve this goal, a few crop parameters were optimised on a particular data set, according to the root mean square error, the normalized deviation and the model efficiency criteria (Beaudoin et al., 2008). Then the model was run on all combinations of soil types and applied nitrogen rates.





RESULTS AND CONCLUSION

The results of the model were in close agreement with the experimental data whatever the soil type or the nitrogen rate applicated. Global RMSE of 1,71 t.ha-1 (9,55% against mean) and 0,59 t.ha-1 (5,25% against mean) were respectively found for biomass growth and grain yields. Differences between observations and forescast yields were most of the time lower than the standard deviation on the measurements. Model efficiencies of 0,49 and 0,79 were obtained respectively for dry matter and grain yields.

EXPECTATIONS

Further study will focus on the whole N balance prediction (soil and crop exportation), in order to develop a methodology that has the potential to be used as a tool for managing the nitrogen applications (date and rates of application).

REFERENCES, see overleaf

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