Modelling plant diseases impact with the Belgian Crop Growth Monitoring System

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Plan of the presentation

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• Objectives
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• Integration of a « disease module » into B-CGMS : calibration & validation
• Conclusions
Introduction

• B-CGMS: an integrated information system predicting reliable, timely and objective estimates of crop yields.

No integration of the effects of the diseases

*Septoria tritici* → major cause of yield loss

• Effects of contrasting diseases can be related to effects on *green leaf area*, or precisely, absorption of photosynthetically active radiation by healthy green tissues (Waggoner & Berger, 1987; Bryson et al., 1997)

• The yield of wheat is particularly related to *duration* between ear emergence and maturity (Thorne, 1966)
Objectives

to develop and to introduce a "diseases module" into B-CGMS
Materials and methods : the data

• 133 situations
  - Field – year – cultivar
  - Fungicide treatment

- Fields: Schockville, Humain, Stehnen, Robelmont, Everlange
- Years: 2003 → 2006
- Cultivars: Drifter, Centenaire, Novalis, Koch, Caspart, Parador, Vivant, Achat, Flair, Aron, Urban, Dekan, Bussard, Akteur, Cubus, Rosario

- Fungicide treatments: Control, GS31, GS37, GS39, GS45, GS59, GS328, GS59, GS378, GS59

- Field observations: Visually estimations of green leaf area and diseases symptoms (%).
Material and method: the model

![Graph showing the relationship between green leaf area (%) and days after flag leaf emergence. The graph includes multiple curves, each representing different impacts on the green leaf area. The x-axis represents days after flag leaf emergence, ranging from 20 to 80, and the y-axis represents the green leaf area (%). The key to understanding the graph involves the parameters k and m, which are used to estimate the impacts on the green leaf area.

- k value impact:
- m value impact:
Results

• No relationship between values of parameter $k$ and grain yield.

• Highly significant correlation between values of parameter $m$ and grain yield:
  
  $y = 2.9655x - 59.154$
  $R^2 = 0.7866$

  $y = 150.53 \ln(x) - 498$
  $R^2 = 0.809$

• Fungicide effects on $m$ varied greatly among experiments and cultivars, reflecting the disease levels.

• Benefits of extending the life of the top three leaves for grain yield.

• Considering that parasitic pressure reduces leaves lifespan and therefore the photosynthetic capacity, this approach makes it possible to take into account the influence of this pressure on yield predictions in B-CGMS.
Integration of a « diseases module » into B - CGMS : How?

- Modification of one of the parameters influencing the leaf senescence : the SPAN parameter
  - by definition SPAN is the lifespan of leaves for a temperature of 35°C
- The initial value of the parameter SPAN is 31.3
Integration of a «disease module» into B-CGMS: calibration

\[ y = 0.215794x + 20.509573 \]
\[ R^2 = 0.46 \]

\[ y = -0.012x^2 + 1.453x - 10.539 \]
\[ R^2 = 0.53 \]
Integration of a « disease module » into B - CGMS : validation

With recalibration of SPAN parameter

with linear relation between $m$ and SPAN

$y = 2.34x - 105.17$
$R^2 = 0.47$
Conclusions

• Substantial improvement of yield assessments: $R^2$ from 0.11 to 0.57

• These results confirm the benefits of extending the life of the top three leaves for grain yield

• For a practical use: estimation for each grid or for a group of grids of the parameter $m$ based on fields observations (network of observations)
Thank you for your attention