Modelling plant diseases impact with the Belgian Crop Growth Monitoring System

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Plan of the presentation

• Introduction
• Objectives
• Materials and methods
• Results
• 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 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 leaf area 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, GS32-GS59, GS37-GS59
- **Field observations:** visually estimations of green leaf area and diseases symptoms (%)
Material and method: the model

\[ \text{Green leaf area at time } t = 100 \times \exp\left(-\exp\left(-k \times (t-m)\right)\right) \]

- **k**: rate of reduction of green leaf area
- **m**: time to rise the inflection point

**Material and method**: the model's k value and 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

Days after flag leaf emergence

Treated Control
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

$y = 2.34x - 105.17$

$R^2 = 0.47$

With recalibration of SPAN parameter

$y = 2.35x - 105.72$

$R^2 = 0.57$
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