Grain Number of Wheat – A Model Comparison

A. Ratjen, U. Böttcher and H. Kage

Introduction
A sufficiently accurate prediction of grain number per square meter (GPSM) is of high importance for most wheat crop simulators. It is more closely related to yield than thousand kernel weight (e.g. Brancourt-Hulmel et al. 2003), albeit the role of GPSM for yield via sink limitation is still controversially discussed. We compared the performance of different existing empirical GPSM algorithms using data from field experiments. Furthermore we propose and test a new algorithm, as a synthesis of existing approaches, aiming to improve the predictive power of wheat crop simulators for GPSM.

Hypothesis
Although shoot dry matter, N nutrition index and photothermal quotient are not independent, a model considering all three parameters can enhance the GPSM prediction.

Contact:
Arne M. Ratjen
E-mail: ratjen@pflanzenbau.uni-kiel.de

Material and Methods

Data base for model comparison:
Field trials in Kiel (northern Germany)
- Three years (2003/04 to 2005/06)
- Five cultivars (4 each year)
- Varying N supply (0-320 kg/ha)
Field trial in Wageningen (the Netherlands) (Groth 1987)
- Two years (1983 and 1984)
- One cultivar
- Varying N supply (0-240 kg/ha)

Measured Parameters:
GPSM, yield, shoot dry weight (DM), shoot N concentration, development stages, daily weather data.
The necessary inputs for the models (Tab.1) were generated by fitting curves to the field data:
DM (logistic growth), shoot N concentration (linear interpolation), growth stages (simulated using a fitted model).
The Wageningen dataset was used for a ceteris paribus comparison between models using one genotype parameter for each model (G see Tab.1), derived by fitting observed GPSM.

The Wageningen dataset was used for a ceteris paribus comparison between models using one genotype parameter for each model (G see Tab.1), derived by fitting observed GPSM.

Results

<table>
<thead>
<tr>
<th>Kiel</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fit parameter</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>G*</td>
<td>[see Tab. 1]</td>
<td>16.1</td>
<td>34.2</td>
<td>0.95</td>
</tr>
<tr>
<td>RMSE [grains/m²]</td>
<td>1808</td>
<td>1912</td>
<td>2513</td>
<td>1301</td>
</tr>
<tr>
<td>rRMSE [% Mean]</td>
<td>9.3</td>
<td>9.9</td>
<td>13.0</td>
<td>6.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wageningen</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fit parameter</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>G</td>
<td>[see Tab. 1]</td>
<td>20.1</td>
<td>39.9</td>
<td>1.36</td>
</tr>
<tr>
<td>RMSE [grains/m²]</td>
<td>3677</td>
<td>2700</td>
<td>2565</td>
<td>1809</td>
</tr>
<tr>
<td>rRMSE [% Mean]</td>
<td>16.6</td>
<td>12.2</td>
<td>11.6</td>
<td>8.2</td>
</tr>
</tbody>
</table>

* no differences between “modern” cultivars (Kiel)

Conclusion
The consideration of all three parameters (DM₆₅, NNI₆₀, Q₄₅) shows best estimates for both datasets.