Uncertainties in predicting grain N uptakes: a case study in the crop rotation systems in Europe

Introduction

- to investigate if continuous simulation is better than single simulation in predicting grain N uptake in the rotation systems across Europe;
- to evaluate how much can be improved for models in predicting grain N uptake under minimum calibration and full calibration;
- to assess the ensemble model effects in simulating grain N uptake for the main crops in the rotation systems;
- to investigate the model performance in predicting management effects on grain N uptake.

(Kollas et al., 2015, European Journal of Agronomy)
## Materials and methods

1. Crops and treatments in the rotations in each site
   - **FO (Denmark):** WHB\WBA\SBA\OAT\PEA\RAP (Tillage, residue)
   - **BR (Germany):** WHB\WBA\SBT (N application, CO2)
   - **MU (Germany):** WHB\WBA\RYE\SBT (Irrigation)
   - **TH (France):** WHB\PEA\SBT (Catch crop, N application)

2. Observation data for minimum and full calibrations

<table>
<thead>
<tr>
<th></th>
<th>FO</th>
<th>BR</th>
<th>MU</th>
<th>TH</th>
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</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>Phenology/1&lt;sup&gt;st&lt;/sup&gt; treatment</td>
<td>Phenology/1&lt;sup&gt;st&lt;/sup&gt; treatment</td>
<td>Biomass /1&lt;sup&gt;st&lt;/sup&gt; treatment 4years</td>
<td>Harvest date/ 1&lt;sup&gt;st&lt;/sup&gt; treatment</td>
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<tr>
<td>Full</td>
<td>Phenology, N concentration above ground, grain N, crop yield</td>
<td>Phenology, soil water content, soil mineral N (0-30cm), N content above ground, grain N, sequential biomass measurements along the season, crop yield</td>
<td>Phenology, soil water content, soil mineral N (0-90cm), N content above ground, grain N, sequential biomass measurements along the season, crop yield</td>
<td>Soil water content, soil mineral N (0-110 cm), biomass, N above ground, grain N, crop yield</td>
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Locations of the experiment sites

16 Mar. 2016
### 3. Models included in the study

<table>
<thead>
<tr>
<th>Model</th>
<th>Abbreviation</th>
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**Simulation modes:**

- **ROTATION** simulation under minimum calibration and full calibration
- **SINGLE** simulation under minimum calibration and full calibration
1.1 Simulated and observed grain N uptake for winter wheat (WHB), winter barley (WBA), pea (PEA) and sugar beet (SBT)
1.2 Effects of model improvement on root mean squared error (RMSE) distribution for grain N for each crop

The blue points represent the RMSE for the e-median of all models in each treatment; The red points represent the RMSE for the e-mean of all models in each treatment;

\[
\text{RMSE}_m = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (O_i - S_{m,i})^2}
\]
2.1 Ensemble effects of model prediction for winter wheat

\[ S_{e-mean}^{n,j} = \frac{\sum_{i=1}^{n} S_{ij}}{n} \quad (n = 1, 2, 3, \ldots, 11) \]

\[ U_{n-mean} = \frac{\sum_{j=1}^{k} |S_{e-mean}^{n,j} - O_j|}{\sum_{j=1}^{k} O_j} \times 100 \]

\[ C_9^n = \frac{8!}{n!(8 - n)!} \]

(Li et al., 2015, Global Change Biology)
2.2 Ensemble effects of model prediction for **winter barley**

![Graph showing ensemble effects of model prediction for winter barley](image)
2.3 Ensemble effects of model prediction for pea
2.4 Ensemble effects of model prediction for sugar beet
3.1 Management effects on grain N uptakes

[Graph showing the effects of various treatments on grain N uptakes, with 'ROD.high' and 'SIN.high' categories compared across different treatments such as 'Catch Crop', 'CO2', 'Irrigation', 'N (BR)', 'N (TH)', 'Residues', and 'Tillage'.]
Conclusions

✓ Full calibration can significantly improve model performance in predicting grain N compared to minimum calibration.

✓ Models performed much better in winter wheat and winter barley, while the simulation of grain N of pea and sugar beet need further improvement.

✓ Higher nitrogen inputs have significant positive effects on grain N for winter wheat, winter barley and sugar beet.

✓ No clear effect of rotation versus single year runs on simulated grain N
Thank you for your attention!