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Nitrogen mineralization potentials in rice-wheat systems in southeastern China
Hofmeier, M.a, Roelcke, M.a, Yong, H.b, Cai, Z.C.c, Nieder, R. a
aInstitute of Geocology, TU Braunschweig, 38106 Braunschweig, Germany
bInstitute of Soil Science, Chinese Academy of Sciences, Nanjing 210008, P.R. China
cCollege of Geography Science, Nanjing Normal University, Nanjing 210046, P.R. China

1. Background & Objectives
The rice (Oryza sativa L.)-wheat (Triticum aestivum L.) double-cropping system in southeastern China is characterized by anaerobic conditions during the irrigated lowland summer rice crop and aerobic conditions during the upland winter wheat crop. However, the alternating water regime leads to high gaseous and leaching losses of nitrogen (N) mainly after the winter wheat crop due to flooding, puddling and ponding of the field for the summer rice crop (Roelcke et al., 2002). In order to minimize these losses, little residual mineral N (N_{min}) should be present in the soil profile at wheat harvest. Mineral N fertilizer application needs to be optimized and adapted to the demand of the winter wheat crop. Therefore, a better understanding of the N transformation processes, including mineralization dynamics of organic N during the winter wheat cropping season is essential. Long-term aerobic incubation laboratory experiments were carried out with soils from two rice-wheat growing regions in southeastern China.

2. Materials & Methods
Aerobic long-term laboratory incubation experiments (182 days) were carried out with soils from rice-wheat double-crop rotations from two different locations in Jiangsu Province (Yixing (31°17’ N 119°53’E) and Huai’an (33°30’N 119°03’E), based on the method by Stanford and Smith (1972), modified by Nordmeyer and Richter (1985). At each site, field-moist soil samples from three depth increments (0-20 cm, 20-60 cm, 60-90 cm) were taken after field preparation for the winter wheat crop. Samples were mixed with quartz sand, filled in 60 ml plastic syringes, incubated by 35 °C and regularly leached with a 0.01 M CaCl_2 solution on days 0, 3, 7, 14, 21, 35, 49, 70, 91, 119, 147 and 182 after the onset of the experiment. Mineral N (NO_3^-N and NH_4^+-N) in the leachates was determined by continuous-flow analysis and the cumulative amounts were used for estimation of mineralization parameters using a double exponential model with two first-order kinetics reactions (Richter et al., 1982):

\[ N(t) = N_a \times \left\{ 1 - e^{-k_a \times t} \right\} + N_p \times \left\{ 1 - e^{-k_p \times t} \right\} \tag{1} \]

The estimated parameters will subsequently be included in the HERMES model (Kersebaum, 1995; Kersebaum and Beblik, 2001) for simulation of the N dynamics in the soil, water and plant system during the winter wheat growing period. Calibration and validation of simulation results will be performed with field N_{min}, gravimetric water contents, as well as plant N uptake data, taken from field experiments conducted in Yixing and Huai’an during three winter wheat cropping seasons (2008-2011).

3. Results & Discussion
Table 1. Properties of the soils used for the long-term incubation experiment.

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth [cm]</th>
<th>pH [H_2O]</th>
<th>CaCO_3</th>
<th>C_\text{org}</th>
<th>N_{\text{tot}}</th>
<th>Sand’</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yixing</td>
<td>0-20</td>
<td>6.2</td>
<td>n.d.</td>
<td>1.7</td>
<td>0.20</td>
<td>0.7</td>
<td>82.9</td>
<td>16.4</td>
</tr>
<tr>
<td></td>
<td>20-60</td>
<td>7.5</td>
<td>n.d.</td>
<td>0.4</td>
<td>0.05</td>
<td>1.6</td>
<td>84.5</td>
<td>13.9</td>
</tr>
<tr>
<td></td>
<td>60-90</td>
<td>7.5</td>
<td>n.d.</td>
<td>0.2</td>
<td>0.05</td>
<td>2.0</td>
<td>86.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Huai’an</td>
<td>0-20</td>
<td>8.3</td>
<td>8.3</td>
<td>1.8</td>
<td>0.26</td>
<td>1.8</td>
<td>53.5</td>
<td>44.8</td>
</tr>
<tr>
<td></td>
<td>20-60</td>
<td>8.4</td>
<td>9.0</td>
<td>1.0</td>
<td>0.08</td>
<td>11.5</td>
<td>57.7</td>
<td>30.8</td>
</tr>
<tr>
<td></td>
<td>60-90</td>
<td>8.4</td>
<td>7.4</td>
<td>0.8</td>
<td>0.07</td>
<td>0.8</td>
<td>65.7</td>
<td>33.4</td>
</tr>
</tbody>
</table>

* Sand: 2-0.063 mm; Silt: 0.063-0.002 mm; Clay: < 0.002 mm

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Soil properties in Yixing and Huai’an are presented in Table 1. The soil in Yixing was developed in alluvial deposits and has a silty clay loam texture. The soils on the experimental sites in Huai’an are relatively young and developed in limnic sediments with high clay contents. Figure 1 shows the cumulative N mineralization in three depth increments of the soils from Yixing and Huai’an. As expected, highest amounts of N were mineralized in 0-20 cm depth of the soils in both locations with a distinctly higher N mineralization in the topsoil of Huai’an. The 20-60 cm depth showed a drastically lower N mineralization for both soils, with slightly higher amounts in the soil from Huai’an. Almost no N mineralization occurred in the 60-90 cm soils depth of both locations.

![Graph showing N mineralization](image)

Figure 1. Cumulative N mineralization during 182 days in three depth increments (0-20 cm, 20-60 cm, 60-90 cm) of experimental soil from Yixing (left) and Huai’an (right), China; error bars represent s.d., n=4.

4. Conclusion
The experimental results showed a clearly higher N mineralization in the soils from Huai’an, which can be explained by higher soil organic matter and clay contents (Table 1). These differences have to be considered for N fertilization recommendations. The results will be used for parameter adaptation in the HERMES model and for simulation of the N dynamics during the winter wheat growing season in rice-wheat systems.

Acknowledgements
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References