Effect of a new urease inhibitor on NH$_3$ volatilization and N utilization in maize in NCP

Qianqian Li*, Xuejun Liu, Fusuo Zhang, Gregor Pasda, Alexander Wissemeier

* lili@cau.edu.cn
* Postdoc, China Agricultural University, CHN
NH₃ emission in China were approximately 9.8 Tg/Year

Huang et al., 2012
Impact of NH$_3$ volatilization

- Financial losses for the farmer.

- Ecological effects include acidification of soil, reduced biodiversity, and eutrophication of aquatic ecosystems.

- Effects on human health include negative impacts of air pollution and smog (e.g., PM$_{2.5}$).
Urease inhibitors inhibit the activity of enzyme urease for a certain period of time and so can reduce NH₃ emissions

LIMburgerhof Urea Stabilizer (Limus®)
Synergistic action of 75%NBPT with 25%NPPT
Ureases in soils differ and require different inhibitors

Experimental 3D structure of the active center of urease from *Bacillus pasteurii*

Experimental 3D structure of the active center of urease after an in silico point mutation (Pearson et al., 1997) Biochem. 36, 8164

Source from Agricultural Center, BASF SE
Ureases in soils differ and require different inhibitors

Docking experiments with NBPT and NPPT suggest differences in binding to the active center of different ureases. NBPT and NPPT, in silico modelling.

Source from Agricultural Center, BASF SE
Effect on NH$_3$ loss under fully controlled environmental conditions without plants (incubation experiments)

Effect on corn yield, RE$_N$ and NH$_3$ loss (field trials)
**Limus® effect on reduction of NH$_3$ loss compared with NBPT**

Potential of UI (NBPT/LIMUS) on reduction of NH$_3$ losses from Urea

![Graph showing NH$_3$ losses over days after fertilization with various concentrations of NBPT and LIMUS.](image)

Li et al., unpublished data
Limus® effect on reduction of NH$_3$ loss compared with NBPT

Compared effect of 0.0025%U1(NBPT/LIMUS) on reduction of NH$_3$ losses from urea

Li et al., unpublished data
Limus® effect on reduction of NH₃ loss compared with NBPT

Compared effect of 0.01%U(NBPT/LIMUS) on reduction of NH₃ losses from urea

Li et al., unpublished data
**Limus® effect on reduction of NH$_3$ loss for different soils**

Simple NH$_3$ test system to screen soils / to demonstrate on farmer level

![Graph showing Benifit index for applied LIMUS across various locations](image)

Li et al., unpublished data
Effect on NH3 loss under fully controlled environmental conditions without plants (incubation experiments)

Effect on maize yield, $R_{EN}$ and NH$_3$ loss (field trials)
Effect of different rate of Limus® on NH₃ mitigation and maize yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Urea-N surface-applied at 3-leaf stage (kg N/ha)</th>
<th>Limus concentration (% w/w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Urea</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td>L 0,04%</td>
<td>130</td>
<td>0,04</td>
</tr>
<tr>
<td>L 0,08%</td>
<td>130</td>
<td>0,08</td>
</tr>
<tr>
<td>L 0,12%</td>
<td>130</td>
<td>0,12</td>
</tr>
</tbody>
</table>

Li et al., unpublished data
Effect of different rate of Limus® on NH$_3$ mitigation and maize yield

<table>
<thead>
<tr>
<th>NH$_3$-N loss (%)</th>
<th>Yangling</th>
<th>Xunxian</th>
<th>Quzhou</th>
<th>n=3</th>
<th>% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>10.4 a</td>
<td>7.6 a</td>
<td>12.6 a</td>
<td>10.2 a</td>
<td></td>
</tr>
<tr>
<td>L 0.04%</td>
<td>6.6 b</td>
<td>3.0 b</td>
<td>5.7 b</td>
<td>5.1 b</td>
<td>50.0</td>
</tr>
<tr>
<td>L 0.08%</td>
<td>3.8 bc</td>
<td>2.7 b</td>
<td>4.9 b</td>
<td>3.8 c</td>
<td>62.7</td>
</tr>
<tr>
<td>L 0.12%</td>
<td>2.4 c</td>
<td>1.7 b</td>
<td>3.7 b</td>
<td>2.6 d</td>
<td>74.5</td>
</tr>
</tbody>
</table>

Li et al., unpublished data
## Effect of different rate of Limus® on NH₃ mitigation and maize yield

<table>
<thead>
<tr>
<th>Grain yield t/ha</th>
<th>Yangling</th>
<th>Xunxian</th>
<th>Quzhou</th>
<th>n=3</th>
<th>rel. grain yield %</th>
</tr>
</thead>
<tbody>
<tr>
<td>no N</td>
<td>5,6 a</td>
<td>7,5 a</td>
<td>4,9 a</td>
<td>6,0 a</td>
<td>74,4</td>
</tr>
<tr>
<td>Urea</td>
<td>7,6 b</td>
<td>8,8 b</td>
<td>7,9 b</td>
<td>8,1 b</td>
<td>100</td>
</tr>
<tr>
<td>L 0,04%</td>
<td>8,2 b</td>
<td>8,9 b</td>
<td>9,9 c</td>
<td>9,0 c</td>
<td>111,1</td>
</tr>
<tr>
<td>L 0,08%</td>
<td>8,0 b</td>
<td>8,9 b</td>
<td>9,9 c</td>
<td>8,9 c</td>
<td>110,4</td>
</tr>
<tr>
<td>L 0,12%</td>
<td>8,4 b</td>
<td>8,7 b</td>
<td>9,3 c</td>
<td>8,8 c</td>
<td>109,0</td>
</tr>
</tbody>
</table>

Li et al., unpublished data
**Effect of different rate of Limus® on NH₃ mitigation and maize yield**

Li et al., unpublished data

<table>
<thead>
<tr>
<th>REₙ %</th>
<th>Yangling</th>
<th>Xunxian</th>
<th>Quzhou</th>
<th>n=3</th>
<th>REₙ response vs U %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>30,8 a</td>
<td>20,3 a</td>
<td>37,5 a</td>
<td>29,5 a</td>
<td></td>
</tr>
<tr>
<td>L 0,04%</td>
<td>47,2 b</td>
<td>24,3 a</td>
<td>69,0 b</td>
<td>46,8 b</td>
<td>58,6</td>
</tr>
<tr>
<td>L 0,08%</td>
<td>47,4 b</td>
<td>25,0 a</td>
<td>72,3 b</td>
<td>48,2 b</td>
<td>63,3</td>
</tr>
<tr>
<td>L 0,12%</td>
<td>52,8 b</td>
<td>24,3 a</td>
<td>72,9 b</td>
<td>50,0 b</td>
<td>69,3</td>
</tr>
</tbody>
</table>

REₙ = (crop N uptake in applied N plot-crop N uptake in N₀ plot)/applied fertilizer N × 100
Conclusion

- Limus® played better effect on reduction of NH₃ losses compared with NBPT.

- Limus® addition (0.04-0.12 %w/w) can significantly reduce NH₃ volatilization by 50-75% compared to urea alone across three sites of NCP.

- Maize grain yield can be increased by 11% with Limus® addition (0.04-0.12 %w/w) under cultivation practice of surface-applying at 3-leaf stage, while the REₙ can be significantly improved by 58-69% compared to urea alone.
Acknowledgements

CAU members:
Xuejun Liu
Xinping Chen
Fusuo Zhang
........

Collaborators:
Wolfram Zerulla
Markus Schmid
Gregor Pasda
Alexander Wissemeier
........

Special thanks to Prof. Volker Römheld

Financial supports: BASF SE, Ludwigshafen, Germany and the National Natural Science Foundation of China (40425007, 31421092).

Thank you very much!