Supplementary Materials

Understanding the Fertilizer Management Impacts on Water and Nitrogen Dynamics for a Corn Silage Tile-Drained System in Canada

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Supplemental Table S1 Soil physical and chemical data of the experimental field for DNDC simulations at Alfred, Canada.

<table>
<thead>
<tr>
<th>Soil depth (m)</th>
<th>Density (g cm$^{-2}$)</th>
<th>SOC $^1$ (kg C ha$^{-1}$)</th>
<th>pH</th>
<th>Clay (fraction)</th>
<th>Field capacity (wfps)$^2$</th>
<th>Wilting point (wfps)</th>
<th>Hydro-conductivity (m hr$^{-1}$)</th>
<th>Porosity (cm$^3$ cm$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.10</td>
<td>1.265</td>
<td>0.032</td>
<td>7.1</td>
<td>0.43</td>
<td>0.68</td>
<td>0.476</td>
<td>0.015</td>
<td>0.41</td>
</tr>
<tr>
<td>0.1-0.3</td>
<td>1.265</td>
<td>0.023</td>
<td>7.1</td>
<td>0.45</td>
<td>0.70</td>
<td>0.476</td>
<td>0.015</td>
<td>0.43</td>
</tr>
<tr>
<td>0.3-0.6</td>
<td>1.391</td>
<td>0.020</td>
<td>7.1</td>
<td>0.49</td>
<td>0.72</td>
<td>0.473</td>
<td>0.015</td>
<td>0.47</td>
</tr>
<tr>
<td>0.6-0.9</td>
<td>1.386</td>
<td>0.015</td>
<td>7.1</td>
<td>0.49</td>
<td>0.72</td>
<td>0.468</td>
<td>0.012</td>
<td>0.48</td>
</tr>
<tr>
<td>0.9-1.2</td>
<td>1.387</td>
<td>0.010</td>
<td>7.1</td>
<td>0.49</td>
<td>0.73</td>
<td>0.468</td>
<td>0.012</td>
<td>0.51</td>
</tr>
<tr>
<td>1.2-1.5</td>
<td>1.392</td>
<td>0.010</td>
<td>7.1</td>
<td>0.49</td>
<td>0.74</td>
<td>0.468</td>
<td>0.010</td>
<td>0.55</td>
</tr>
<tr>
<td>1.5-1.8</td>
<td>1.395</td>
<td>0.005</td>
<td>7.1</td>
<td>0.49</td>
<td>0.75</td>
<td>0.470</td>
<td>0.008</td>
<td>0.55</td>
</tr>
</tbody>
</table>

$^1$SOC soil organic carbon; $^2$wfps water filled pore space.
Supplemental Table S2 The calibrated DNDC model parameters at Alfred, ON, Canada.

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameters</th>
<th>Default</th>
<th>Calibrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>Grain fraction</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Stem+leaf fraction</td>
<td>0.44</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>Root fraction</td>
<td>0.16</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Grain C:N</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Stem+leaf C:N</td>
<td>80</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Root C:N</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Water requirement (g water g\textsuperscript{-1} DM)</td>
<td>150</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Thermal degree days (GDD at a base 0 °C)</td>
<td>2500</td>
<td>2300</td>
</tr>
<tr>
<td></td>
<td>Maximum root depth (m)</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>N\textsubscript{2}O</td>
<td>Microbial nitrifier growth rate multiplier</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>(Controls the growth rate of nitrifiers in the soil mass)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum hourly nitrification rate multiplier</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>(Controls the maximum hourly rate of nitrification)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microbial denitrifier growth rate multiplier</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>(Controls the growth rate of denitrifiers in the soil mass)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage</td>
<td>Drainage Ke: fraction of vertical Ks</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>(2 times the KSat value for lateral flow to tiles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N leaching</td>
<td>Fraction of maximum mobile N</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>(NO\textsubscript{3}-N subject to mobilization per hourly time step)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fraction of maximum preferential N movement</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>(fraction of N in a saturated layer that is subject to preferential movement to tiles)</td>
<td></td>
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</table>
Supplemental Table S3 Management practices for long term simulation at Alfred, ON, Canada.

<table>
<thead>
<tr>
<th>Period</th>
<th>Treatment</th>
<th>Tillage</th>
<th>Treatment</th>
<th>Period</th>
<th>Treatment</th>
<th>Tillage</th>
<th>Treatment</th>
<th>Period</th>
<th>Treatment</th>
<th>Tillage</th>
<th>Treatment</th>
<th>Period</th>
<th>Treatment</th>
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<th>Treatment</th>
<th>Period</th>
<th>Treatment</th>
<th>Tillage</th>
<th>Treatment</th>
</tr>
</thead>
</table>
Supplemental Table S4 Statistical evaluation of cumulative nitrate leaching and N\textsubscript{2}O emission simulations using the DNDC model at Alfred, Canada

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>Measured (kg N ha\textsuperscript{-1})</th>
<th>Simulated (kg N ha\textsuperscript{-1})</th>
<th>Samples no.</th>
<th>RMSE (kg N ha\textsuperscript{-1})</th>
<th>nRMSE (%)</th>
<th>NSE</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative N\textsubscript{2}O emissions (kg N ha\textsuperscript{-1})</td>
<td>RF</td>
<td>1.14</td>
<td>0.89</td>
<td>114</td>
<td>0.156</td>
<td>26.3</td>
<td>0.84</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>RS</td>
<td>0.89</td>
<td>0.84</td>
<td>114</td>
<td>0.046</td>
<td>11.6</td>
<td>0.98</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>IS</td>
<td>1.16</td>
<td>1.00</td>
<td>114</td>
<td>0.102</td>
<td>18.5</td>
<td>0.94</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.58</td>
<td>0.60</td>
<td>114</td>
<td>0.031</td>
<td>10.3</td>
<td>0.98</td>
<td>0.99</td>
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<tr>
<td></td>
<td>DF</td>
<td>1.37</td>
<td>1.18</td>
<td>114</td>
<td>0.108</td>
<td>15.2</td>
<td>0.94</td>
<td>0.98</td>
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<tr>
<td></td>
<td>DS</td>
<td>1.21</td>
<td>1.12</td>
<td>114</td>
<td>0.101</td>
<td>18.9</td>
<td>0.95</td>
<td>0.99</td>
</tr>
<tr>
<td>Cumulative nitrate leaching (kg N ha\textsuperscript{-1})</td>
<td>RF</td>
<td>16.29</td>
<td>13.16</td>
<td>738</td>
<td>2.17</td>
<td>25.1</td>
<td>0.86</td>
<td>0.96</td>
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<tr>
<td></td>
<td>RS</td>
<td>11.81</td>
<td>11.07</td>
<td>738</td>
<td>1.03</td>
<td>17.2</td>
<td>0.93</td>
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<tr>
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<td>IS</td>
<td>35.00</td>
<td>25.87</td>
<td>738</td>
<td>4.05</td>
<td>11.6</td>
<td>0.97</td>
<td>0.99</td>
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<tr>
<td></td>
<td>C</td>
<td>6.38</td>
<td>7.29</td>
<td>738</td>
<td>1.61</td>
<td>61.6</td>
<td>0.47</td>
<td>0.91</td>
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<tr>
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<td>DF</td>
<td>21.00</td>
<td>17.25</td>
<td>738</td>
<td>2.55</td>
<td>22.9</td>
<td>0.88</td>
<td>0.97</td>
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<tr>
<td></td>
<td>DS</td>
<td>17.13</td>
<td>15.02</td>
<td>738</td>
<td>2.21</td>
<td>24.9</td>
<td>0.87</td>
<td>0.96</td>
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</tbody>
</table>
Supplemental Fig. S1  Annual and seasonal temperature (T), precipitation (P) and solar radiation (SR) from 1986 to 2015 at Alfred, Canada
Supplemental Fig. S2 Comparing the measured and simulated cumulative drainage using the DNDC model at Alfred, Canada.
Supplemental Fig. S3 Simulations of daily N₂O emissions (a-f) from 2012-2014 using the DNDC model at Alfred, Canada.
Supplemental Fig. S4 Long-term effects of different fertilizer types on annual nitrous oxide (N$_2$O) emissions, nitrate (NO$_3^-$) leaching and ammonia (NH$_3$) using the DNDC model at Alfred, Canada.
Supplemental Fig. S5 Simulating effects of different fertilizer types and timing on (a) 50-year average and (b) annual changes of soil organic carbon using the DNDC model at Alfred, Canada. Bars are standard errors (n=30).