Long-term Management Effects on Crop Yields and Soil N Cycling

Agronomy Update 2018
Presented by Miles Dyck
University of Alberta
management affects soil properties and processes

New guidelines reflect benefits of no-till farming

Posted Aug. 28th, 2014 by Robert Arnason

Soil fertility | North Dakota university is the first in the U.S. to adopt new corn recommendations

The 11-page guide makes it clear that no-till soil is distinct from tilled soil. NDSU experts say farmers with fields dedicated to continuous no-till, for six years or longer, need 40 to 50 pounds less nitrogen per acre to grow corn than producers with tilled fields.

the case for long-term plots

• Long-term experiments required to understand soil response to changes in management because soil properties change slowly

• Information from Long-term experiments can support contemporary management decisions
Breton Classical Plots
Breton Classical Plots

- 5-year, WOBHH
- 5-year, WOBHH
- 5-year, WOBHH
- 5-year, WOBHH
- 2-year, WF

11) check
10) NPS(-K)
  9) NPKS
  8) PKS(-N)
  7) NPK(-S)
  6) Lime
  5) check
  4) NKS(-P)
  3) NPKS
  2) Manure
  1) check
<table>
<thead>
<tr>
<th>5-yr: WOBHH</th>
<th>2yr: W-F</th>
<th>Treatment</th>
<th>Plot/Treatment</th>
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<tbody>
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<td>0-0-0-0</td>
<td>0-0-0-0</td>
<td>Check</td>
<td>1, 5, 11</td>
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<tr>
<td>87.5-?-?-?</td>
<td>90-?-?-?</td>
<td>Manure (M)</td>
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<td>90-0-46-20</td>
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<td>PKS(-N)</td>
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<td>50-22-0-20</td>
<td>90-22-0-20</td>
<td>Check</td>
<td>11</td>
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</table>

- **N source:** 46-0-0-0
- **P source:** 0-45-0-0
- **K source:** 0-0-60-0
- **S source:** 0-0-0-90
Breton Classical Plots
Gray Soils

Gray Luvisol

D. Brown Chernozem

SETTLERS SNAPPED UP THE BEST FARMLAND FIRST

GOOD SOIL WAS GOLD FOR EARLY SETTLERS

Go West, young man | Settlement of the Prairies rested on the fertility of the soil and the perseverance of those who heeded the call to move west and make a living on the frontier.

Homes made from prairie soil helped early pioneers survive.

Breaking soil was difficult. The soil quality discovered beneath would dictate the success of the farms. | WESTERN DEVELOPMENT MUSEUM ARCHIVE PHOTO

Western Producer; The soil issue
Average Wheat Yields: 2007-2016 rotation averages

Fertility Treament
Check Manure NPKS PKS(-N) NKS(-P) NPS(-K) NPK(-S)
wheat yield (kg ha\(^{-1}\))

Average Wheat Yields: 2007-2016 rotation averages

Fertility Treament
Check Manure NPKS PKS(-N) NKS(-P) NPS(-K) NPK(-S)
wheat yield (bu ac\(^{-1}\))
Average Wheat N Uptake in Grain and Straw: 2007-2016

Fertility Treatment

Fertility Treatment

wheat N uptake (kg N ha$^{-1}$)

wheat N uptake (kg N ha$^{-1}$)
Average Wheat Yields: 2007-2015 rotation response to fertilizer NPKS

![Graph showing wheat yield response to different fertilizer treatments.](image-url)
Nutrient management planning

• Long-term rotation and fertilization affects soil nutrient balances and response to added nutrients

• On-farm rotations may not always be consistent, but...

• Keeping records of crops, yields, and fertilizer applications can help to estimate N, P, K, S exports over time and help make fertilization application decisions

• Nutrient management planning to address N, P, K, S deficiencies will increase fertilizer use efficiency
Linking long-term management and productivity to greenhouse gas emissions – nitrous oxide, $N_2O$
Cumulative growing season $N_2O$ emissions (2013-2016)
Fertilization-yield-soil N-N$_2$O emission feedback

![Graph showing the relationship between total soil N (0-15 cm) and growing season N$_2$O-N emissions for different fertilization treatments.](image-url)
N\textsubscript{2}O-N per kg grain → intensity

<table>
<thead>
<tr>
<th>Fertility Treatment</th>
<th>Control</th>
<th>Manure</th>
<th>NPKS</th>
<th>PKS(-N)</th>
<th>NPK(-S)</th>
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</thead>
<tbody>
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<td>0.0</td>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
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</table>

**WF**

**5yr-WOBHH**

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![Chart showing kg N\textsubscript{2}O-N kg\textsuperscript{-1} grain (X10\textsuperscript{-3} kg kg\textsuperscript{-1}) for different fertility treatments.](chart.png)

**Y-axis:** kg N\textsubscript{2}O-N kg\textsuperscript{-1} grain (X10\textsuperscript{-3} kg kg\textsuperscript{-1})

**X-axis:** fertility treatment
Applications

- Growing season N$_2$O emissions affected by long-term soil N balance and both fertilizer and non-fertilizer sources of N

- Positive (increasing) soil N balance associated with higher yields but also higher N$_2$O emissions.

- Addressing all nutrient deficiencies is key to increased crop N uptake which will reduced N$_2$O emission intensity $\Rightarrow$ N$_2$O-N per yield
Acknowledgements

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• Leah Predy – undergraduate student
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• Past Breton Plots Academic Leads and Support Staff
• Breton Plots Donors

• Funders: Shell Canada, Fertilizer Canada, International Plant Nutrition Institute, ACIDF, Alberta Wheat Commission, NSERC
Extra links

• Recent article in Better Crops (p.7-9):
  • http://www.ipni.net/publication/bettercrops.nsf/0/0A88BF43B62A15E78525806B004DB7D4/$FILE/BC-2016-4.pdf or

• More information about the Breton Plots:
  • http://prairiesoilsandcrops.ca/articles/volume-5-10-screen.pdf or
  • http://prairiesoilsandcrops.ca/volume5.php or
  • http://bretonplots.ales.ualberta.ca/Endowment-Fund
# Growing Conditions 2007-2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Precipitation (mm)(^z)</th>
<th>Growing Season Precipitation (mm)(^y)</th>
<th>Growing season GDD(^x)</th>
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<tbody>
<tr>
<td>2007</td>
<td>664</td>
<td>491</td>
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<tr>
<td>2008</td>
<td>375</td>
<td>286</td>
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<tr>
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<td>278</td>
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<td>487</td>
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<td>2015</td>
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<td>180</td>
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<tr>
<td>2016</td>
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<td>392</td>
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</table>

\(^z\)October 1 of previous calendar year to September 30 of stated calendar year  
\(^y\)April 1 – August 31 of stated calendar year  
\(^x\)base 5°C