Nutrient management and fertility considerations with cover crops

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Basics of Soil Testing

- Uses of soil testing
  - Predict fertilizer and lime needs prior to planting
  - Monitor nutrient status in season
  - Monitor soil test levels over time as a measure of the impact of the fertility program
  - Address environmental concerns related to potential nutrient runoff or leaching
In Nutrient Management the Primary Objectives are:

• Determine the fertility and pH status of an area, field or farm, with the goal of removing fertility as a yield limitation

• Use that information to predict where fertilizer responses will or will not occur
  • Increase the return on our fertilizer investment
  • Increase the efficiency of fertilizer use
  • Reduce the potential for environmental injury
Points to consider

• Establish sampling areas to address differences in soils and past management

• Sample to the appropriate depth, considering the soil test and tillage

• Take an adequate number of cores

• Sample regularly at an appropriate time and when possible the same time

• Take care in handling and shipping samples

• Consider the reliability of individual tests and interpret tests realistically, considering the goal of predicting where a response will or will not occur
Soil Sampling Approaches

- Divide fields into uniform areas.
- Soil color (Aerial photograph).
- Topography (uplands, sloping, bottomland).
- Past inputs (limed vs. unlimed).
- Use judgment on management size: One acre in 200 is probably not worth the cost.
- Soil series (NRCS Soil Survey, Web Soil Survey:  
Nutrient management and fertility considerations with cover crops
Overview

• Improve nutrient availability with cover crops:
  • Decomposing biomass
  • Nutrient cycle (subsurface and surface)
• Considerations/effect of different types of cover crops
Nutrient management considerations

• Cover crops are expected to capture residual nitrate N.

• What amounts of nutrients will a cover crop accumulate in the top and root biomass?

• How will the accumulated nutrients affect nutrient availability in the soil?

• Are supplemental nutrients beneficial for stimulating growth?
Nutrient management considerations

- With increased biomass and soil cover, N fertilizer placement can be more relevant.
- Monitor key soil parameters such as organic matter: correct sampling is important!
Nitrogen fertilizer replacement value provided to sorghum by cover crops

Ashland Bottoms, Kraig Rozeboom

Sorghum response to N fertilizer rate after cover crops

Estimated N fertilizer replacement value provided to grain sorghum by cover crops

<table>
<thead>
<tr>
<th>Cover crop</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Across years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double-crop soybean</td>
<td>52</td>
<td>6</td>
<td>-74</td>
<td>-8 b</td>
</tr>
<tr>
<td>Late-maturing soybean</td>
<td>45</td>
<td>26</td>
<td>40</td>
<td><strong>40 a</strong></td>
</tr>
<tr>
<td>Sorghum–sudangrass</td>
<td>-55</td>
<td>-63</td>
<td>-239</td>
<td>-119 c</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>31</td>
<td>-6</td>
<td>-68</td>
<td>-14 b</td>
</tr>
<tr>
<td>Daikon radish</td>
<td>6</td>
<td>-10</td>
<td>-103</td>
<td>-36 b</td>
</tr>
</tbody>
</table>

Nitrogen mineralization

• Initial conversion to NT results in the accumulation of organic matter with a required accumulation of organic nitrogen

• Consider this:
  • 1% organic matter in 1 foot of soil
  • = ~40,000 lb organic matter/acre
  • = ~23,000 lb organic carbon/acre
  • = ~2,300 lb organic nitrogen/acre

• Transition period varies with environment and cropping system (5-10+ years commonly quoted)
How does management affect soil organic carbon?

(Modified from Tilman, 1998)
Corn Yield as affected by Method of UAN Application

<table>
<thead>
<tr>
<th>Method</th>
<th>Yield, bu/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast</td>
<td>168</td>
</tr>
<tr>
<td>Dribbled</td>
<td>176</td>
</tr>
<tr>
<td>Knifed</td>
<td>188</td>
</tr>
</tbody>
</table>

Gordon, 5-year average
Immobilization and volatilization potential

- Limited to surface broadcast applications of nitrogen for immobilization and urea-based forms for volatilization
  - Subsurface banding to place nitrogen below residue limit immobilization
  - Broadcasting nitrogen when temperatures are low and precipitation is imminent to limit volatilization
What about P and K?

- Cover crops can take up P and K and return to the upper soil layer (increase root access to the next crop?).
Keep P and K in the field...

N. Nelson, 2017
Should I fertilize my cover crops?

• Fertilizer application (N, P, K) can increase cover crop biomass production:
  • Response will vary by specie.
  • More biomass (grazing and soil cover).

• Can be an opportunity for nutrient application for the rotation.

• Decisions should be made based on soil test information.
Nutrients are cycled, but is there any net gain in available levels?

• Nutrient uptake reduces available soil levels by uptake, but then replenishes them as the biomass decomposes.

• For an increase in available nutrient levels in the soil there must be a net gain, not just cycling.

• Deep rooting crops bring nutrients from the subsoil to the surface.
Summary

• Cover crops provide a mechanism for:
  • Recovering residual nutrients
  • Cycling nutrients in the surface soil
  • Moving nutrients from the subsoil to the surface soil.

• With adequate soil nutrient levels adding supplemental fertilizer to cover crops may provide limited benefit.
Ongoing project – corn and soybean 2017-2018

- Evaluation of Soil Health Test to Determine Fertilizer Needs
  - Corn
  - Soybean
- Multi-location
- Different management system
Soil Sampling Depth

• Immobile nutrients accumulate in the top few inches of soil. Their availability should be measured using a 0 to 6” surface soil sample.

  • Shallower samples give high test results, over estimate nutrient supply, and under estimate fertilizer needs.

  • Deeper samples give low test results, under estimate nutrient supply and over estimate fertilizer needs.
Effect of tillage on soil test levels

<table>
<thead>
<tr>
<th>depth</th>
<th>plow</th>
<th>chisel</th>
<th>no-till</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td>ppm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4</td>
<td>30</td>
<td>191</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>242</td>
<td>49</td>
<td>270</td>
</tr>
<tr>
<td>4-8</td>
<td>28</td>
<td>188</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>178</td>
<td>35</td>
<td>197</td>
</tr>
<tr>
<td>8-12</td>
<td>22</td>
<td>189</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>162</td>
<td>19</td>
<td>185</td>
</tr>
</tbody>
</table>
Exceptions to the normal 0-6” Sampling Depth for pH and Lime Recommendations:

• **In continuous no-till**, pH and lime requirement should be measured using a 0-3” surface sample, unless you plan to incorporate lime with a plow.

• **Perennial forage crops**, pH and lime recommendations should be made from a 0-3” surface sample, unless you plan to incorporate lime with a plow.
Sampling Depths for Mobile Nutrients

- While P and K are relatively immobile in soils and accumulate in the surface few inches, Nitrate-N, Sulfur (S) and Chloride (Cl) are mobile and move through the soil profile.

- We recommend a 24” Profile Soil Sample to test for mobile nutrients such as nitrate-N in the soil. 10-15 cores are still needed to give a high quality sample.

- I have taken the samples and know it is very hard work, so we only recommend profile testing to make N recommendations for corn, milo, cotton, canola and wheat, or for required environmental monitoring.
Number of Cores to Make a Good Sample

- Soils vary across very short distances in nutrient supply due to many factors including:
  - Position on the landscape
  - Past erosion
  - Parent material of the soil
  - Previous manure and fertilizer applications, including “Cow Pie Mosaic”

- To account for that variation you should take 20-30 surface cores and 10-20 subsoil per sample
EXAMPLE OF THE RELATIONSHIP BETWEEN NUMBER OF SOIL CORES PER COMPOSITE SAMPLE AND ERROR

CONFIDENCE INTERVAL (+- ppm P)

NUMBER OF CORES PER SAMPLE

MEAN SOIL P = 19ppm
When to Take Soil Samples

- P, K, Zn and lime always the same time.
- Focus on times when soil conditions are good, long enough before planting to really use the information.
- Be consistent.
- Late fall, winter and early spring-November through March are good.
When to take soil samples?

- For N, S and Cl

- **Summer crops**: after harvest in the fall, but before the soil warms in the spring. (corn, grain sorghum and sunflowers)

- **Fall crops**: before planting in the fall.
  - Spring or winter samples to predict topdress N needs don’t work real well. (wheat)
Handling samples before sending to lab

- Avoid contamination with dirty buckets, galvanized buckets, etc.
- Never oven dry soil samples! High temperatures can alter test results, especially K.
- Critical for nitrate-N samples to air dry if the sample won’t be shipped for a few days.
Consider the accuracy and reliability of individual soil tests

- What constitutes a good soil test
  - Good relationship between soil test level and yield
  - Accurately predicts nutrient needs
  - Simple
  - Inexpensive
  - Precise
  - Reproducible
Reliability, usefulness and cost effective rating for soil test

<table>
<thead>
<tr>
<th>Test</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pH</td>
<td>100</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>85</td>
</tr>
<tr>
<td>Potassium</td>
<td>80</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>75</td>
</tr>
<tr>
<td>C.E.C</td>
<td>60</td>
</tr>
<tr>
<td>N (profile nitrate)</td>
<td>50</td>
</tr>
<tr>
<td>Total N</td>
<td>45</td>
</tr>
<tr>
<td>Zn</td>
<td>45</td>
</tr>
<tr>
<td>Ca</td>
<td>40</td>
</tr>
<tr>
<td>Mg</td>
<td>40</td>
</tr>
<tr>
<td>S</td>
<td>40</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0</td>
</tr>
</tbody>
</table>

Ted Peck, 2003
Conclusions: Where should I focus my attention in ST?

• In Kansas the greatest return to fertilization is from N, P, and Zn, but......
• Sulfur and chloride responses can be seen on cereals
• Iron chlorosis is also common, but pH and OM may be more useful than the soil test
Conclusion: Be consistent in sampling

- Sample the same areas to develop a good ST history
- Sample the same time of year
- Be careful to sample the same depth
- Use the same lab to ensure the same testing procedures are followed
- Don’t invest more time and money than you really will use
Conclusions

• For immobile nutrients and lime, use a surface 0-6” sample
  • In long-term no-till or forages, 0-3 for pH and lime

• For mobile nutrients use a 0-24” profile sample before planting.

• Take lots of cores

• Be consistent
### Cover crop effects on runoff

<table>
<thead>
<tr>
<th></th>
<th>101</th>
<th>104</th>
</tr>
</thead>
<tbody>
<tr>
<td>total runoff (ft³)</td>
<td>2100</td>
<td>2099</td>
</tr>
<tr>
<td>area (ac)</td>
<td>1.20</td>
<td>1.27</td>
</tr>
<tr>
<td>runoff (inches)</td>
<td>0.48</td>
<td>0.46</td>
</tr>
<tr>
<td>peak runoff (cfs)</td>
<td>1.06</td>
<td>1.60</td>
</tr>
<tr>
<td>time to peak (min)</td>
<td>28</td>
<td>17</td>
</tr>
<tr>
<td>time to initiation of runoff (min)</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>runoff duration (min)</td>
<td>141</td>
<td>102</td>
</tr>
</tbody>
</table>

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**Graph 1:**
- **Runoff (inches):**
  - 2016 (soybean) 7.0 ± 0.5
  - 2017 (corn) 3.5 ± 0.3

**Graph 2:**
- **Flow rate (cfs):**
  - 104 (No Cover Crop)
  - 101 (Cover Crop)
Fertilizer management effects on P loss

~30% decrease

~45% decrease

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Questions?

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