Cover crops, N additions, and soil health

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UMN EXTENSION

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The Minnesota Office for Soil Health is a collaborative of the Minnesota Board of Water and Soil Resources and the University of Minnesota Water Resources Center

www.wrc.umn.edu/mosh
WHAT WE’LL DO HERE...

- Why cover crops?
- How cover crops?
- Do cover crops add N, or require more N?
SOIL HEALTH IS....

The continued capacity of the soil to function as a vital living ecosystem

What functions do we care about?
Is your soil healthy?

- YES
  - Does it allow water to soak in quickly?
    - NO
    - Does it drain?
      - YES
      - Does it crust?
        - NO
      - NO
      - Does your crop recover most of the nutrients you apply?
        - NO
        - Are there areas where plants die or grow poorly?
          - YES
          - Probably healthy
          - NO
          - Probably not healthy
  - YES
    - Probable healthy

Andrew McGuire, WSU
SOIL BIOLOGY BUILDS SOIL STRUCTURE, FUNCTION Follows STRUCTURE

Costa et al. 2018
INfiltration increases with cover crop

- Conventional
- Livestock grazing
- No-till
- Cover Crop
- Longer Crop rotation
- Perennial
BIOLOGY DRIVES FUNCTION VIA STRUCTURE

Icons from Alice Noir, iconosphere, Lea Lortal, Miroslava, ProSymbols, Colleen Wilson, Creative Mania, kiddo, Vectors Market, Guilhem, Gregory Montigny and Symbolon from the Noun Project
SOIL HEALTH PRINCIPLES

• Keep the soil covered
• Minimize disturbance
• Increase crop diversity
• Keep living roots in the ground
• Integrate livestock
COVER CROPS INTEGRATE PRINCIPLES

• Keep the soil covered
• Minimize disturbance
• Increase crop diversity
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Photo: Martin Larsen, Olmsted County
MANY CHOICES OF COVER CROPS

Species: Winter-hardy? N-fixer? Big roots?

Photos: Indiana Conservation Cropping Systems Initiative, UMN Extension
MANY CHOICES OF COVER CROPS

Seeding: interseeded or post-harvest?

Photos: Martin Larsen, Olmsted County
MANY CHOICES OF COVER CROPS

Planting: Green? Glyphosate? Roller crimp?

Photos: Martin Larsen, Olmsted County and Indiana Conservation Cropping Systems Initiative
A TOOL TO EVALUATE SOME OF THE CHOICES

Midwest Cover Crops Council

mccc.msu.edu
Selector Tools
Row Crop Tool

- Indiana
- Illinois
- Iowa
- Kansas
- Michigan
- Minnesota
- Missouri
- Nebraska
- North Dakota

- Ohio
- Ontario
- South Dakota
- Wisconsin
- Ontario
- NRCS
- ARS
HOW WILL COVER CROPS AFFECT N?
LEGUMES COVERS CAN SLOWLY RELEASE N

<table>
<thead>
<tr>
<th>Relative Rate of N Supply or Demand</th>
</tr>
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- **N supplied by fertilizer**
- **N supplied by legume mineralization**
- **N demand by crop**

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Crews and Peoples 2005
COVERS RELEASE N AT DIFFERENT RATES

O’Connell et al. 2015
Cover crops can use nitrate when corn and beans are not growing, thus reducing the asynchrony between soil nitrate production and crop nitrate uptake.

In the shaded areas, the soil produces nitrate, but there is no crop to use it. As a result, some nitrate is lost to waterways.
Arlington 2017

Corn yield (bu/ac)

Nitrogen rate (lb/ac)

+ 128 lb-N/ac

- 7 bu/ac

No cover

Winter rye

Ruark, UW-Madison
LESS N REQUIRED

MORE N REQUIRED

RUARK, UW-MADISON

LESS YIELD

MORE YIELD

CHANGE IN MAX YIELD (BU/AC)

CHANGE IN OPTIMUM N RATE

+/- 10 LB-N/AC

+/- 4 BU/AC

+/- 10 LB-N/AC

+/- 4 BU/AC
Change in optimum N (lb/ac) vs. Cover crop biomass (lb/ac)

- Winter Rye
- Annual Ryegrass
- Spring Barley

Ruark, UW-Madison
## HOW MUCH N DO COVERS TAKE UP?

<table>
<thead>
<tr>
<th>Cover crop biomass (lb/ac)</th>
<th>Estimated N uptake (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1,000</td>
<td>&lt;25</td>
</tr>
<tr>
<td>1,000–2,000</td>
<td>25–45</td>
</tr>
<tr>
<td>&gt;2,000</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>

*There was no clear effect when winterkilled cover crops were used based on Wisconsin research (inset).*
Nitrogen Immobilization

Cover Crop
C:N ratio about 40:1

Bacteria
C:N ratio about 5:1
Nitrogen Immobilization

Cover Crop
C:N ratio about 40:1

Consume enough carbon from the rye for respiration & body structure

Bacteria
C:N ratio about 5:1
Nitrogen Immobilization

Cover Crop
C:N ratio about 40:1

Consume enough carbon from the rye for respiration & body structure

Bacteria
C:N ratio about 5:1
Microbes prefer low C/N ratio residue
Immobilization is temporary

**Bacteria**
C:N ratio about 5:1

Consume two bacteria to get enough carbon for function and reproduction
Total C:N of 10:2

**Bacteria Feeding Nematode**
C:N ratio about 10:1

Only Needs 1 part N

Excrete 1 part N to soil solution-
Available N
Boost the proportion of N in your starter
Give it time

Snapp & Surapur 2018
WILL WE LOSE YIELD? CORN

Figure 1. Trends with respect to cover crop effect on corn yields at 10 site-years from 2009 to 2010 and 25 site-years from 2011 to 2017.

Data from Practical Farmers of Iowa
WILL WE LOSE YIELD? SOYBEAN

Figure 2. Trends with respect to cover crop effect on soybean yields at 6 site-years from 2009 to 2010 and 25 site-years from 2011 to 2019.

Soybean Yields 2009-2010  Soybean Yields 2011-2019

- **Yield improvement**
- **No change**
- **Yield reduction**

Data from Practical Farmers of Iowa
POST-CORN, GOING TO SOY: USE CEREAL RYE

• Why?
  • Rye is winter hardy and tolerant of residual herbicide

• How?
  • Interseed at R5-R6 if you can
  • Terminate with glyphosate
  • Strip-till or no-till soybean

Liz Stahl, Axel Garcia y Garcia
RYE FITS A COLD CLIMATE BEST

Germination temperature

Clover, 50 F
Brassica, 45 F
Rye, 34 F

Typical harvest

Minimum soil temperature, 0-5 cm (°C)

Day of Year
WHAT ABOUT THE COST?

• Seed: grasses will be cheaper than brassicas or legumes
• Planting method: use what’s readily available
• Weed control: a heavier stand might eliminate a post-emergence spray
• SWCD support: use it to experiment
PLANTING COVERS AND NO/LOW-TILL GO TOGETHER

• Allows for more cover crop growth
• Speeds up soil structure development
  \[1 + 1 > 2\]
• Saves money
PLANTING COVERS AND NO/LOW-TILL GO TOGETHER

**Crop Enterprise Analysis**  
*(Farms Sorted By Tillage System)*

**Soybeans on Cash Rent**

<table>
<thead>
<tr>
<th></th>
<th>Avg. Of All Farms</th>
<th>Moldboard</th>
<th>Chisel/Reduced</th>
<th>No Till</th>
<th>Ridge Till</th>
<th>Strip Till</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield per acre (bu.)</td>
<td>49.24</td>
<td>53.43</td>
<td>49.13</td>
<td>46.68</td>
<td>54.48</td>
<td>53.27</td>
</tr>
<tr>
<td>Gross return per acre</td>
<td>526.91</td>
<td>562.20</td>
<td>526.78</td>
<td>493.32</td>
<td>585.40</td>
<td>550.76</td>
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<tr>
<td>Total direct expenses per acre</td>
<td>382.16</td>
<td>411.15</td>
<td>384.30</td>
<td>349.79</td>
<td>367.88</td>
<td>374.60</td>
</tr>
<tr>
<td>Return over direct exp per acre</td>
<td>144.75</td>
<td>151.05</td>
<td>142.48</td>
<td>143.53</td>
<td>217.52</td>
<td>176.15</td>
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<tr>
<td>Net return per acre</td>
<td>83.55</td>
<td>85.86</td>
<td>81.12</td>
<td>89.28</td>
<td>160.59</td>
<td>104.96</td>
</tr>
<tr>
<td>Labor &amp; management charge</td>
<td>30.65</td>
<td>31.13</td>
<td>30.37</td>
<td>29.38</td>
<td>40.27</td>
<td>36.42</td>
</tr>
<tr>
<td>Net return over lbr &amp; mgt</td>
<td><strong>56.64</strong></td>
<td><strong>55.58</strong></td>
<td><strong>54.10</strong></td>
<td><strong>66.70</strong></td>
<td><strong>121.43</strong></td>
<td><strong>81.31</strong></td>
</tr>
</tbody>
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From FINBIN.umn.edu
SOIL HEALTH PRINCIPLES

• Keep the soil covered
• Minimize disturbance
• Increase crop diversity
• Keep living roots in the ground
• Integrate livestock
• … talk to people
Are you a cover cropper interested in Farm Business Management Program? Email me about scholarship $. 

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