2018 Cover Crop and Soil Health Research Webinar Series

Frost seeding red clover: Current research on nitrogen and rotational benefits, production economics

January 31, 2018
Why the winter wheat + cover crop combination?

Sizable wheat acreage in Wisconsin

50% of season-long GDD accumulation remains after harvest. Captured solar radiation can be converted to plant-available N, soil C

Straw harvest leaves soil erosion prone

Can address soil health and quality issues

Does the alternative make sense?
Standard Deviations (inches):
Total: 4.30   June: 2.28   July: 1.89   August: 2.37
Variable August precipitation affects cover crop performance.

Figure 1. Impact of August rainfall on clover biomass yield. Stute, 2009

August rainfall:
- 2007: 11.04”
- 2008: 1.07”

Above ground biomass (tons/a)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red clover interseeded</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Berseem clover seeded after wheat harvest</td>
<td>1.07</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Red clover – corn system: Process

• Winter wheat pushed for production
• Common medium red clover “frost-seeded” in mid-March
  – ATV mounted cyclone seeder
    • Seed double spread at ½ rate, centers split
    • 20-30 acres/hour
  – Co-applied with fertilizer using air-flow equipment
• Wheat straw spread
• Clover clipped in early-mid September with a stalk chopper
• Clover terminated in late October
  – Glyphosate and 2,4-D (24 and 32 oz./a + AMS)
  – Glyphosate burndown (24 oz./a + AMS)
• Corn no-till planted, starter, row cleaners
• N (28% UAN) PRE or side-dressed
• Confirmation: MRTN plots, Stalk nitrate test
Frost Seeding Red Clover in Winter Wheat
Jim Stute, University of Wisconsin (UW) Extension, Rock County
Kevin Shelley, UW Nutrient and Pest Management Program

Grow your own nitrogen
If you plant winter wheat, you have an opportunity to “grow” your own nitrogen (N) to help manage input costs and accrue soil quality benefits. The age-old practice of green manuring, especially in conjunction with wheat, can produce significant creditable N for corn the next year. It also protects the soil and may be eligible for cost share under local and Federal conservation programs.

Multi-year research in Wisconsin has demonstrated that red clover (Trifolium pratense) is the most productive and reliable legume choice for green manuring if interseeded into winter wheat in early spring (table 1). Interseeded red clover captures the entire growing season which helps maximize nitrogen credits. Seeding clover or other forage legumes after wheat harvest is more risky due to the potential for dry conditions and a shorter growing season. Delayed germination and slow growth frequently limit seeding year yield and N production when seeded after wheat harvest. Adequate rainfall in August is critical for producing acceptable yield for summer seedings (figure 1). Red clover offers the additional advantage of being a non-host for soybean cyst nematode, a problem with many of the other legume cover crop options.

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Inconsistent stands

Incomplete termination

Credit: Jamie West, UW Soil Science
Corn response to additional nitrogen following clover

Source: Stute and Shelley, unpublished

Trial locations: East Troy, Janesville, Cottage Grove 2009-2017, 7 site years, n=168
# How much Nitrogen?

**UWEX green manure nitrogen credits**

<table>
<thead>
<tr>
<th>Crop</th>
<th>&lt; 6&quot; growth</th>
<th>&gt; 6&quot; growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red clover</td>
<td>40</td>
<td>50 - 80</td>
</tr>
</tbody>
</table>

*Source: A2809 Nutrient application guidelines for field, vegetable and fruit crops in Wisconsin*

**WI Average (160 samples)**

- Two-thirds above ground: 55-75%
  - 96 lb/a
- One-third below ground: 25%-45%
  - 45 lb/a

Total 141 lb/a
Wisconsin Research

Nitrogen and Rotation Effects

Janesville, 2010
Janesville, 2010

Yield Difference: 27 bu/a, 15.3%

Regression

<table>
<thead>
<tr>
<th>Regression</th>
<th>N credit (lb-N/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>41</td>
</tr>
<tr>
<td>LP*</td>
<td>46</td>
</tr>
<tr>
<td>QP</td>
<td>82</td>
</tr>
</tbody>
</table>

No Cover

Red Clover
Arlington, 2016

Yield Difference: -16 bu/a, 6.9%

Regression

<table>
<thead>
<tr>
<th>Regression</th>
<th>N credit (lb-N/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>32</td>
</tr>
<tr>
<td>LP</td>
<td>57</td>
</tr>
<tr>
<td>QP*</td>
<td>92</td>
</tr>
</tbody>
</table>

Corn yield (bu/ac) vs Nitrogen rate (lb-N/ac)
Arlington, 2017

Yield Difference: 9 bu/a, 5.2%
East Troy, 2017

Yield Difference: 0 bu/a

Clover

Red clover • Fallow

Fallow

\[ y = -0.0021x^2 + 0.743x + 164.07 \]

\[ R^2 = 0.688 \]

\[ y = -0.0031x^2 + 1.0494x + 147.83 \]

\[ R^2 = 0.6077 \]

N Rate (lb/a)
Research Summary (to date)

N Credits
46 to 92 lb/a
Consistent with UWEX recommendations but.......impact of harvest?

Rotational Response
-6.9 to 15.3%, average 3.4%
Source of variability unclear, needs to be examined

2018 sites:
Arlington (rotation, credit x tillage and harvest interactions)
Cottage Grove and East Troy (rotation, credit)
Palmyra (response to added N)
Rotational Yield Response

Locations: WI, MI, OH, PA, ONT

33 site-years, 132 individual comparisons

Response Ratio
Corn Yield Following Clover Relative to Fallow

Response 12% +/- 10

- Mean: 1.12
- median: 1.10
- sd: 0.10
- cv(%): 9.06
- max: 1.40
- min: 0.96
- Range +/- 1 sd: 1.02-1.22
Economic Analysis

Partial Budgeting: Added costs and returns

Constant Costs: Establishment, management and termination, interest

Yield Dependent Costs: Drying, hauling, P and K removal

Returns: Additional yield, N credit

3-year average prices (2014-2016), 40 lb. N credit

Wisconsin: 10 year average corn yield: 147 bu/a

<table>
<thead>
<tr>
<th>Price ($/Bu)</th>
<th>Net ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.50</td>
<td>23.34</td>
</tr>
<tr>
<td>3.75</td>
<td>27.84</td>
</tr>
<tr>
<td>4.00</td>
<td>32.34</td>
</tr>
</tbody>
</table>
## Table 3. Net return ($/acre) based on yield response and corn price by base yield level.

<table>
<thead>
<tr>
<th>Yield (bu/a)</th>
<th>Price (bu/a)</th>
<th>Yield Response (%)</th>
<th>Yield Increase (bu/a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>(18.37) (15.73) (13.09) (10.45) (7.82) (5.18) (2.54)</td>
<td>2.50</td>
<td>10.10</td>
</tr>
<tr>
<td>3.10</td>
<td>(18.12) (15.35) (12.59) (9.83) (7.07) (4.30) (1.54)</td>
<td>3.00</td>
<td>11.74</td>
</tr>
<tr>
<td>3.20</td>
<td>(17.87) (14.98) (12.09) (9.20) (6.32) (3.43) (0.54)</td>
<td>3.50</td>
<td>13.37</td>
</tr>
<tr>
<td>3.30</td>
<td>(17.62) (14.60) (11.59) (8.58) (5.57) (2.55)</td>
<td>4.00</td>
<td>14.99</td>
</tr>
<tr>
<td>3.40</td>
<td>(17.37) (14.23) (11.09) (7.95) (4.82) (1.68)</td>
<td>4.50</td>
<td>16.62</td>
</tr>
<tr>
<td>3.50</td>
<td>(17.12) (13.85) (10.59) (7.33) (4.07) (0.80)</td>
<td>5.00</td>
<td>18.24</td>
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<tr>
<td>3.60</td>
<td>(16.87) (13.48) (9.78) (6.20)</td>
<td>5.50</td>
<td>19.86</td>
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<tr>
<td>3.70</td>
<td>(16.62) (13.10) (9.59) (6.08) (2.57)</td>
<td>6.00</td>
<td>21.48</td>
</tr>
<tr>
<td>3.80</td>
<td>(16.37) (12.73) (9.09) (5.45) (1.82)</td>
<td>6.50</td>
<td>23.10</td>
</tr>
<tr>
<td>3.90</td>
<td>(16.12) (12.35) (8.59) (4.83)</td>
<td>7.00</td>
<td>24.72</td>
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<tr>
<td>4.00</td>
<td>(15.87) (11.98) (8.09) (4.20) (0.32)</td>
<td>7.50</td>
<td>26.34</td>
</tr>
<tr>
<td>4.10</td>
<td>(15.62) (11.33) (7.28)</td>
<td>8.00</td>
<td>27.96</td>
</tr>
</tbody>
</table>

### Study Methods

- **Economic analysis of cover crops:** Impact of interseeding cover crops at reduced cost in small grain rotations
- **Yield response:** Based on price and yield average

### Breakeven response: Between 4 and 8%

- Depends on price and yield average
- Breakeven response: Between 4 and 8%

**Available at:**

www.michaelfields.org