Research on Benefits of Cover Crops

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Why Choose Small Grains as Cover Crops?

- Grow rapidly in cool weather
- Easy to plant and get established
- Keep growing after moderate frost
- Seed is “relatively” inexpensive
- Some winter-hardy and some not
- Easy to control – not a weed
- Good environmental and soil benefits
- So far, no other cover crop “fits” as well in Iowa in a corn-soybean rotation
Rye after Corn Silage
Oats after Soybean
Rye in Spring on Berger Farm
Corn and Soybeans have a 7 Month “BROWN” Gap

Winter Cover Crops “Catch” Losses

Cover Crops Fill the “BROWN” Gap with “GREEN” Plants

Corn or Soybean Crop at Maturity approx. Oct. 1

Corn or Soybean Crop at Emergence approx. May 1

Soil productivity is lost during the “BROWN” gap because there are no “GREEN” plants to protect soil and recycle nutrients.

Phosphorus
Soil OM
Nitrogen
Topsoil

Winter Cover Crops “Catch” Losses

Cover Crops Fill the “BROWN” Gap with “GREEN” Plants
Benefits of Using Small Grain Cover Crops

- Reduced erosion
- Reduced nitrate leaching
- Increased soil organic matter
- Reduced phosphorus losses
- Improved weed control – especially organic systems
- Provide spring forage for cattle
- Part of manure management plan
- Conservation Payments – EQIP & CSP
Erosion Measurements with Simulated Rainfall

NO COVER CROP  OAT COVER  RYE COVER
Which side has 30% cover?
RUSLE2 Erosion Estimates Using Beta Version of Cover Crop Vegetation Files

- Corn–Soybean rotation, NT, spring anhydrous, 5% slope, 150 ft slope length, Ames, IA
  - without rye cover crop = 2.1 t/ac/yr
  - with rye cover crop = 1.2 t/ac/yr

- Continuous Corn Silage, NT, spring anhydrous, 5% slope, 150 ft slope length, Ames, IA
  - without rye cover crop = 4.8 t/ac/yr
  - with rye cover crop = 1.9 t/ac/yr
Erosion Summary

• Winter cover crops reduce erosion by replenishing residue cover and root mass, increasing infiltration, and by anchoring other residue. In no-till anchoring other residue may be the most important.

• Winter cover crops are especially effective in reducing rill erosion.

• Unlike some conservation practices, erosion control is not the only benefit of winter cover crops.
Nitrate Loss in Tile Drainage
Flow Meters & Sample Collectors

Fig 1. Average NO$_3$ concentrations of drainage water for control, oat, and rye treatments in 2008. Gaps in the data resulted when no drainage occurred.
Annual N Loss in Tile Drainage for a Corn-Soybean Rotation with or without a Winter Cover Crop

- No Cover Crop
- Rye Cover Crop
- Oat Cover Crop

Fig. 2

Annual NO₃ mass loss (kg-N ha⁻¹)
## Total Nitrate-N Lost 2002-2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrate-N lost</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9-yr total</td>
<td>9-yr avg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lbs/acre</td>
<td>lbs/acre</td>
<td></td>
</tr>
<tr>
<td>Corn-soybean</td>
<td>386</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Corn-Soyb w. Rye</td>
<td>181</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Reduction</td>
<td>205</td>
<td>23</td>
<td></td>
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<tr>
<td>% Reduction</td>
<td>53%</td>
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Nitrogen Summary

• **Winter cover crops reduce N losses in tile drainage by taking up N and reducing soil N concentrations during the times of the year when corn and soybean are not present and a lot of drainage is occurring.**

• **Winter cover crops don’t seem to have a large impact on the total annual cumulative drainage because a mulching effect reduces water loss during the summer offsetting spring uptake.**

• **Unlike other practices used to reduce N contamination of water, winter cover crops provide other benefits.**
Rye Cover Crop Effect on Soil Quality in a Corn Silage System

- 17% more total soil organic matter
- 47% more Particulate Organic Matter (POM)
- 48% greater Potential N mineralization
- It is easier to see changes in these measurements in a corn silage system after 8 years, but they indicate that even in a corn grain system the trends are in the right direction
Cover Crops and No-Till Soil Structure
Rye Cover Crop Root Weight and Rooting Depth in the Spring

<table>
<thead>
<tr>
<th>Year</th>
<th>Root Dry Weight (lbs/acre)</th>
<th>Rooting Depth (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>294.41</td>
<td>38.00</td>
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<tr>
<td>2005</td>
<td>642.34</td>
<td>32.71</td>
</tr>
<tr>
<td>2006</td>
<td>606.66</td>
<td>45.75</td>
</tr>
<tr>
<td>2007</td>
<td>458.34</td>
<td>36.44</td>
</tr>
<tr>
<td>2008</td>
<td>388.08</td>
<td>….</td>
</tr>
<tr>
<td>Avg.</td>
<td>477.96</td>
<td>38.22</td>
</tr>
</tbody>
</table>
Some Risk to Main Crop Yields

- Soybean yields no change.
- Corn silage yields no change.
- Corn grain yields on average 4 to 6 bu/ac lower following rye cover crop in our experiments. No change with oats. If rye killed 14 d before corn planting and at less than 8” tall risk greatly reduced.
Observations

• Does not happen every year or in every field
• Other factors later in the year may limit yield or allow corn following rye to compensate for reduced early growth or reduced population
• It seems to occur more often with cold and dry conditions at corn planting
• Yield reductions more often in the early years of our studies – What has changed?
• Very similar to no-till continuous corn
What are Possible Causes of Corn Yield Drag Following Rye Cover Crops

- Water use or dry soil at planting (rare)
- Nitrogen immobilization
- Cold soil from increased surface residue
- Planter problems from surface residue
- Disease or pest problems – “green bridge”
- Rotation effect or allelopathy
- Most of these possible causes/problems should increase with increasing rye biomass
Corn Population Following a Rye Cover Crop vs. Yield Difference

$y = -2 \times 10^{-7} x^2 + 0.0119x - 214.12$

$R^2 = 0.4234$
Corn Yield Ratio (with rye/wo rye) vs. Average 4 in soil temperature (°F)

Regression equation:

\[ y = -0.001154x^2 + 0.138901x - 3.184520 \]

\[ R^2 = 0.506460 \]
\[ y = -1E^{-11}x^3 + 2E^{-08}x^2 - 2E^{-05}x + 0.999 \]

\[ R^2 = 0.4482 \]
What does 800 lbs/acre of rye shoot dry weight look like?
What does 800 lbs/acre of rye shoot dry weight look like?
Practices to Reduce the Risk of Corn Yield Drag Following Rye Cover Crops

- Kill rye cover crops 14 days before corn planting or use spring oat which winter kills
- Kill rye cover crops as soon as they reach 1000 lbs/acre in the spring; about 6 to 8 in tall
- Increase corn population/stand - ???
- Apply some N and P fertilizer at planting
Killing a Rye Cover Crop with Glyphosate

• Apply acid equivalent (a.e.) of 1 lb/acre (28 oz WeatherMax or 43 oz of generic)

• Use low spray volume – check label (e.g. WeatherMax is labeled for 3-20 gal/acre; 7-10 gal/acre would be reasonable)

• Add AMS (ammonium sulfate)

• Add Non-ionic Surfactant if not included in formulation (NIS is in WeatherMax already)

• Try to spray on days when temperatures are above 50 F in the day and above 40F at night. Sunny days are best.

• Try to spray between 10 AM and 4 PM or start spraying when dew is dry and end by 4 PM.

• Use or have available an ATV sprayer if possible so that timing is not as limited by wet field conditions
WELCOME TO THE MIDWEST COVER CROPS COUNCIL WEBSITE

The goal of the Midwest Cover Crops Council (MCCC) is to facilitate widespread adoption of cover crops throughout the Midwest, to improve ecological, economic, and social sustainability.

WHO WE ARE?

The MCCC is a diverse group from academia, production agriculture, non-governmental organizations, commodity interests, private sector, and representatives from federal and state agencies collaborating to address soil, water, air, and agricultural quality concerns in the Great Lakes and Mississippi river basins (including Indiana, Michigan, Ohio, Manitoba, Ontario, Illinois, Wisconsin, Minnesota, Iowa, and North Dakota).

WHY COVER CROPS?

Cover crops are an effective tool to reduce soil erosion and increase nutrient recycling on farmlands, thereby also decreasing the soil and nutrient loads entering lakes and waterways. Cover crops can have numerous other benefits including improvement of soil quality, pest management, fertility management, water availability, landscape diversification, and wildlife habitat.
Questions?
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