Environmental Benefits and Management of Small Grain Cover Crops in Corn-Soybean Rotations

Thomas C. Kaspar  
*United States Department of Agriculture, tom.kaspar@ars.usda.gov*

Jeremy Singer  
*United States Department of Agriculture, jeremy.singer@ars.usda.gov*

ben Knutson  
*United States Department of Agriculture*

Keith A. Kohler  
*United States Department of Agriculture, keith.kohler@ars.usda.gov*

Dan B. Jaynes  
*United States Department of Agriculture, dan.jaynes@ars.usda.gov*

See next page for additional authors

Follow this and additional works at: [http://lib.dr.iastate.edu/leopold_pubspapers](http://lib.dr.iastate.edu/leopold_pubspapers)

Part of the [Agriculture Commons](http://lib.dr.iastate.edu/leopold_pubspapers) and the [Agronomy and Crop Sciences Commons](http://lib.dr.iastate.edu/leopold_pubspapers)

**Recommended Citation**

[http://lib.dr.iastate.edu/leopold_pubspapers/162](http://lib.dr.iastate.edu/leopold_pubspapers/162)

This Presentation is brought to you for free and open access by the Leopold Center for Sustainable Agriculture at Iowa State University Digital Repository. It has been accepted for inclusion in Leopold Center Pubs and Papers by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
Environmental Benefits and Management of Small Grain Cover Crops in Corn-Soybean Rotations

Abstract
These slides offer research results on cover crops.

Keywords
Agronomy, Corn-soybean cropping systems, Cover crops double crops strip cropping

Disciplines
Agriculture | Agronomy and Crop Sciences

Authors
Thomas C. Kaspar, Jeremy Singer, ben Knutson, Keith A. Kohler, Dan B. Jaynes, and Thomas B. Moorman

This presentation is available at Iowa State University Digital Repository: http://lib.dr.iastate.edu/leopold_pubspapers/162
Environmental Benefits and Management of Small Grain Cover Crops in Corn-Soybean Rotations

Tom Kaspar
Jeremy Singer
Ben Knutson
Keith Kohler
Dan Jaynes
Tim Parkin
Tom Moorman
Outline

• What are cover crops?
• Review environmental benefits of cover crops: reducing erosion and nitrate leaching
• Cover crop establishment and growth
• Cover crop effects on corn and soybean yields
• Cover crop cultivars
• Cover crop survey results
• Future research
What are Cover Crops?

- Crops that cover the soil
- Winter cover crops grow between harvest and planting of annual cash crops, in Iowa usually corn and soybean
- In the Upper Midwest the cover crop growing season is short and cold. So cool season and/or winter hardy plants (e.g. small grains) work best.
Cover Crop Work in Iowa

• In the 1980s - Rick Exner and Rick Cruse, ISU and Dick Thompson, Practical Farmers of Iowa
• Late 1980s - ARS-NSTL began looking at cover crops with encouragement from NRCS with regard to highly erodible land and soybeans
• 1990 - Leopold Center grant to look at small grain cover crops - Tom Kaspar, Steve Corak, Keith Kohler, and Tim Johnson
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 inexpensive
• Some are winter-hardy and some are not
• Easy to control and does not pose a threat as a weed in main cash crop
Oats after Soybean
Rye after Corn Silage
After Simulated Rainfall

NO COVER CROP  OAT COVER  RYE COVER
Steady State Infiltration Rate

Interrill Infiltration Rate as Affected by Cover Crops

Interrill Sediment Rate as Affected by Cover Crops

**Interrill Erosion**

Rill Erosion

Rill Erosion Rate as Affected by Cover Crops

Nitrate Loss in Tile Drainage Measurements
Cumulative annual drainage for 2002-2005

Control
Rye Cover Crop

2002: 227 mm (Control), 209 mm (Rye Cover Crop)
2003: 346 mm (Control), 301 mm (Rye Cover Crop)
2004: 248 mm (Control), 253 mm (Rye Cover Crop)
2005: 175 mm (Control), 139 mm (Rye Cover Crop)
Average: 249 mm (Control), 226 mm (Rye Cover Crop)
Average annual flow-weighted nitrate-N concentration of drainage water for 2002-2005

Kaspar et al., In Revision
Cumulative annual nitrate-N load of drainage water for 2002-2005

- **2002**: Control 40.4 kg/ha, Rye Cover Crop 11.2 kg/ha
- **2003**: Control 81.1 kg/ha, Rye Cover Crop 33.9 kg/ha
- **2004**: Control 47.2 kg/ha, Rye Cover Crop 23.0 kg/ha
- **2005**: Control 34.4 kg/ha, Rye Cover Crop 11.1 kg/ha
- **Avg.**: Control 50.8 kg/ha, Rye Cover Crop 19.8 kg/ha
## Total Nitrate-Nitrogen Lost 2002-2005

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrate-N lost, 4-yr total kg ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn-Soyb w. Rye</td>
<td>79</td>
</tr>
<tr>
<td>Corn-soybean</td>
<td>201</td>
</tr>
</tbody>
</table>

Kaspar et al. (in revision) J. Environ. Qual.
Estimated change in N balance over 4 years (2002-2005) for a corn-soybean rotation with a rye winter cover crop and a corn-soybean rotation without a rye cover crop (based on estimates of Jaynes and Karlen, 2005).

<table>
<thead>
<tr>
<th></th>
<th>Applied N</th>
<th>Wet/Dry Deposition</th>
<th>N Fixation</th>
<th>Grain N removed</th>
<th>Drainage N Loss</th>
<th>Change in Soil NO3</th>
<th>Change in N Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn-Soyb</td>
<td>481</td>
<td>40</td>
<td>485</td>
<td>-785</td>
<td>-201</td>
<td>-38</td>
<td>-18</td>
</tr>
<tr>
<td>Corn-Soyb with rye</td>
<td>481</td>
<td>40</td>
<td>461</td>
<td>-752</td>
<td>-79</td>
<td>-69</td>
<td>+82</td>
</tr>
</tbody>
</table>
Benefits of Using Small Grain Cover Crops

- Reduced erosion
- Reduced nitrate leaching
- Increased soil organic matter
- Improved early season weed control
- Provide spring forage for ruminants
Establishing Small Grain Cover Crops with Overseeding

- Overseeding before leaf drop - winter hardy and non-winter hardy small grains
- Soybean – mid to late Aug. aerial seeding or using tractor with rotary or drop spreader
- Corn – late Aug to early Sept. aerial seeding - limited success in Iowa
- Watch soil moisture, rainfall, & temps
- Incorporation or loose soil helps
Cover Crop Overseeded into Soybean 1995-2002

<table>
<thead>
<tr>
<th></th>
<th>Avg</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oat</td>
<td>0.60</td>
<td>1.16</td>
<td>0.10</td>
</tr>
<tr>
<td>Rye</td>
<td>2.08</td>
<td>4.03</td>
<td>1.38</td>
</tr>
</tbody>
</table>

1.0 Mg/ha = 0.446 Tons/acre
Establishing Small Grain Cover Crops with a Grain Drill or Shallow Tillage

- Following seed corn, silage corn, early maturing soybean, and early maturing grain corn – only winter hardy small grains – rye, winter wheat, triticale
- Mid Sept. to late Oct. (will survive later)
- Lower seeding rate than overseeding
- More reliable stand establishment
- Destroys some surface cover
Rye Cover Crops Drilled after Main Crop Harvest

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>2.31</td>
<td>3.28</td>
<td>3.16</td>
</tr>
<tr>
<td>Silage</td>
<td>-----</td>
<td>0.45</td>
<td>1.90</td>
</tr>
<tr>
<td>Corn</td>
<td>0.86</td>
<td>2.04</td>
<td>2.59</td>
</tr>
<tr>
<td>Grain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.0 Mg/ha = 0.446 Tons/acre
Cover Crop Planting Date

Rye Cover Crop Shoot Biomass vs Planting Date

Shoot Biomass (Mg/ha)

DOY

Sept 1 = 244
Sept 15 = 258
Oct 1 = 274
Oct 15 = 288
Nov 1 = 305
Nov 15 = 319
Rye Cover Crop Shoot Biomass vs Kill Date
Planted Sept. 30, 2005

Shoot Biomass (Mg/ha)

DOY

Mar 1 = 60
Mar 15 = 74
Mar 30 = 89
Apr 15 = 105
Apr 20 = 110
Differences Between Years

Apr 16 2004  2.1 Mg/ha

Apr 15 2005  3.0 Mg/ha
Soybean Yield Following a Rye Cover Crop


Kaspar et al., unpublished
Average Corn Yield Following Cover Crops 1995-2001

<table>
<thead>
<tr>
<th>Cover Crops</th>
<th>Corn Yield (bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Cover Crops</td>
<td>161.0</td>
</tr>
<tr>
<td>Oat</td>
<td>162.4</td>
</tr>
<tr>
<td>Oat/Rye</td>
<td>144.7</td>
</tr>
<tr>
<td>Rye</td>
<td>140.3</td>
</tr>
</tbody>
</table>
Management for Corn Following a Rye Cover

- Kill rye cover crop 10 to 14 days before planting corn
- Plant cover crops in a skip-row pattern, i.e. only in the interrows
- Use a starter fertilizer with N
- Plant corn at higher population than normal
Kelly Tile Plots Rye Cover Crop Treatment
### Corn Yield Following Rye Cover Crops Recent Years

<table>
<thead>
<tr>
<th>Year</th>
<th>Rye CC (bu/ac)</th>
<th>Check (bu/ac)</th>
<th>Avg (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyd 2006</td>
<td>189.85</td>
<td>177.00</td>
<td>185.55</td>
</tr>
<tr>
<td>Boyd 2005</td>
<td>185.00</td>
<td>177.00</td>
<td>181.00</td>
</tr>
<tr>
<td>Boyd 2004</td>
<td>193.00</td>
<td>177.00</td>
<td>185.00</td>
</tr>
<tr>
<td>Boyd 2003</td>
<td>195.00</td>
<td>177.00</td>
<td>187.00</td>
</tr>
<tr>
<td>Kelly 2006</td>
<td>209.00</td>
<td>177.00</td>
<td>192.00</td>
</tr>
<tr>
<td>Kelly 2005</td>
<td>214.00</td>
<td>177.00</td>
<td>192.00</td>
</tr>
<tr>
<td>Kelly 2004</td>
<td>210.00</td>
<td>177.00</td>
<td>192.00</td>
</tr>
<tr>
<td>Kelly 2002</td>
<td>196.00</td>
<td>177.00</td>
<td>188.00</td>
</tr>
<tr>
<td>AERC 2006</td>
<td>185.00</td>
<td>177.00</td>
<td>181.00</td>
</tr>
<tr>
<td>AERC 2005</td>
<td>173.00</td>
<td>177.00</td>
<td>175.00</td>
</tr>
<tr>
<td>AERC 2004</td>
<td>194.00</td>
<td>177.00</td>
<td>184.00</td>
</tr>
<tr>
<td>AERC 2003</td>
<td>189.00</td>
<td>177.00</td>
<td>182.00</td>
</tr>
<tr>
<td>AERC 2002</td>
<td>176.00</td>
<td>177.00</td>
<td>176.00</td>
</tr>
<tr>
<td>Avg</td>
<td>192.00</td>
<td>177.00</td>
<td>184.50</td>
</tr>
</tbody>
</table>

**Kaspar et al., unpublished**
Cover Crop Varieties Average Shoot Dry Weight

Three Year Avg. Shoot Dry Weight of 20 Small Grain Cultivars

LSD = 0.41
Cover Crop Species-Varieties

Species-Variety Effect on Corn Yield in 2005

Kaspar, unpublished
Cover Crop Varieties Corn Population vs Yield

Avg CC Variety Corn Yield vs Population

y = 0.0027x + 109.08

R² = 0.5413

Corn Population

Corn Yield (bu/ac)

Check

Aroostook
Cover Crop Survey Results

- 3500 producers in IL, IN, IA, and MN.
- 36% response rate.
- 18% said they had used cover crops.
- 6% in IA used cover crops within 5 years.
- Greater use in IL and IN.
- 80% using conservation practices.
- 43% using conservation practices with cost sharing, 57% w/out.
Survey Results Con’t

• 56% said they would use cover crops with cost-sharing.
• On average, respondents replied that a minimum cost-share payment of $23/acre would be needed to “encourage” them to plant cover crops.
Future plans

• Small grain cultivar evaluations
• N balance of corn-soybean rotations with rye cover crops
• Continue to examine corn yield depression
• Cover crops in systems with corn stover removal
• Integrating manure injection with small grain cover crops.
Monthly distribution of precipitation, drainage, and approximate evapotranspiration for fifteen years at the project site (Helmers et al. 2005, ASAE)