IMPROVING PERFORMANCE OF RYE COVER CROP SYSTEMS

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Crop Yield and Nitrogen Loss effect of Rye can vary widely

To Improve performance, determine scenarios with lowest N loss and practical crop management
Rye Cover Crops Studied for Decades.

- Decrease:
  - Nitrate Loss
  - Compaction
  - Soil Erosion
  - Yields/Profit?

- Increase:
  - Management Costs
  - Nutrient Cycling
  - Forage Opportunities
  - Yield/Profit?
Presentation Overview:

- Crop modeling to predict:
  - Risk of N loss
  - Agronomic performance
  - Compare alternative weather scenarios

- Considerations for establishing Corn and Soybeans into Rye Cover
APSIM Model
(Agricultural Production Systems Simulator)
Our Expectations for Using Model:

1. Evaluate effect of management on Nitrate leaching.
2. Better represent soil and crop dynamics over time.
3. Focus on the cropping system instead of individual measurements.
4. Better evaluate the impact of weather.
5. Extrapolate existing data over time.
Six Locations

Same general system:
Rye Cover Crop (Drilled)
Corn-Soybean Rotation
Tile water sampling

Site Specific Differences:
Fertilizer Management
Termination/seeding
Soils & Drainage system
Measurements Collected from Each Site

- Deep Soil Sampling
  - Texture & OM to 36” depth
- Soil Samples (NO3-N and NH4)
  - ~ every 3 weeks
- Soil Temperature and Moisture
  - 6”, 12”, 18” depth
- Plant Biomass
  - Nitrogen and Carbon
- Tile Nitrate and Tile Flow
  - ~ Every 2 weeks
Predicted and Observed Soil Temperatures

Soil Temperature, 0-6 inches

Predicted

Observed

Soil Temp, C
Observed Nitrate-N Loss - Site 2

2015 - Average Rainfall
10 ppm Nitrate-N
6.5 lb N loss/ac
Rye-Soy, Flow all season

2016 - Dry after June
3 ppm Nitrate-N
0.11 lb N loss/ac
Rye-Corn, No/low flow after May

2017 - Dry after July
4 ppm Nitrate-N
0.98 lb N loss/ac
Rye-Soy, No/low flow after 7/10

Single flow sampling values makes estimating per acre N loss difficult
A few single events drive losses. Which makes measuring losses accurately difficult.

Modeling to compare with other management scenarios.
Site 2: Field Management

• Corn Planted on May 10
• Soybean Planted May 15
• Rye Cover Crop
• N Management
  • 151 lb N Spring UAN for corn
• Tile nitrate and flow bi-weekly
Site 2.
4/15/2017

• No cover plots in the field

• Entire field drilled rye

• Model evaluation of termination and rainfall scenarios
Site 2: Soil Nitrate by Rye Termination Dates

<table>
<thead>
<tr>
<th>Soil Nitrate-N, lb/acre</th>
<th>July 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SoybeanCornSoybeanCorn</td>
<td></td>
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<tr>
<td>Potential Nitrogen Immobilization Difference in soil N near planting time</td>
<td></td>
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<tr>
<td>Rye Planting and Termination Scenarios</td>
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<tr>
<td>CS Rye: Oct 15-Apr 10</td>
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<tr>
<td>CS Rye: Oct 15-Apr 19</td>
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<tr>
<td>CS Rye: Oct 15-May 1</td>
<td></td>
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<tr>
<td>CS Rye: Oct 1-May 1</td>
<td></td>
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<tr>
<td>CS No Rye</td>
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</tbody>
</table>
Site 2: Annual Nitrogen Loads by Rye Termination Dates

<table>
<thead>
<tr>
<th>Nitrate-N Load, Lb/acre</th>
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<tbody>
<tr>
<td>20</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>0</td>
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</tbody>
</table>

**Rye Planting and Termination Scenarios**
- CS Rye: Oct 15-Apr 10
- CS Rye: Oct 15-Apr 19
- CS Rye: Oct 15-May 1
- CS Rye: Oct 1-May 1
- CS No Rye
Site 2: Rye Biomass by Rye Termination Dates

Rye Planting and Termination Scenarios

- CS Rye: Oct 15-Apr 10
- CS Rye: Oct 15-Apr 19
- CS Rye: Oct 15-May 1
- CS Rye: Oct 1-May 1
- CS Rye: Oct 1-May 1
- CS No Rye
Site 2: Termination Scenario Summary

• Rye termination timing did not affect yield
  • Corn planted late (May 9)

• ~35 lb soil NO3/ac difference between rye and no-rye at planting.

• Later rye termination reduced nitrogen loss but difference was not large

• Earlier planting and later termination, large difference in rye biomass
  • 7,500 lb/ac vs. 2,750 lb/ac
April-July Rainfall Simulation Scenarios

- Observed rainfall
  - Rye or No Rye

- 25% more rainfall April-July
  - Rye

- 25% less rainfall April-July
  - Rye or No Rye
Increase or Decrease by 25% April-July Rainfall
April-July Rainfall Change
Nitrate Load – Site 2

April-July Rainfall Scenarios
- CS Rye: Observed Rainfall
- CS Rye: <25% than Observed
- CS Rye: >25% than Observed
- CS No Rye: <25% than Observed
- CS No Rye: Observed Rainfall
Rainfall Simulation Summary: Site 2

- Rye reduced N losses ~50% whether rainfall increased or decreased in season:
  - Over 4 years total N loss ~25 to ~10 lb N/ac

- Low nitrate loss potential, low loss reduction potential
2015- Average Rainfall
~16 ppm Nitrate-N
~12.4 lb N loss/ac
Rye-Soy, Flow all season

2016- Average Rainfall
~16 ppm Nitrate-N
~12.2 lb N loss/ac
Rye-Corn, No/low flow after May

2017- Dry after July
~14 ppm Nitrate-N
~12.3 lb N loss/ac
Rye-Soy, No/low flow after 7/10

Again, Single flow sampling values makes estimating per acre N loss difficult
Site 1. Spring 2017
Site 1: Field Management

• Corn Planted on April 24
• Soybean planted May 10
• Rye Cover Crop
• N Management
  • Fall Liquid Swine Manure Nov. 15
  • Sidedress N
• Tile nitrate and flow bi-weekly
Site 1: Yields by Rye Termination Scenarios

Rye Planting and Termination Scenarios
- CS Rye: Oct 1-Apr 12
- CS Rye: Oct 1-Apr 19
- CS Rye: Oct 1-Apr 27
- CS No Rye

<table>
<thead>
<tr>
<th>Year</th>
<th>Corn</th>
<th>Soybean</th>
<th>Corn</th>
<th>Soybean</th>
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<tbody>
<tr>
<td>2014</td>
<td>280</td>
<td>140</td>
<td>280</td>
<td>140</td>
</tr>
<tr>
<td>2015</td>
<td>280</td>
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<td>280</td>
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<tr>
<td>2016</td>
<td>280</td>
<td>140</td>
<td>280</td>
<td>140</td>
</tr>
<tr>
<td>2017</td>
<td>280</td>
<td>140</td>
<td>280</td>
<td>140</td>
</tr>
</tbody>
</table>
Site 1: Annual Nitrogen Loads by Rye Termination Date

Nitrate-N Load, Lb/acre

Rye Planting and Termination Scenarios
- CS Rye: Oct 1-Apr 12
- CS Rye: Oct 1-Apr 19
- CS Rye: Oct 1-Apr 27
- CS No Rye
Site 1: Rye Biomass by Rye Termination Date

Rye Biomass, Lb/acre

Rye Planting and Termination Scenarios
- CS Rye: Oct 1-Apr 12
- CS Rye: Oct 1-Apr 19
- CS Rye: Oct 1-Apr 27
- CS No Rye
Site 1: Rye Termination Timing Scenarios

• Corn yield slightly decreased by late cover crop termination

• Large soil nitrate differences between rye and no-rye plots for corn.

• More rye biomass in 2016, better growing conditions

• Model under predicted N Losses

• Later rye termination slightly reduced nitrogen loss.
1. Farmer Practice CRS: Nov 15 Manure Appl.

2. Farmer Practice CRS: Hypothetical Oct 15 Manure

3. Farmer Practice CRS: Hypothetical Sep 15 Manure

4. No Cover Crop- Nov 15 Manure Appl.

*Cover Crop Planted Oct.1 in all Scenarios
Site 1: Annual Nitrogen Loads by Manure Appl. Timing

Nitrate-N Load, Lb/acre

Manure
- CRS Nov15
- CRS Oct15
- CRS Sep15
- CRS No Rye Nov15

Year: 2014, 2015, 2016, 2017, 2018
- Corn
- Soybean
Site 1: Manure Date Scenario

• Corn yield is slightly decreased from Sept 15 application in 2015

• Larger soil nitrate in the fall from early manure applications.

• Losses were reduced by cover crop for all dates.
Site 1: April-July Daily Rainfall Change by 25%
Site 1: Yield by April-July Rainfall Change

April-July Rainfall Scenarios
- CS Rye: Apr-Jul Rain-Observed
- CS Rye Apr-Jul Rain <25%
- CS Rye Apr-Jul Rain >25%
- CS Apr-Jul Rain Observed
Site 1: Soil Nitrate by Rainfall Variability

Soil Nitrate-N, lb/acre

Cover Crop effect
Site 1: April-July Rainfall Change

• Slightly lower corn yield with more rainfall

• Annual loads slightly higher with higher rainfall

• Even with higher rainfall rye effect is noticeable

• Slightly less rye biomass with more rainfall
Site 3: Wright County

Bioreactor and Rye Cover Crop
Site 3: Field Management

- Corn Planted April 28
- Soybean Planted May 14
- Rye Cover Crop
- N Management
  - Preplant 45 lb N
  - Sidedress 90 lb N
- Tile nitrate bi-weekly and flow continuous
Site 3: Soil Nitrate by Rye Termination Timing

Soil Nitrate-N, lb/acre

Rye Planting and Termination Scenarios
- CS Rye: Oct 10-Apr 12
- CS Rye: Oct 10-Apr 19
- CS Rye: Oct 10-Apr 27
- CS No Rye
Site 3: Annual Nitrogen Loads by Rye Termination Timing

Nitrate-N Load, Lb/acre

Rye Planting and Termination Scenarios
- CS Rye: Oct 10-Apr 12
- CS Rye: Oct 10-Apr 19
- CS Rye: Oct 10-Apr 27
- CS No Rye

Dates:
- Soybean: 2015, 2016, 2017, 2018
Site 3: Rye Biomass by Termination Timing

Rye Planting and Termination Scenarios:
- CS Rye: Oct 10-Apr 12
- CS Rye: Oct 10-Apr 19
- CS Rye: Oct 10-Apr 27
- CS No Rye
Site 3: Rye Termination Scenario

- Amount of rye biomass was the lowest among sites
- Annual Nitrogen loads were not affected by rye or rye termination timing.
- Model showed no effect cover crop on yield
Measured Yields - Small Plot (2 reps)

Corn Yield by Treatment

Soybean Yield by Treatment
Take Home Messages

• Crop systems modeling combined with farmers’ field data allows study of effect of different management scenarios

• Modeling scenarios and observed data confirmed that cover crops can reduce nitrogen loads and soil nitrate in the soil.
  • Can but don’t always
Take Home Messages 2

• Nitrogen availability for corn after rye can be an issue, especially in years with large amount of rye biomass.

• Planting cover crop can potentially reduce the risk of nitrogen loss from fall manure applications.

• Modeling can generate field-specific estimates of N loss without intensive water sampling.
Considerations for Corn Planting into Rye

• Corn needs nitrogen early and near the crop row.

  • In the soil. Strategies: plant on NH₃ band, Planter N, AMS broadcast

  • UAN with burndown can work but dry conditions or wet residue are possible. Nitrogen not in the soil
Considerations for Corn Planting into Rye Continued

• Planter settings critical for consistent depth and emergence
  • Row Cleaners
  • Downforce adjustment based on conditions
  • Sharp openers
  • Close seed trench!

• Incorrect planter settings are less forgiving planting into Rye
• When in doubt, terminate rye as early as weather permits
Strategies to Manage Rye Risk to Corn

• Strip Tillage
  • w/Banded fertilizer

• Creates improved seedbed and reduces planter setting challenges
Planting Considerations - Soybean

• Soil dries out differently with actively growing rye

• Planter can ride up on thick rye biomass
  • may require depth and/or down pressure adjustment

• Soybeans are more forgiving than corn when planting into Rye
  • yield less sensitive to final stand
ISA Bulletin: Improving Establishment
Precision Rye Seeding Research Trials

• Less seed. Similar growth?
• Reduce interference to planter
• Change N dynamic in row?
• Termination flexibility?
• Skip row drill, twin rows, 15”, 20”, 30” spacing all possible
Acknowledgements

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• Suzanne Fey- ISA Analytics

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