Cover Crops and Crop Nutrients

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With input from Peter Tomlinson

Why Cover crops?
• Cover crops have been used to enhance the sustainability of cropping systems (Lu et al. 2000)
  – Improving soil quality and health
  – Reducing environmental pollution
    • Soil erosion
    • Nutrient leaching
    • Nutrient runoff, etc.
  – Enhancing nutrient cycling
    • Reducing N losses

Cover crops and nutrients
• Grow it: Legumes fix atmospheric N
• Bring it: On sandy soils especially, any cover crop can be used to scavenge N and keep it from leaching from the soil profile
• Keep it: Cover crops slow runoff, so this deters sediment-bound nutrients from leaving the field as easily
• Speed it: Will a healthier soil (more microbes, more diversity) lead to more rapid nutrient cycling?
Wheat                       Sorghum                     Soybean
– Chemical Fallow (CF)
– Double Crop Soybean (DSB)
– Summer non-legume (SL) – sorghum-sudan
– Summer legume (SNL) – forage soybean
– Winter non-legume (WL) – radish
– Winter legume (WNL) – crimson clover

<table>
<thead>
<tr>
<th>Cover crop</th>
<th>Dry matter (ton ac⁻¹)</th>
<th>N content (lb ac⁻¹)</th>
<th>C:N ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer legume</td>
<td>0.6 b</td>
<td>42.1 b</td>
<td>14:1b</td>
</tr>
<tr>
<td>Summer non-legume</td>
<td>2.6 a</td>
<td>60.3 a</td>
<td>39:1a</td>
</tr>
<tr>
<td>Winter legume</td>
<td>1.5 b</td>
<td>88.5 a</td>
<td>16:1b</td>
</tr>
<tr>
<td>Winter non-legume</td>
<td>2.7 a</td>
<td>67.3 b</td>
<td>39:1a</td>
</tr>
<tr>
<td>Summer legume</td>
<td>1.3 bc</td>
<td>70.9 b</td>
<td>18:1b</td>
</tr>
<tr>
<td>Summer non-legume</td>
<td>1.1 c</td>
<td>37.7 c</td>
<td>24:1c</td>
</tr>
<tr>
<td>Winter legume</td>
<td>3.4 b</td>
<td>256 a</td>
<td>14:1b</td>
</tr>
<tr>
<td>Winter non-legume</td>
<td>6.0 a</td>
<td>147 b</td>
<td>45:1a</td>
</tr>
<tr>
<td>Winter legume</td>
<td>1.3 c</td>
<td>73.5 c</td>
<td>17:1b</td>
</tr>
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<td>0.7 c</td>
<td>28.7 c</td>
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Objective
Determine how legacy effects of legume and non-legume summer and winter cover crops between wheat and sorghum impact:
• N availability in the cropping system
• Yield response of sorghum to N fertilization
Sorghum Planting and Fertility

N fertilizer management
- 0, 40, 80, 120, & 160 lbs N ac⁻¹
- 28% UAN subsurface banded
- Straight flat-coulter liquid fertilizer applicator
- Following sorghum planting

Soil total C (g kg⁻¹)

Nitrogen Response
Sorghum Response to Cover Crops
(8-year average, 2009 to 2016)

Yield (bu/ac)
0 20 40 60 80 100 120 140 160 180
Nitrogen fertilizer (lb/a)

- Chemical Fallow
- Double-crop Soybean
- Summer Legume
- Summer Non-legume
- Winter Legume
- Winter Non-legume

L.S.D. (0.05)

Both DSB and SL

2012 Sorghum Response to Cover Crops

Grain yield (lb ac⁻¹)
0 10 20 30 40 50 60 70

Cover crop treatment

Chemical fallow 88 b - -
Double-crop soybean 91 b 8 b 2.64
Summer legume 100 a 30 a 9.90
Summer non-legume 64 c -45 c -14.85
Winter legume 87 b -1 b -0.33
Winter non-legume 87 b -3 b -0.99

Means with different letters within columns are significantly different (LSD=0.05)

Regression equation of grain yield for chemical fallow as a function of N fertilizer rate
Solved the equation substituting the mean grain yield at 0-N for each cover crop treatment

N Fertilizer Replacement Value

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<tr>
<th>Cover crop treatment</th>
<th>Mean grain yield at 0 N rate (bu/ac)</th>
<th>Fertilizer N equivalent credit (lb N/ac)</th>
<th>Fertilizer N value @ $0.33/lb N ($/ac)</th>
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<tr>
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<td>88 b</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>8 b</td>
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<td>9.90</td>
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<td>64 c</td>
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<td>Winter legume</td>
<td>87 b</td>
<td>-1 b</td>
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<td>27.00</td>
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<tr>
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<td>-45 c</td>
<td>-40.50</td>
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- Regression equation of grain yield for chemical fallow as a function of N fertilizer rate
- Solved the equation substituting the mean grain yield at 0-N for each cover crop treatment

Management Implications

- Cover crop selection and N management will impact sorghum productivity
  - Potential to replace a portion of cash crop N requirement with summer legume cover crops
    - 30 lbs N/ac contributed by late maturing soybeans
  - High C:N ratio cover crop such as sorghum-sudangrass, will required additional N input.

- Although no significant improvement on N supply with winter cover crops, there may be other potential benefits.
  - Reduce potential N losses

- N rate to optimize sorghum yields (8-yr avg) after:
  - SNL: ~ 120 lbs N ac⁻¹
  - Other cover crops and DSB: ~ 80 lbs N ac⁻¹
MIDWEST COVER CROPS COUNCIL SELECTOR TOOL

https://mccc.msu.edu/
N from legume cover crops

• 4: Cowpeas: 10-80 lbs
• 4: Sunn hemp: 20-120 lbs N
• 4: Sweetclover: 5-50 lbs N
• 4: Hairy vetch: 5-100 lbs N

N from legume cover crops

• 3: Mung beans: 10-80 lbs N
• 3: Red clover: 5-100 lbs N
• 3: Spring field pea: 5-50 lbs N
• 3: Winter pea: 5-60 lbs N
• 3: Soybeans: 10-75 lbs N
• 3: Chickling vetch: 5-50 lbs N
• 3: Common vetch: 5-50 lbs N

N from legume cover crops

• 2: Crimson clover: 5-70 lbs N
• 2: Guar: 2-120 lbs N
• 2: Spring lentils: 5-20 lbs N
• 2: Winter lentils: 5-20 lbs N
Decomposition of cover crops and nutrient release is still actively being researched.

- Clip cover crops right before we spray them out.
- Stuff a known amount into the bag, stake them to the ground.
- Pick them up every 2-4 weeks.
- Samples are being analyzed for C, N, ash, etc. and along with the mass and the soil temperature and moisture data, will be used in the development/refinement of nutrient availability models.