Growing Your Own Nitrogen through Cover Crops

August 16, 2019 | Practical Farmers of Iowa | Small Grains Conference

Julie Grossman, Associate Professor, Department of Horticultural Science
Cover crops are HOT news!

Best Summer Cover Crops
For weed suppression and a major boost to soil fertility, sow these four fast-growing summer cover crops in any patch possible, even during your prime gardening season.

Cover Crops, a Farming Revolution With Deep Roots in the Past

Sonoma County grower switches cover crop regime
Veteran Sonoma County grape grower Duff Bevill of Healdsburg, Calif., is changing his cover crop regime to generate more nitrogen for his wine grape vines.

Plant cover crops in fall to protect, improve soil
By Will Hehemann
UAPB School of Agriculture, Fisheries and Human Sciences
October 21, 2016
Cover crop: non-cash crop plants integrated into cash crop rotations

Spatial or temporal integration	Range of interconnected benefits

Our lab optimizes legume management to provide non-legume plants with nitrogen they need for growth, and improve soil quality and functioning, especially in organic systems.
Cover crops can have lots of benefits!

- enhance mycorrhizal numbers
- add N (legume)
- add organic matter
- suppress weeds
- suppress nematodes
- reduce erosion
- increase infiltration of water
- decrease nutrient loss
- attract beneficial insects

Cover crops

---

Free fertilizer!

Table 9.5. Green manure nitrogen credits.

<table>
<thead>
<tr>
<th>Crop</th>
<th>&lt; 6” growth</th>
<th>&gt; 6” growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb N/a to credit</td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>40</td>
<td>60–100 a</td>
</tr>
<tr>
<td>Clover, red</td>
<td>40</td>
<td>50–80 a</td>
</tr>
<tr>
<td>Clover, sweet</td>
<td>40</td>
<td>80–120 a</td>
</tr>
<tr>
<td>Vetch</td>
<td>40</td>
<td>40–90 a, b</td>
</tr>
</tbody>
</table>

\[ a \] Use the upper end of the range for spring seeded green manures that are plowed under the following spring. Use the lower end of the range for fall seedings.

\[ b \] If top growth is more than 12 inches before tillage credit 110–160 lb N/a.
Biological Nitrogen Fixation

- Plant residue
- Organic N
- Microbial decomposition
- Inorganic N

Primary decomposition - physical breakdown
Management of legumes to meet goals of organic agriculture can take place at two main points:

- Managing the symbiosis
- Managing the residue
Rhizobia infection

A

root epidermis
root cortex
root hair
rhizobia
1st nodule meristem

B

infection thread

C

developing nodule

Lévai & Veres (2013)
Who inoculates?

- 45% always inoculate
- 39% don’t inoculate
- 16% only when introducing a new legume

O’Connell et al. (2014)
Having legumes in rotation with cash crops modifies and improves rhizobia population size

History of Hairy vetch (HV) in the rotation increased nodule number per plant

...as well as nodule mass per plant...

...and number of rhizobia present in the soil

Mothapo et al., *Biology and Fertility of Soils, 2013*
Total legume N contributed can be high in Southern regions of US

Legume Biomass N (Kg ha⁻¹)

- Hairy Vetch
- Crimson Clover
- Austrian Winter Pea

Appx 178 lb/Acre

* Designates 1 year of data only

How much N (and especially fixed N) can winter annual legume contribute in the Upper Midwest?
Cover crop legume treatments

V1
Hairy vetch 1
(Vicia villosa R.)

V2
Hairy vetch 2
(Vicia villosa R.)

CLO
Red clover
(Trifolium pretense)

MIX
Mix (Vicia villosa R. 2 + Secale cereale L.)

RYE
Cereal rye (Secale cereale L.)

With inoculant ×

Without inoculant
Does inoculation increase nodulation?

All treatments are not significant at $\alpha = 0.05$.

*Error bars represent standard error.

- Nodule mass
- Total shoot biomass
- Total shoot N
- %Ndfa

Perrone et al., 2018, In preparation
### Shoot biomass and plant N

**In MN, overwintered legumes contribute between 26 – 79 lbs/acre N**

<table>
<thead>
<tr>
<th></th>
<th>2015-2016</th>
<th></th>
<th>2016-2017</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grand Rapids</td>
<td>Lamberton</td>
<td>Grand Rapids</td>
<td>Lamberton</td>
</tr>
<tr>
<td></td>
<td>Biomass</td>
<td>N</td>
<td>Biomass</td>
<td>N</td>
</tr>
<tr>
<td>Trt</td>
<td>Mg ha(^{-1})</td>
<td>kg ha(^{-1})</td>
<td>Mg ha(^{-1})</td>
<td>kg ha(^{-1})</td>
</tr>
<tr>
<td>MIX</td>
<td>2.5 ab</td>
<td>39 b</td>
<td>3.1 ab</td>
<td>79 a</td>
</tr>
<tr>
<td>V1</td>
<td>1.5 b</td>
<td>52 ab</td>
<td>2.0 bc</td>
<td>74 a</td>
</tr>
<tr>
<td>V2</td>
<td>1.8 ab</td>
<td>71 a</td>
<td>1.9 c</td>
<td>73 a</td>
</tr>
<tr>
<td>CLO</td>
<td>0.9 c</td>
<td>30 b</td>
<td>0.6 d</td>
<td>23 b</td>
</tr>
<tr>
<td>RYE</td>
<td>3.0 a</td>
<td>35 b</td>
<td>3.7 a</td>
<td>53 a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2016-2017</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grand Rapids</td>
<td>Lamberton</td>
</tr>
<tr>
<td></td>
<td>Biomass</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Mg ha(^{-1})</td>
<td>kg ha(^{-1})</td>
</tr>
<tr>
<td>MIX</td>
<td>1.9 a</td>
<td>29 a</td>
</tr>
<tr>
<td>V1</td>
<td>ND*</td>
<td>ND</td>
</tr>
<tr>
<td>V2</td>
<td>0.3 b</td>
<td>10 ab</td>
</tr>
<tr>
<td>CLO</td>
<td>0.1 b</td>
<td>3 b</td>
</tr>
<tr>
<td>RYE</td>
<td>1.9 a</td>
<td>29 a</td>
</tr>
</tbody>
</table>

*ND, Not Determined

---

Doesn’t quite give us enough time to get what we need! Small grains may provide a longer fall growth period and thus increase N contribution.

Perrone et al., 2018, In preparation

[University of Minnesota Logo]

[Driven to Discover]
## Nitrogen Fixed

<table>
<thead>
<tr>
<th>Trt</th>
<th>2015-2016</th>
<th>2016-2017</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grand Rapids</td>
<td>Lamberton</td>
</tr>
<tr>
<td></td>
<td>%Ndfa kg ha(^{-1})</td>
<td>%Ndfa kg ha(^{-1})</td>
</tr>
<tr>
<td>MIX</td>
<td>99 a</td>
<td>9 c</td>
</tr>
<tr>
<td>V1</td>
<td>84 ab</td>
<td>43 a</td>
</tr>
<tr>
<td>V2</td>
<td>38 bc</td>
<td>36 ab</td>
</tr>
<tr>
<td>CLO</td>
<td>36 c</td>
<td>11 b</td>
</tr>
<tr>
<td></td>
<td>82</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ND*</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>103</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>53</td>
<td>10</td>
</tr>
</tbody>
</table>

*ND, Not Determined

Perrone et al., 2018, In preparation
Management

When growing a cover crop 3 things need to happen:
1. Planting
2. Termination
3. Incorporation
Management - planting

But I don’t have time to squeeze them in!

- Difficult after corn interseeding, underseeding
Management – planting

New technologies from maize systems may provide the opportunity to interseed cover crops into standing crops, like corn

Cereal rye aerially interseeded at corn maturity
(Wilson et al., 2013)

Annual ryegrass and mixtures with legumes drill-interseeded at V2-V6
(Curran et al., 2018)

Interseeding with different levels of soil disturbance at V7
(Noland et al., 2018)
Small grains may provide new cover crop opportunities

1. Warm Season annuals
   - Berseem clover, crimson clover

2. Perennial clovers
   - Medium red clover

3. Cool season annuals
   - Field pea, hairy vetch
Management - termination

- Termination goal: 50% of plants flowering
- Flowering = max nitrogen
- What if I let the cover crop go to seed?
  1. Weedy next year
  2. Nitrogen tied up in seed, not biomass
N from legume is released slowly over season

Challenges: nutrient immobilization

Very mature crimson clover mulch

Hairy vetch mulch
Management – incorporation

Residue on surface?

Residue incorporated?
Management - Legumes & grasses in biculture
Management - Legumes & grasses in biculture
How much nitrogen did we add with a cover crop?

• Let’s say we grew medium red clover (in the rotation described by Graham Adsit yesterday – so beautiful!)

• We got a strong stand; how to we determine how much nitrogen we got from the crop?

What information do you think we need to know?

1.

2.

3.
Estimating N credits from cover crops

What we need to know:
1. How much plant material is in a given area
2. How much nitrogen is in that material
3. How quickly will the material decompose and become available
1. How much plant material is in a given area?

Sample your biomass!

• Use a ruler or yardstick to measure out a known area in your cover cropped area

• Clip the plants within the square at several places in your field

• Dry the samples in the oven (or truck dash) until they are crunchy dry
1. How much plant material is in a given area?

CONVERT TO BIOMASS per ACRE

\[
\text{dry sample weight (lb)} \times \frac{43,560 \text{ ft}^2}{\text{acre}} = \frac{\text{lbs biomass}}{\text{acre}}
\]
1. How much plant material is in a given area?

HOW MUCH BIOMASS PER ACRE DO I HAVE?

\[
\frac{\text{dry sample weight (lb)}}{\text{area sampled (ft}^2\text{)}} \times \frac{43,560 \text{ ft}^2}{\text{acre}} = \frac{\text{lbs biomass}}{\text{acre}}
\]

\[
\frac{0.6 \text{ lbs}}{8 \text{ ft}^2} \times \frac{43,560 \text{ ft}^2}{\text{acre}} = \frac{3,267 \text{ lbs biomass}}{\text{acre}}
\]
2. How much nitrogen is in that material?

<table>
<thead>
<tr>
<th>Cover Crop</th>
<th>Examples</th>
<th>% N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legumes</strong></td>
<td>Hairy vetch</td>
<td>4% at flowering</td>
</tr>
<tr>
<td></td>
<td>Clovers</td>
<td>3% as seeds are maturing</td>
</tr>
<tr>
<td></td>
<td>Pea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sunn hemp</td>
<td></td>
</tr>
<tr>
<td><strong>Non-legume grasses</strong></td>
<td>Rye</td>
<td>3% at flowering</td>
</tr>
<tr>
<td></td>
<td>Oat</td>
<td>2% as seeds are maturing</td>
</tr>
<tr>
<td></td>
<td>Sorghum sudangrass</td>
<td></td>
</tr>
<tr>
<td><strong>Non-legume broadleaves</strong></td>
<td>Buckwheat</td>
<td>Similar or a little less than</td>
</tr>
<tr>
<td></td>
<td>Tillage radish</td>
<td>grasses</td>
</tr>
<tr>
<td></td>
<td>Canola</td>
<td></td>
</tr>
</tbody>
</table>

3,267 lb biomass /acre x 0.04 = 130 lbs N from cover crop!
3. How quickly will the material decompose and become available?

MICROBES HAVE TO EAT THE MATERIAL FOR IT TO BE AVAILABLE FOR PLANTS

Leave the cover crop on the surface

40% will be available in year 1

Incorporate it belowground

50% will be available in year 1
3. How quickly will the material decompose and become available?

MICROBES HAVE TO EAT THE MATERIAL FOR IT TO BE AVAILABLE FOR PLANTS

<table>
<thead>
<tr>
<th>Leave the cover crop on the surface</th>
<th>Incorporate it belowground</th>
</tr>
</thead>
<tbody>
<tr>
<td>40% will be available in year 1</td>
<td>50% will be available in year 1</td>
</tr>
<tr>
<td>$130 \text{ lb N} \times 0.4 = 52 \text{ lb N/ac}$</td>
<td>$130 \text{ lb N} \times 0.5 = 65 \text{ lb N/ac}$</td>
</tr>
</tbody>
</table>
Managing Cover Crops Profitably

What to grow, why to grow it and how to grow it!

SARE publication; FREE!
Thank you!

Julie Grossman
jgross@umn.edu