Managing Nitrogen with Cover Crops

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Legumes

- Growth not limited by soil N
- High tissue N concentration (3-4% N)
  - C:N ratio < 20
- Rapid N mineralization during decomposition
- Not very good at reducing N leaching
Legumes

When compared to:

1. Mineral fertilizers
   - Slower release rates
   - Lower energy use
   - Renewable resource

2. Animal Waste
   - No new P
   - No transport costs
   - Low volatility
Hairy vetch (*Vicia villosa*)

- Winter annual legume
- Seed at 20-30 lb/ac; 0.5-1.5” deep
- High biomass producer (4000-7000 lb/ac)
  - Produce more than 150 lb N/ac
  - Good weed control
- Disease suppression in vegetables
Crimson clover (*Trifolium incarnatum*)

- Winter annual legume
- Seed at 8-15 lb/ac; 0.25-0.5” deep
  - Biomass (1000-3500 lb/ac)
  - Produce more than 130 lb N/ac
  - Improves soil structure
Austrian winter peas (*Pisum sativum*)

- Winter and spring annual
- Seed at 50-80 lb/ac; 1-2” deep
- Biomass (1000-3500 lb/ac)
- Produce more than 130 lb N/ac
- Improves soil structure/reduces compaction
Total above ground plant available nitrogen from hairy vetch (lb PAN ac\(^{-1}\))

- MA, NY, PA: 18-31 lb PAN ac\(^{-1}\)
- MD: 56-93 lb PAN ac\(^{-1}\)
- NC_Gold, NC_Sali, NC_Kin: 93-156 lb PAN ac\(^{-1}\)
Need covers for multiple functions

- No-till has soil conservation benefits
- Successful due to herbicides/herbicide resistant crops
Nutrient supply vs. weed control

• Grasses: High weed suppression, low N supply
  - Cereal rye (Secale cereale L.)

• Legumes: Low weed suppression, high N supply
  - Hairy vetch (Vicia villosa Roth)
Weed Biomass 2013

Cereal Rye:HairyVetch Mixture Proportion

- 100%: 0
- 80:20
- 60:40
- 40:60
- 20:80
- 0:100

ha⁻¹
Grasses

- Tremendous N scavenging
- Erosion control
- Weed suppression as a mulch
- Growth limited by soil N
- Lower tissue N concentration (1-2%)
  - C:N ratio > 25
- Possible N immobilization during decomposition
- Excellent at reducing N leaching
Cereal rye nitrogen content across a fall fertilizer gradient

Fall nitrogen application rate (kg ha\(^{-1}\))
Cover crop biomass across mixture proportions

North Farm 2012

Biomass, Mg ha⁻¹

0 5 10 15

Total

Rye

Vetch

Hairy vetch/Cereal rye seeding rate (proportion of monoculture)
Cover crop biomass across mixture proportions

North Farm 2012

Biomass, Mg ha$^{-1}$

Total

Rye

Vetch

Hairy vetch/Cereal rye seeding rate (proportion of monoculture)
Cover crop biomass across mixture proportions

N. Farm 2012

Biomass, Mg ha$^{-1}$

Cereal rye monoculture

Total

Rye

Vetch

Hairy vetch monoculture

Hairy vetch/Cereal rye seeding rate (proportion of monoculture)
Cover crop biomass across mixture proportions

Meta-analysis (Poffenbarger et al. 2014)

• Mixture vs. monocultures
  • > biomass
  • = 50% legume content equivalent to pure legume
  • Drivers for over yielding: proportion, seed applied, and GDD
C:N ratio of hairy vetch monocultures and mixtures

C:N ratios:
- Hairy vetch (16:1)
- Cereal rye (83:1)

50:50 = 25-30:1;
N immobilization/mineralization threshold
C:N ratios:
Hairy vetch (16:1); Cereal rye (83:1)

50:50 = 25-30:1; N immobilization/ mineralization threshold
Cereal rye and hairy vetch monoculture and mixture N content

Shoot N Content, kg ha$^{-1}$

Hairy Vetch: Cereal Rye Biomass

South Farm 2013

HV

HV BFN

CR

Tot

HV:CR Sown

0:1

0.2:0.8

0.4:0.6

0.6:0.4

0.8:0.2

1:0

Poffenbarger et al.
Cereal rye and hairy vetch monoculture and mixture N content

North Farm 2012

South Farm 2012

North Farm 2013

South Farm 2013

Hairy Vetch:Cereal Rye Biomass

Poffenbarger et al.
Nutrient management

*Determine the right:* rate, source, time, and placement

- Focus is on reducing potential for losses:
  - Leaching
  - Erosion
  - Volatilization

- Increasing use efficiency
  - lowers cost of production and conserves natural resources
Improving nitrogen mgmt. in corn

V6: Period of greatest N uptake
Cover crop decomposition and N release
Nitrogen release over time

Tillage

- Pure hairy vetch
- 50/50 mix
- Pure rye

N released (lb ac⁻¹)
0 28 52 70 90 109 131

Time (days)
0 28 52 70 90 109 131
Nitrogen release over time

No-till

Tillage

Pure hairy vetch

50/50 mix

Pure rye

Pure hairy

50/50 mix

Pure rye

Time (days)

N released (lb ac\(^{-1}\))
Moving beyond C:N ratios to quality
(decision support tools for growers; water and nitrogen)

Call for farmers to participate
Effects of hairy vetch and mineral fertilizer on corn yield

- **With vetch**: 
  - Corn grain, Mg ha\(^{-1}\)
  - Fertilizer N, kg ha\(^{-1}\)
  - Yields ranging from 10 to 12 Mg ha\(^{-1}\)

- **No hairy vetch**: 
  - Corn grain, Mg ha\(^{-1}\)
  - Fertilizer N, kg ha\(^{-1}\)
  - Yields ranging from 6 to 8 Mg ha\(^{-1}\)

200 bushels/ac
Managing N in cereal covers
(may need to adjust split application rates)
N and P Management

Balancing N needs with P concerns
- legume cover crops + organic amendments
- apply amendments at P removal rates
- soil reserves as "buffer"
Poultry litter nutrient properties

<table>
<thead>
<tr>
<th>Nutrient pool</th>
<th>lbs/ton</th>
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<tbody>
<tr>
<td>Total N</td>
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<tr>
<td>NH4-N</td>
<td>14</td>
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<tr>
<td>Org-N</td>
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<tr>
<td>PAN</td>
<td>42</td>
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<tr>
<td>P$_2$O$_5$</td>
<td>58</td>
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<tr>
<td>K$_2$O</td>
<td>52</td>
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- **N-based rate:** Need ~3 tons/acre to supply 140 lbs PAN/acre
  - 174 lbs P$_2$O$_5$/acre
  - 156 lbs K$_2$O/acre

- **P-based rate:** Need ~1.5 tons/acre to supply 85 lbs P$_2$O$_5$/acre
  - 63 lbs PAN/acre
  - 78 lbs K$_2$O/acre
Poultry litter N availability over time

Total ammonium and nitrate; g N kg⁻¹ amendment

- PL
- PPL
- PFMB
- FM

Time, d
• N losses to atmosphere (~50% of NH$_4$-N lost)
• Nutrient losses in run-off
Manure subsurface band applicator
Soil inorganic N in grass/legume cover crops over time

<table>
<thead>
<tr>
<th>Corn growth stage</th>
<th>Cereal rye</th>
<th>Mixture</th>
<th>Hairy vetch</th>
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Effect of cover crop and poultry litter application method on corn yield

![Graph showing the effect of cover crop and poultry litter application method on corn yield.](image-url)
Effect of cover crop and poultry litter application method on corn yield

Weeds

Hairy vetch/Cereal rye sown proportion

Grain yield (bushels acre⁻¹)
Integrated fertility management in field corn

Grain yield (bushels acre\(^{-1}\))

N source and application method
- Surface UAN
- SSB PL

Hairy Vetch
Cereal Rye

Bare Ground

Biomass proportion

0.0
0.2
0.4
0.6
0.8
1.0
Questions