Cover Crops for Organic Production

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Cover crops in organic production

- **Source of nutrients**
- **Source of organic matter**
  - soil structure, aeration, drainage
- **Crop rotation**
- **Disease suppression**

Special role of soil nitrogen
Cover crops in organic production

- Important as an economical N source
  - short-term soil organic matter

- Amount of N fixed depends upon species, growth period, growing conditions
  - more vigor = more N

- Value of cover crop N in cost / benefit analysis
Organic nutrient management

- Increased soil organic matter
  - nutrient availability
  - cation exchange capacity
  - water retention

- Nitrogen availability – nitrogen use efficiency
Specific effects on soil N

- Nitrogen fixation
- Source of soil N for subsequent crops
- Nitrogen trapping
  - less important in organic environment
Nitrogen fixing

- **Legumes and legume/grass mixes**
  - fix atmospheric N > own needs and recycle N

- **Amount of N fixed depends upon species, growth period, growing conditions**
  - more vigor = more N

- **Vigorous legume or mix** > 100 to 200 lb N/A
  - October to March

- **Warm season species for summer**
Nitrogen from cover crops after incorporation

- $N$ released from cover crop regardless of source
  - mature grasses have *** effect > OM

- Mineralization is conversion to mineral N
  - macro and micro fauna >
  - temperature is important; moisture
C:N ratio is important

- Low C:N speeds decomposition
  - legumes >>> grasses, grains
  - mustards, buckwheat, etc. are intermediate

- N content may be lower and more slowly available
  - organic N > ammonium > nitrate

- Avoid deficiency - supply alternative N
# Effect of C:N on nitrogen availability

<table>
<thead>
<tr>
<th>C: N RATIO</th>
<th>NITROGEN AVAILABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>high</td>
</tr>
<tr>
<td>10 - 20</td>
<td>medium</td>
</tr>
<tr>
<td>20 - 30</td>
<td>low</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>negative</td>
</tr>
</tbody>
</table>
### Effect of C:N on N availability

<table>
<thead>
<tr>
<th>Percentage of N in cover crop</th>
<th>Effect of N release</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>will tie up N</td>
<td>cereal straw</td>
</tr>
<tr>
<td>1.0</td>
<td>will tie up N</td>
<td>cereal straw</td>
</tr>
<tr>
<td>1.5</td>
<td>will tie up N</td>
<td>cereal at heading</td>
</tr>
<tr>
<td>2.0</td>
<td>will tie up N</td>
<td>cereal before heading</td>
</tr>
<tr>
<td>2.5</td>
<td>will release N</td>
<td>mustards at heading and immature cereal</td>
</tr>
<tr>
<td>3.0</td>
<td>will release N</td>
<td>mustards, legumes, and juvenile cereal</td>
</tr>
<tr>
<td>3.5</td>
<td>will release N</td>
<td>legumes and immature mustards</td>
</tr>
<tr>
<td>4.0</td>
<td>will release N</td>
<td>legumes</td>
</tr>
<tr>
<td>State</td>
<td>Plant</td>
<td>Terminate</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------------------</td>
</tr>
<tr>
<td>MD</td>
<td>Mid September</td>
<td>Mid May – June</td>
</tr>
<tr>
<td>CA</td>
<td>Early November</td>
<td>Early April</td>
</tr>
<tr>
<td>CA</td>
<td>Early November</td>
<td>Early April</td>
</tr>
<tr>
<td>GA</td>
<td>October–November</td>
<td>April</td>
</tr>
<tr>
<td>NC</td>
<td>October</td>
<td>Mid April</td>
</tr>
<tr>
<td>KY</td>
<td>Mid September</td>
<td>Mid May</td>
</tr>
<tr>
<td>ME</td>
<td>Mid August</td>
<td>Late May</td>
</tr>
<tr>
<td>WA</td>
<td>Mid September</td>
<td>Late April</td>
</tr>
<tr>
<td>WA</td>
<td>Mid September</td>
<td>Late April</td>
</tr>
<tr>
<td>WA</td>
<td>Late September</td>
<td>Mid April</td>
</tr>
</tbody>
</table>
N availability to succeeding crop

- Total amount related to species, vigor
  ~ 100 – 200 lb N / acre

- Species, stage of development affect decomposition
  ~ 20-50% total N ---> succeeding crop

- Synchrony of availability
  - timing relative to crop need

  ~ 1 study with organic peppers in SB Co. >
  equivalent production to 100 lb N / acre
Total N availability VS synchrony

- Cover crop incorporation
- Nitrate availability with cover crop
- Background nitrate availability without cover crop

Crop demand
Prepare beds. apply plastic, drip tape
arrival of plants from nursery

Rate of N Mineralization and Nitrogen Uptake

Pre-plant cover crop mineralization

Cover crop incorporation

Southern Districts

Crop N demand

Northern Districts

Week

Time
"Nitrogen contribution of rye–hairy vetch cover crop mixtures to organically grown sweet corn"

Renewable Ag. and Food Systems

A. Lawson, A. M. Fortuna, C. Cogger, A. Bary, and T. Stubbs
Crop and Soil Sciences, WSU Pullman, WA
afortuna@wsu.edu

Common problems with efficient use cover crops.
Incubate in lab and compare to field?

- **Lab** – Vetch and rye mixes to provide varying N composition
  incubate > evaluate N availability

- **Field** – incorporate cover crops with varying nitrogen composition after varying periods
  evaluate soil N and crop uptake
  - compared to varying rates of feather meal N
## Composition of incubation materials

<table>
<thead>
<tr>
<th>Cover crop treatment</th>
<th>Biomass (g kg(^{-1}))</th>
<th>Total N (mg kg(^{-1}))</th>
<th>N concentration (g kg(^{-1}))</th>
<th>C:N ratio</th>
<th>Rye (%)</th>
<th>Vetch (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(^{100})</td>
<td>1.11</td>
<td>398</td>
<td>36</td>
<td>13</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>R(^{50}) V(^{50})</td>
<td>1.90</td>
<td>549</td>
<td>29</td>
<td>18</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>R(^{75}) V(^{25})</td>
<td>1.90</td>
<td>440</td>
<td>24</td>
<td>21</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>R(^{100})</td>
<td>1.80</td>
<td>293</td>
<td>16</td>
<td>26</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
Nitrogen contribution of cover crops for sweet corn

Increasing mineralization for 4-5 weeks then plateau
Nitrogen contribution of cover crops for sweet corn

*Salinity from nitrate – affect microbes and mineralization?*
Incubate in lab and compare to field?

- N increase for 28 days incubation then levels off

  EC affect microbial activity?

  EC 1.3 to 3.0 and can decrease mineralization

- Higher rate of N mineralization with more vetch VS rye possible to slow mineralization rate to match uptake? "Designer" cover crops??
<table>
<thead>
<tr>
<th>Year</th>
<th>Cover Crop</th>
<th>Biomass (Mg ha(^{-1}))</th>
<th>N Uptake (kg ha(^{-1}))</th>
<th>N concentration (g kg(^{-1}))</th>
<th>C:N ratio</th>
<th>Rye (%)</th>
<th>Vetch (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>2.76</td>
<td>62</td>
<td>22.3</td>
<td>19</td>
<td>78</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Late</td>
<td>1.50</td>
<td>34</td>
<td>22.7</td>
<td>18</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Early</td>
<td>4.81</td>
<td>76</td>
<td>15.9</td>
<td>27</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Late</td>
<td>2.90</td>
<td>50</td>
<td>17.5</td>
<td>25</td>
<td>95</td>
<td>5</td>
</tr>
</tbody>
</table>
## Nitrogen contribution of cover crops for sweet corn

Feather meal available N rate (kg ha\(^{-1}\))

<table>
<thead>
<tr>
<th>Year</th>
<th>Cover Crop</th>
<th>0 Early June</th>
<th>0 PSNT</th>
<th>0</th>
<th>56 Post Harvest</th>
<th>112 Post Harvest</th>
<th>168 Post Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Early</td>
<td>8</td>
<td>18</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Late</td>
<td>7</td>
<td>16</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>7</td>
<td>15</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>2010</td>
<td>All</td>
<td>6</td>
<td>15</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td>13</td>
</tr>
</tbody>
</table>

Highest cover crop N presidedress but insufficient little N from cover crop.
Nitrogen contribution of cover crops for sweet corn

<table>
<thead>
<tr>
<th>Year</th>
<th>Feather meal available N (kg ha(^{-1}))</th>
<th>Ear fresh weight (Mg ha(^{-1}))</th>
<th>Above-ground dry matter (Mg ha(^{-1}))</th>
<th>N uptake (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>0</td>
<td>18 c(^1)</td>
<td>7.79 b</td>
<td>110 d</td>
</tr>
<tr>
<td></td>
<td>56</td>
<td>21 b</td>
<td>8.28 b</td>
<td>143 c</td>
</tr>
<tr>
<td></td>
<td>112</td>
<td>22 ab</td>
<td>8.54 ab</td>
<td>166 b</td>
</tr>
<tr>
<td></td>
<td>168</td>
<td>24 a</td>
<td>9.04 a</td>
<td>189 a</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
<td>12 b</td>
<td>6.76 c</td>
<td>90 d</td>
</tr>
<tr>
<td></td>
<td>56</td>
<td>16 a</td>
<td>7.54 b</td>
<td>119 c</td>
</tr>
<tr>
<td></td>
<td>112</td>
<td>18 a</td>
<td>7.85 b</td>
<td>134 b</td>
</tr>
<tr>
<td></td>
<td>168</td>
<td>17 a</td>
<td>8.41 a</td>
<td>150 a</td>
</tr>
</tbody>
</table>
Summer warm season cover crops

- Often grasses or warm season grains apply N or need to sponge N?
- Cowpea or Crotalaria among warm season legumes
- Water and management important
Cost / benefit of cover crop N

- Direct costs of producing
  - water may be most important

- Lost opportunity costs
  - loss of use of land

- Cover crop to scavenge N during rainy periods
  VS early or late market

- SOM and water retention
  VS irrigation frequency and leaching potential
Cover crop management for organic production

- Select cover crop based on specific needs / tradeoffs
- Total N for succeeding crop is commonly \( \sim 100 \text{ lb N} \)
- Build soil organic matter – short VS long term
- Seasonal limitations – N contribution related to vigor
- Market windows may drive decisions
Summary - Cover Crop N

- Critical importance for organic production
  - one of most economical N sources
  - improve soil organic matter

- Amount of N fixed depends upon species, growth period, growing conditions
  - more vigor = more N

- Actual N contribution can vary

- Value of cover crop N in cost / benefit analysis
Also see

Cover Crops for Vegetable Production
A Grower's Handbook

University of California
Agriculture and Natural Resources Publication # 3517
ucanr.org
Cover Crops for Organic Production

Mark Gaskell, Farm Advisor
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