Optimizing the Benefits of Hairy Vetch in Organic Production

Dr. John Teasdale, USDA-ARS

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http://www.extension.org/organic_production

Dr. John Teasdale, USDA-ARS Sustainable Agricultural Systems Lab, Beltsville, MD

Should I use hairy vetch as a cover crop?

Objectives for cover cropping:

- Prevent erosion
  - maintain soil quality, prevent degradation of water quality
- Sequester carbon
  - improve soil quality, mitigate global warming
- Recycle nutrients
  - maintain fertility, prevent degradation of water quality
- Fix nitrogen
  - improve soil fertility, meet crop N requirements
- Reduce weeds/pests
  - enhance weed/pest control, reduce pesticide use
- Reduce radiation to soil
  - cool soil, reduce evaporation

Objective for cover cropping USING HAIRY VETCH:

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### Hairy vetch (Vicia villosa Roth)

- Winter annual legume
- Produces abundant biomass high N content (120-160 lb/A) low C/N ratio (10 to 14)
- Best before high N-requiring crops
- Establishes easily
- Most winter hardy annual legume cover crop
- Widely adapted to much of U.S. except north of Zone 4
- Good spring ground cover by vines

### How should I plant hairy vetch?

**Seedbed**
- Firm, good soil-seed contact
- Good drainage, poor establishment in wet areas
- Raised beds, if beds needed for succeeding crop

**Planting Methods**
- Drill - best
- Grass/forage seeder - good
- Broadcast – poor (unless ideal moisture conditions)

**Seeding Rates**
- 15-30 lb/A
- 30 lb/A recommended for high N requiring organic crops

### Potential for scarification to eliminate hard seed


### Which “cultivar” should I use?

What is the germplasm diversity of hairy vetch?

1) Collect biomass fragments
2) Extract gDNA & amplify
3) Cut gDNA
4) Determine sizes of gDNA fragments

Amplified Fragment Length Polymorphism (AFLP) analysis with the objective of characterizing the genetic relatedness among all vetch accessions in the USDA germplasm collection.

- Jude Maul et al, USDA-ARS Sustainable Agriculture Systems Lab, Beltsville, MD

Crop Science (2011) 51:2615-2625

Global sources of the *Vicia villosa* USDA-National Plant Germplasm Collection

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Accessions</th>
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<tbody>
<tr>
<td>Afghanistan</td>
<td>3</td>
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<tr>
<td>China</td>
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<td>Greece</td>
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<td>Spain</td>
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<td>Iran</td>
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<td>Syria</td>
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<td>Australia</td>
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<td>Denmark</td>
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<td>Israel</td>
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<td>Tajikistan</td>
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<td>Spain</td>
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<td>Italy</td>
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<td>Turkey</td>
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<td>Yugoslavia</td>
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</table>

Hierarchical clustering of worldwide *Vicia villosa* accessions based on amplified fragment length polymorphism (AFLP) marker analysis.

Flowering date is an important trait that defines genomic variability in hairy vetch.

- Late flowering
- Early flowering

Flowering

Winterhardiness

Winter dormancy

Late flowering – More winter hardy – More winter dormancy

Early flowering – Less winter hardy – Less winter dormancy
Selected “populations” of hairy vetch

Late flowering/more winter hardy
• Nebraska common (derived from Madison?)
• Albert Lea

Early flowering/less winter hardy – Auburn derived
• AU Early Cover (J. Mosjidis, Auburn AL)
• Purple Bounty (T. Devine, ARS Beltsville)
• Purple Prosperity (T. Devine, ARS Beltsville)
• Groff AUJC (S. Groff, PA farmer)

Mixed characteristics
• VNS Oregon

When should I plant hairy vetch?

• Best when soil temperature and moisture conditions are moderate
• Permit sufficient growing degree days to obtain high biomass and nitrogen content before termination in spring
• Develop a plan for timing/method of spring vetch termination and crop planting before vetch is planted

Method and timing of hairy vetch termination for planting organic spring crops

Tillage – at vetch vegetative or flowering

No-tillage (mow or roll) – at vetch flowering only

Method and timing of hairy vetch termination for planting organic spring crops

Tillage – at vetch vegetative or flowering
• Prepare seedbed for early spring planting
• Incorporate amendments
• Facilitate N release
• Facilitate cultivation of weeds – uproot/desiccate seedling

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No-tillage (mow or roll) – at vetch flowering only
• Preserve soil organic matter
• Mulching benefits from surface residue
  ✓ Reduce soil and nutrient losses
  ✓ Improved rain infiltration and lower evaporation
  ✓ Weed suppression
Hairy vetch biomass accumulation is a linear function of growing degree days

\[
265 \text{ lb/A biomass for every } 100 \text{ GDD (base } 39^\circ\text{F)}
\]


Example:

Transplant vegetable crops following a hairy vetch cover crop
Plow-till hairy vetch.
Transplant on the 90-percent frost-free date.
Require 4,000 pounds of vetch dry biomass per acre.
Compute the GDD (39°F base) requirement = 1509.
Determine fall vetch planting date.

<table>
<thead>
<tr>
<th>Location</th>
<th>Planting date</th>
<th>90% frost-free date</th>
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<tbody>
<tr>
<td>Binghamton, NY</td>
<td>August 24</td>
<td>May 15</td>
</tr>
<tr>
<td>Peoria, IL</td>
<td>September 8</td>
<td>May 2</td>
</tr>
<tr>
<td>Beltsville, MD</td>
<td>September 28</td>
<td>May 6</td>
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<tr>
<td>Nashville, TN</td>
<td>October 13</td>
<td>April 19</td>
</tr>
<tr>
<td>Raleigh, NC</td>
<td>October 18</td>
<td>April 17</td>
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Abdul-Baki & Teasdale (2007) USDA Farmers Bulletin 2280

How should I manage crops following hairy vetch?

System for No-Till Tomatoes in Hairy Vetch

- Mowing
- Transplanting
- Staking

Polyethylene Mulch...versus...Hairy Vetch Mulch

Soil Erosion

- 93% of events, runoff volume greater in plastic than vetch
- 90% of events, soil loss greater in plastic than vetch

<table>
<thead>
<tr>
<th>Year</th>
<th>Plastic</th>
<th>Vetch</th>
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<tr>
<td>1997</td>
<td>492</td>
<td>33</td>
</tr>
<tr>
<td>1998</td>
<td>247</td>
<td>39</td>
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<tr>
<td>1999</td>
<td>535</td>
<td>118</td>
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</table>

Rice et al. 2001. J. Environ. Qual. 30:1808-1821

Early Season Soil Temperature and Tomato Response

<table>
<thead>
<tr>
<th>Mulch</th>
<th>Hours/day soil temp. &gt; 20°C</th>
<th>Early root length (cm/dm³)</th>
<th>Early fruit yield (Mg/ha)</th>
<th>Total fruit yield (Mg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Poly</td>
<td>19</td>
<td>245</td>
<td>15</td>
<td>88</td>
</tr>
<tr>
<td>Bare Soil</td>
<td>12</td>
<td>203</td>
<td>10</td>
<td>77</td>
</tr>
<tr>
<td>Vetch</td>
<td>11</td>
<td>180</td>
<td>7</td>
<td>96</td>
</tr>
</tbody>
</table>

1. No-till vegetable crops in hairy vetch require a sufficiently long season to overcome early season temperature depression.

Vetch-grown tomato plants accumulate gene transcripts that enhance
- disease suppression
- delayed senescence

(Mattoo et al.)

Tomato gene expression patterns differ in response to hairy vetch versus nitrogen fertilizer

Quantitative real time polymerase chain reaction (qPCR) analysis

Fatima et al. (2012) Functional Plant Biology, in press
Gene Up-regulation in Response to Hairy Vetch


Soil microbial community structure in the tomato rhizosphere

Phospholipid fatty acid (PLFA) composition – Redundancy analysis

How do I manage nitrogen following a hairy vetch cover crop?


Corn response to nitrogen following hairy vetch

Tomato Response to Mulches and Nitrogen


Sources of Nitrogen in Organic Production

Soil Nitrogen | Legumes | Animal manures

Chilean Nitrate | By-products
2. Hairy vetch alone may not provide sufficient N for optimum crop yield; supplemental N may be required.

Proviso: In mature organic soil with high mineralization potential, this may not be true.

More research is required!

Nitrogen release from cover crops in soil cores cumulative N during 55 days after kill (relative scale)

Nitrogen from hairy vetch needs to be managed with similar care as is required of fertilizer N management.

- Avoid use on soils prone to leaching.
- A vetch-grass mixture may mitigate potential leaching and denitrification losses from vetch.

Can organic corn be produced with a roller-crimper system?
Can organic corn be produced with a roller-crimper system?

For more details see eOrganic webinar: Curren et al. (3/22/11)
The evolution, status, and future of organic no-till in the northeast US

Reduced-Tillage Organic Corn Production in a Hairy Vetch Cover Crop

Potential, roll-kill system can provide equivalent or better yields along with enhanced environmental benefits compared to a tillage-based system.

However,
- Potential for corn stand reduction,
- Inadequate weed suppression by vetch mulch,
- Reduced cultivation efficacy.

Weed suppression by hairy vetch residue is inadequate

>8000 lb/A residue biomass is typically required for good weed suppression, however
- vetch residue rarely exceeds 5000 lb/A
- vetch residue decomposes rapidly

Mixtures of hairy vetch and small grains can increase residue biomass and weed suppression

Reduced cultivation efficacy in rolled hairy vetch

Legend
V = Hairy vetch
VR = Vetch + Rye
VRC = Vetch + Rye + Crimson clover


Reduced cultivation efficacy in rolled hairy vetch

Teasdale et al. 2012 Agron. J. in press

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Teasdale et al. 2012 Agron. J. in press
4. Requirements for a successful organic, reduced-tillage, vetch-based system

- Extended growing season
  - avoid cool spring soil
  - delay termination until vetch flowering
  - permit full expression of anti-senescence vetch properties
- Ample and evenly distributed rainfall to release N from vetch
- Supplemental N sources: soil reserves or amendments
- Weed management plan
  - Low weed seedbank/absence of perennial weeds
  - High residue levels (perhaps cover crop mixture)
  - Post-plant weed management strategy

**Questions?**

Contact information:
John Teasdale
USDA-ARS
Sustainable Agricultural Systems Lab
Building 001 Room 245
Beltville, Maryland 20705
Email: john.teasdale@ars.usda.gov

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