MSU-Bozeman
Cover Crop Research

NPGA Research Panel

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Cathy Zabinski (root ecology), Anton Bekkerman (economics),
and Perry Miller (presenter, 994-5431; pmiller@montana.edu)
MSU legume (pea or lentil) cover crop research since 1999 has found higher grain yields and/or protein after cover crops when:

1. Seeding winter pea (vs spring pea)
2. Seeding spring legumes early (vs late)
3. Terminating legumes at first bloom (vs pod)
4. Tilling cover crop (vs spraying)

Why?

More N fixed (1)

More time for soil water to be recharged and N to become released from residue (1, 2, 3)

Faster N release and fewer N losses (4)
Questions still to be answered

- Do cover crop mixtures improve yield, protein, and soil health more than legume-only?
- Do yield and soil health benefits increase with number of cover crop cycles?
Study 1: Cover crop cocktails, one 2-year cycle, four site years

- Objective: Determine effects of “functional groups” within mixed cover crops on plant yield and soil health
- 2 sites in Triangle (Dutton and Conrad), 2 sites in Gallatin Valley (Amsterdam and Bozeman)
- Monitored 7 farm fields as well
### Plant Functional Groups & Species

#### Nitrogen Fixers
- **Spring Pea** *Pisum sativum*
- **Lentil** *Lens culinaris*

#### Tap Root
- **Safflower** *Carthamus tinctorius*
- **Purple Top Turnip** *Brassica rapa*

#### Fibrous Root
- **Oats** *Avena sativa*
- **Proso millet** *Panicum miliaceum*

#### Brassica
- **Daikon radish** *Raphanus sativus*
- **Winter Canola** *Brassica napus*

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**Common Vetch** *Vicia sativa*

**Italian Ryegrass** *Lolium multiflorum*

**Camelina** *Camelina sativa*
Effect of cover crop treatment on spring wheat grain yield at Dutton (2014)

Housman et al., unpub. data, Dutton

Cover Crop Mix
Percent legume and termination timing affects plant available N (PAN)

**Take home:** Legume % less than 50 can result in low available N esp if terminated late

Willamette Valley, Oregon
Sullivan and Andrews, 2012
Potentially Mineralizable N

Preliminary Results

Potentially Mineralizable N (0-10cm)

kg NH4 - N ha^-1

Site

Amsterdam Conrad Dutton Bozeman

Treatment

FULL PEA SF MFR

*a

*b

*
Microbial Biomass

Preliminary Results

![Microbial Biomass Graph]

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<th>Site</th>
<th>Treatment</th>
<th>FULL</th>
<th>PEA</th>
<th>SF</th>
<th>MFR</th>
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2013 Soil Temperature study (2 inch)

Cover crops terminated on 5 July

Bozeman

Temperature °C

Jones, Miller, et al. unpublished
Study 1: Take home messages on yield and soil quality

- After one cycle, spring wheat grain yields higher after pea and N fixers than most other mixes.
- Relatively minor soil health differences; not unexpected given only one cycle.
Study 2: Eight-year, plot study

- Objective: Determine long-term effects of legume-containing rotations vs. fallow on subsequent wheat mainly in no-till.
- \(~16\text{ inch annual precip. (4 miles west of Bozeman)\)
Study 2. Experimental Design

- Unique feature is deep, uniform silt loam soil and relatively abundant winter precip. to recharge soils.
- Focus here on No-till pea forage/legume cover crop-wheat vs. fallow-wheat
- Spring or winter wheat planted in even years. 2010 was wettest of wheat years, 2012 record drought.
- 2 N rates: Full (3 lb available N/bu) and ½ N
Legume or fallow year

Wheat year
Study 2: 8 year plot study, Grain yield in 8\textsuperscript{th} year (2010 - wet)

@ 12% moist
Study 2: 8 year plot study, Grain protein in 8\textsuperscript{th} year

\begin{itemize}
  \item \textbf{Fallow-Wheat}
  \item \textbf{LGM-Wheat}
\end{itemize}

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<th>N fertilizer rates</th>
<th>Fallow-Wheat</th>
<th>LGM-Wheat</th>
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<tbody>
<tr>
<td>Full N rate (lbs/ac)</td>
<td>124.00</td>
<td>83.00</td>
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<tr>
<td>Half N rate (lbs/ac)</td>
<td>39.00</td>
<td>0.00</td>
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Change in soil N over time

2012 = record drought
Study 2 Economics (2009 – 2012)

4 yr Average Discounted Present Value of Net Returns ($/ac)

Miller et al. (in press)

Pea CC-Wht (full N)
Fallow-Wht (full N)
Pea CC-Wht (1/2 N)
Fallow-Wht (1/2 N)
Study 2: Take home messages

- In the first 3 cycles, wheat grain yield was not higher after legume than after fallow.

- After 4 two-year cycles, wheat grain yield and protein were higher after legume CC than after fallow.
  - Higher than normal precipitation in 2010 likely 1) increased release of available N from an increased organic N pool, and 2) made N limiting to growth.
  - Over 100 lb N/ac was saved in 2010 following legume cover crop compared to fallow!

- 4-yr economic returns were more stable with cover crop (less dependent on N rate) during wet and record drought years
Acknowledgments

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• USDA – WSARE
• NRCS – CIG
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• Montana Wheat and Barley Committee
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• Susan Tallman
• Meg Housman
• Ann McCauley
• Jeff Holmes
Questions?

For additional information on soil fertility topics including information on cover crops, see http://landresources.montana.edu/soilfertility