Green Manures: Effect of Termination Strategy and Organic Phosphorus Fertilizer on Subsequent Crop

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- Please fill out short survey at:
  
  www.montanaorganicassociation.org

Details in “Organic Matters”
Objectives

- Discuss nutrient dilemma facing organic farmers
- Show Montana research results on the effect of green manures on subsequent yields and nutrient availability
- Discuss recommendations based on different goals
There are 14 mineral nutrients that have been found to be essential for growth of most plants:

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Micronutrients</th>
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</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>Boron (B)</td>
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<tr>
<td>Phosphorus (P)</td>
<td>Chloride (Cl)</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Copper (Cu)</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>Iron (Fe)</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>Manganese (Mn)</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Molybdenum (Mo)</td>
</tr>
<tr>
<td></td>
<td>Nickel (Ni)</td>
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<td></td>
<td>Zinc (Zn)</td>
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</tbody>
</table>

The macronutrients are simply needed in larger amounts by the plant than the micronutrients. Nutrient deficiencies of the bolded nutrients have been observed in Montana.
How many of these 14 can be ‘grown’ (and won’t need to be replaced with fertilizer)?
Green Manures (ex: alfalfa, clover, pea, buckwheat)

- Positive: Replenish N supply w/ N fixation
- Positive: May increase P availability?
- Negative: No immediate economic benefit
- Negative: Use soil water, especially perennial legumes
Questions asked by organic farmers and Perry Miller

- Where can annual legumes be grown in Montana and can they supply enough N for subsequent small grain crop?
- What annual legumes work best for organic farmers?
- What termination times produce highest yield for subsequent crop?
Dry Pea Production Area
Study Sites: Big Sandy (Quinn's) and Bozeman (Post Farm)
Effect of Green Manure and Termination Timing on Winter Wheat Yields at Big Sandy: 2006

Why might you prefer winter pea to fallow when wheat yields were the same?

Why was yield following spring pea no better than mustard?
Effect of Green Manure and Termination Timing on Winter Wheat Protein at Big Sandy: 2006

Why did winter pea termination at pod have higher ww grain protein than winter pea terminated at bloom or tilled fallow?
Why did green manures mostly outcompete tilled fallow in 2007, but not in 2006?
WW yield was higher when green manure terminated at bloom

- Why might you want to terminate at pod anyway?
Effect of Green Manure and Termination on Green Manure N content at Big Sandy: 2006

- Winter pea: Not measured
- Spring pea: Not measured
- Mustard: Not measured
- Buckwheat: Not measured
- Winter pea: Not measured
- Tilled fallow: Not measured

Aboveground N Content (lb/ac)
Other Big Sandy 2007 Findings

- Pryor yields were higher than Northstar yields (58 vs 49 bu/ac)
- Yields for different row spacings (5 vs 10 in.) were identical (though middle row wasn’t packed)
- Yields for different seeding rates (20 vs 40 seeds/sq. ft.) were almost identical (53 vs 54 bu/ac)
Questions on Big Sandy Results?
Bozeman - 2006

- Some results similar: Winter wheat following WP bloom and tilled fallow had the highest yields (~ 70 bu/ac).
- Some results different: Winter wheat yields did not differ between bloom and pod when data averaged by crop. Why?
- Focus was on termination strategies: vinegar, vinegar-mow, “crimp” rolling (no-till)
Crimp roller

- Crimps without cutting
- Downside: Would need a no-till disc seeder to seed through residue
- Effective at pod, but not at bloom
Effect of winter pea termination method on winter wheat yield

Why of interest?
Effect of termination timing and method on winter wheat yield at Bozeman (2007)
Questions so far?
Phosphorus cannot be ‘grown’, needs to be eventually replaced

- In short term, green manures may be able to make P more available.
- In long term, organic P fertilizers such as rock phosphate, bone meal, or manure will need to be added.
- Only about 50-100 years of P left in Montana soils at typical removal rates. Yields will suffer well before this point.
Crop Species that Acidify Rootzone

- Buckwheat
- Legumes
- Some Mustards
Rootzone pH of four crops
Mechanism for Acidification of the Rhizosphere

Plant Uptake

\( \text{Ca}^{2+} \)

\( \text{H}_2\text{PO}_4^- \)

Apatite

\( 2\text{H}^+ \)

Rock Phosphate Dissolves

Rhizosphere
Questions so far?
Effect of green manure crop and rock phosphate on subsequent winter wheat grain yield, Big Sandy: 2007

![Bar graph showing the effect of green manure crops and rock phosphate on winter wheat grain yield.](image)

- **Buckwheat**
- **Mustard**
- **Spring Pea**
- **Tilled Fallow**

**Average Olsen P = 14 ppm**

**Previous Crop Tilled at Pod**
Summary

- Replacing fallow with an annual legume increased wheat yields in moist years.
- Winter wheat yields were consistently the highest following winter pea terminated at bloom.
- If your goal is to increase soil N levels, terminating at pod is recommended, though short term yields will be less.
- Crimp rolling of green manures may reduce tillage.
- Rock phosphate may improve yields, especially when used with buckwheat or pea, though likely not economical at moderate to high Olsen P levels.
Questions?
For more Information:

Soil Fertility Website:
http://landresources.montana.edu/soilfertility

Cropping Systems Website:
http://scarab.msu.montana.edu/CropSystems
While it’s fresh on your mind:

- Please fill out short survey at:

  [www.montanaorganicassociation.org](http://www.montanaorganicassociation.org)

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