SOIL BUILDING CROPS

Improving soil health and battling disease through rotation

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Improving Soil Health

• In Prince Edward Island, we have seen a decrease in soil organic matter over the past two decades.

• Soil Organic Matter:
  – Increases water holding capacity and CEC of soil
  – Reservoir for nutrients
  – Reservoir for beneficial microorganisms
Soil Health: a Potato Definition

• For many potato producers, a healthy soil is not just good soil organic matter, good soil structure, and a healthy microbial community, but is also free from soil-borne pests and diseases

  – *Verticillium* and root lesion nematodes
  – *Streptomyces scabies* (common scab)
  – *Rhizoctonia*
  – Wireworm
Building Healthier Soils

• A number of soil-borne pests/diseases have limited chemical control options, or those options are unavailable in PEI (ie. fumigation)
• Organic amendments (ie. manure) are often unavailable or don’t fit with food safety regulations
• Most Island growers are already used to growing non-commercial forage crops (ie. red clover) to feed the soil for the potato crop.
• So, tackling both of these challenges through use of rotation crops has rapidly increased.
Mustards

• Has been shown to be effective in reducing wireworm damage under double-cropping system (Noronha, AAFC)

• Literature from other areas has shown beneficial effect on early dying complex, common scab, Rhizoctonia
Mustards

- Requires considerable tillage
- Requires water for biofumigation
- Requires adequate fertilization for maximum benefit
- Data from WSU has shown that mustards can host both *V. dahliaea* and root lesion nematodes
- Can be used as a fall cover crop following wheat/barley/peas
- Brown vs. Caliente – depends on what you’re trying to do!
Buckwheat

• Has also been shown to be effective at fighting wireworm, possibly without need for green manure incorporation.

• Fast establishment, weed fighter, soil conditioner, phosphorus scavenger, low fertility requirements
Buckwheat

• Not frost tolerant (poor fall cover crop choice)
• Needs to be planted into warm soil
• Considerations for white mold in tight rotations with other host crops
• Doesn’t regrow as well from mowing as mustard
Evaluating Mustard & Buckwheat

- Grower trial, east of Charlottetown, 2017
- Russet Burbank
- Comparison of different rotations on marketable yield of potatoes, including wireworm damage
- Had history of wireworm damage
## Evaluating Mustard & Buckwheat

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Total Yield (cwt/ac)</th>
<th>Market. Yield (cwt/ac)</th>
<th>WW Damage (holes/tuber)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P – W Wheat – Soy</td>
<td>353.7</td>
<td>273.8</td>
<td>2.0</td>
</tr>
<tr>
<td>P – BW – BW</td>
<td>420.1</td>
<td>337.1</td>
<td>0.3</td>
</tr>
<tr>
<td>P – Mus – Mus</td>
<td>470.0</td>
<td>404.5</td>
<td>0.3</td>
</tr>
<tr>
<td>P – Mus – BW</td>
<td>450.7</td>
<td>409.1</td>
<td>0.2</td>
</tr>
<tr>
<td>P – Fallow – Fallow</td>
<td>371.4</td>
<td>271.8</td>
<td>0.1</td>
</tr>
<tr>
<td>P – Fallow – Mus</td>
<td>387.9</td>
<td>324.8</td>
<td>0.6</td>
</tr>
</tbody>
</table>

*Yields adjusted to 7 plants/10 ft row. Graded to Canada #1*
## Evaluating Mustard & Buckwheat

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Spring RLN (#/kg soil)</th>
<th>Fall RLN (#/kg soil)</th>
<th>Spring V. dahliae (cells/g)</th>
<th>Fall V. dahliae (cells/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat – Soy</td>
<td>200</td>
<td>420</td>
<td>1680</td>
<td><strong>10384</strong></td>
</tr>
<tr>
<td>Mus – Mus</td>
<td>180</td>
<td>940</td>
<td>1469</td>
<td>2065</td>
</tr>
<tr>
<td>BW – BW</td>
<td>360</td>
<td>280</td>
<td>697</td>
<td>1833</td>
</tr>
</tbody>
</table>

Testing before potato planting and at potato harvest

**Not much difference in nematode numbers but big difference in Verticillium**
Sorghum Sudangrass

- Trap crop for Verticillium
- Builder of soil organic matter
- Root system doubles after first mowing, compaction fighter
- Can be underseeded with forage (ie. alfalfa)
- Soil conditioner, easy tillage following sudangrass
Sorghum Sudangrass

• Inconclusive results on whether it multiplies nematodes
• Warm season crop, can’t be planted until mid-June (weed mgmt)
• Don’t let it get too mature (woody) or it can tie up N
Forage Pearl Millet

• Literature from Quebec showing effect on reducing RL nematode populations (Belair et al. 2005)
• Similar management to sorghum sudangrass, good for soil OM and soil structure, similar growing season
• Can be grown in mixture with sorghum sudangrass (50/50)
Sudangrass/Pearl Millet

• Still have a lot of questions about beneficial effect on reducing Early Dying symptoms, improving yield under local conditions

• Research by Mario Tenuta in MB in 2008 showed that Verticillium numbers might not noticeably decrease in soil samples, but disease incidence went down and yield increased.
Tillage Radish

• Growing acreage in PEI in 2017 & 2018
• Establish in August following wheat, barley, peas, or biofumigant crop
• Large taproots to break compaction layers, improve water infiltration, prevent nitrate leaching
• Somewhat frost tolerant, breaks down easily in spring
Tillage Radish

- No data on yields/disease incidence following tillage radish
- Host for Verticillium and nematodes?
- Odor issue for frozen fields that don’t maintain snow cover? (Happened in PEI this winter)
- Consider seeding along with a grass crop for better C:N ratio
Multi-species mixtures

• Much to be learned on how different mixtures may help with some soil health attributes but may not help with others.
• How diverse is necessary?
• Multi-year mixtures to reduce tillage?

• PEI Potato Board & AAFC rotation trial (Aaron Mills) comparing 2 species (SS + FPM), 5 species (SS, FPM, BW, Mustard, Faba), and 12 species mixture in potato rotation. Started in 2018
Fall Root Lesion Nematodes (#/kg of soil)

- Green Peas: 1270
- Mustard: 1471
- Ryegrass: 1613
- Grass/Legume: 5392
- Barley/Wheat: 1836
- Sudangrass: 2664
Some Recommendations

• **Try one or two fields first** before making a large change to rotation crops. *Include a check strip!*

• Match the needs of the field with the strengths/weaknesses of the rotation crop.

• Do *Verticillium* and nematode testing when nothing actively growing in the spring to get the most accurate measurement of year over year effect of crops on pop’ns

• Same goes for soil OM – big difference between spring and fall conditions on numbers
Some Recommendations

• If trying to build or maintain soil OM...**consider the amount of tillage in rotation**, and whether there is an opportunity to reduce tillage passes.

• **Use of fall cover crops** to build soil OM is gaining traction, but important to understand effects on soil-borne diseases and pests.
Questions?

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Participating PEI Growers

PEI Potato Conference: Feb 19-20 - Red Shores, Ch’town