Historical Changes in Total and Recalcitrant Soil C of Wheat Cropping Systems in Pendleton, OR

Stephanie Jenck
• Carbon sequestration in soil
  • SOC pool 3.3x larger than atmosphere, 4.5x larger than biotic pool (Lal 2004)

• Organic carbon declined when soil was cultivated with conventional tillage, even with additions of manure (Rothamstead, Pendleton, Champaign, Columbia) (Reicosky et al. 1995)
  • If OC vulnerable to climate change and management, how are recalcitrant-C pools reacting? (Tubiello et al. 2007, Rusmussen et al. 1980, Buyanovsky et al. 1996)
• Soils reach an equilibrium after 60 years of cultivation (Jenny 1941)
  • Can long-term experiment (LTE) stations help to navigate and gain knowledge on carbon dynamics in soil?
  • Are models correctly depicting real-world data?
### Recalcitrant-C
- How much recalcitrant-C (non-hydrolyzable C) is in the soil of a till-based wheat cropping system?

### C-sequestering amendment
- Over time, does manure and pea-vine amendments increase %NHC in soil?

**Hypothesis:**
If manure is applied, there will be an increase and more %NHC in the soil than the control and pea-vine treatment.

**Questions/Hypothesis**
Future Goals:
• Compare data to CROPSYS model
• Producer’s expectations for long-term C storage

Gain knowledge of site data on long-term experiments (LTE) at Columbia Basin Agricultural Research Center (CBARC) to calculate effects of climate change and management

Impacts of Research
Soil/Plots

- Site: Pendleton, OR
- Climate: Semi-arid
- Precipitation: <18in/yr
- Soil: Walla Walla silt loam
- Management: W/F system, conventional tillage

Table 1. Treatment identification and field plot designation.

<table>
<thead>
<tr>
<th>Treatment No.</th>
<th>Field Plot</th>
<th>Organic-N Addition</th>
<th>Residue/Nitrogen Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1508</td>
<td>Manure¹</td>
<td>No burn, No nitro.</td>
</tr>
<tr>
<td></td>
<td>1518</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1509</td>
<td>Pea Vines²</td>
<td>No burn, No nitro.</td>
</tr>
<tr>
<td></td>
<td>1519</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1510</td>
<td>---</td>
<td>No burn, No nitro.</td>
</tr>
<tr>
<td></td>
<td>1511</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1520</td>
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</tr>
</tbody>
</table>

¹Manure = 10 tons/acre crop ²Pea Vines = 1 ton/acre crop
Note: All management strategies have been continuous since 1931.

Methodology
Methodology

Acid Hydrolysis
- 1g soil
- 6M HCl
- Digest for 16hrs
- Pour off supernatant
- Diluted and dried

%NHC = non-hydrolyzable carbon
- Resistant-C
- Ranges 30-70% of SOC (Paul et al. 2001)
- ~1400 years older than total SOC

Soil loss
- %NHC skewed with loss of soil particles (Plante et al. 2006)

\[
\%NHC = \frac{\left(\frac{gC}{kg \text{ sample}}\right)_{\text{after}} \times \frac{\text{mass}_{\text{after}}}{\text{mass}_{\text{before}}}}{\left(\frac{gC}{kg \text{ sample}}\right)_{\text{before}}}
\]
Organic C & N
- 0.2-0.3g dry soil
- %C and %N calculated using a CHN dry combustion analyzer

Carbonates had to be identified as they can misinterpret C data (Paul et al. 2000)
- HCl-test
Figure 1. %NHC compared to depth through time in manure and pea plots. All available depth measurements were applied on graph.
Figure 2. Total C and NHC through time. All depth measurements were averaged to the 1<sup>st</sup> and 2<sup>nd</sup> foot.
Figure 3. Estimated C content of soil in the 1st ft, using averaged data.

Figure 4. %C retained in soil (1st ft.) by estimating amount of C applied vs. actual soil tests. Averaged 1st ft data used.
**Conclusion**

- %TC constant in manure/pea
- Carbon retained in pea treatment, not manure
  - C:N ratio of manure smaller than pea vines (Rasmussen et al. 1980)
- %NHC decrease through time
  - NHC being lost/utilized in soil top foot
  - Attempt no-till system, where manure show largest pool of NHC (Lorenz et al. 2006)
  - Age of NHC create difficulty determining fluctuation
- Modify hydrolysis procedure to account for lost C

**Limitation**

- Soil loss during procedure
  - NHC is 30-70% SOC, so change may only be determined in size of pool (Paul et al. 2001)
  - Greater %NHC in silt-size fraction (Plante et al. 2006)
Climate change and carbon sequestration in soil

- Is it worth time and effort?
- Are producer’s going to benefit?
Thank you for your time!

Acknowledgements

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Questions?


