1. INTRODUCTION

Fire transforms soil organic matter (SOM) into stable forms of organic carbon compounds rich in condensed aromatic rings collectively known as pyrogenic organic C (PyC). Wildfires are becoming larger and more catastrophic in the Western US, likely transferring more PyC to soils. However, the factors controlling the dynamics of PyC and its influence on ‘native’ SOM mineralization rates are not fully understood. We addressed this gap in PyC research by using a stable isotope (13C) labeling technique to trace the fate of 13C-enriched PyC produced from Pinus banksiana into two C pools (CO₂, and dissolved C) in surface and subsurface soils. This allowed us to answer the following questions:

• How are mineralization rates of PyC and its losses from soils as dissolved C) in surface and subsurface soils. This allowed us to answer the

2. MATERIALS AND METHODS

7-month laboratory incubation study

• We used dual-labeled (13C and 15N) jack pine PyC produced at 300°C and 450°C (Table 1, Hatton et al. 2016).

Table 1. Chemical composition and physical properties of PyC 300 and PyC 450. Modified from Hatton et al. (2016).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Yield</th>
<th>Total C</th>
<th>N</th>
<th>O</th>
<th>H</th>
<th>CN</th>
<th>CHN</th>
<th>CHN/CH</th>
<th>PyC (%)</th>
<th>aP</th>
<th>bP</th>
<th>aKN</th>
<th>bKN</th>
<th>Particle density</th>
<th>Bulk density</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1300</td>
<td>45</td>
<td>609</td>
<td>5.4</td>
<td>286</td>
<td>46</td>
<td>124</td>
<td>0.8</td>
<td>0.3</td>
<td>2.57</td>
<td>18.8</td>
<td>20.8</td>
<td>1.33</td>
<td>0.33</td>
<td>75</td>
<td>4.3</td>
</tr>
<tr>
<td>J1500</td>
<td>27</td>
<td>785</td>
<td>5.4</td>
<td>187</td>
<td>29</td>
<td>145</td>
<td>0.4</td>
<td>0.2</td>
<td>2.03</td>
<td>15.9</td>
<td>15.2</td>
<td>2.05</td>
<td>0.15</td>
<td>63</td>
<td>13</td>
</tr>
</tbody>
</table>

- Surface (0-10 cm) and subsurface (50-70 cm) forest soils (Muskellongue series; fine-loamy, mixed, mesic; Ulicic Haploxeralf, Dahlgren et al. 1997) were incubated with and without added PyC.
- Incubation was conducted in the dark at 55% soil field capacity and 25°C.

Measurements

• 13C-CO₂ was measured periodically to determine the proportion of PyC in total CO₂ respired from soil.
• 13C-DOC was measured once a month to determine the proportion of dissolved PyC in total DOC lost from soil during leaching (<0.45 μm particle size).

3. RESULTS AND DISCUSSION

3.1 PyC losses from soil as CO₂ after 7 months of incubation

PyC formed at 300°C mineralized faster than that formed at 450°C, whereas soil depth had no effect on the mineralization rates of PyC.

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3.2 Total PyC leached from soil as dissolved PyC after 4 months of incubation

The addition of PyC 300 significantly decreased the proportion of native SOM mineralized from surface soils.

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- It is possible that the addition of PyC 300 to soils led to significant shifts in microbial community structure, with microorganisms preferentially degrading PyC 300 over native SOM.

4. CONCLUSIONS

• Our results suggest that fire application temperature affects the chemical and physical characteristics of PyC, therefore controlling the behavior of PyC in soils.
• PyC formed at 450°C is more stable in soils than PyC 300°C. This was reflected in losses of PyC as both CO₂ and DOC.
• Additions of PyC formed at 300°C inhibited the mineralization rates of native SOM.

- Our results suggest that one year after fire or application in soil, PyC formed at lower temperatures will degrade faster than that formed at higher temperatures.
• These results highlight the importance of considering formation temperature when using PyC (or biochar) as a means to sequester carbon in soils.

Future directions:

Analysis:

• 13C- phospholipid fatty acids
• Solid and liquid-state 13C-NMR
• Density fractionation of SOM

ACKNOWLEDGMENTS

UC-Davis, Stable Isotope Facilities Funding for this study was provided by NSF CAREER grant (to A.A.B.).

References

Dahlgren et al. Geoderma (1997)
Hatton et al. Biogeochemistry (2016);