Bioavailability of metsulfuron and sulfentrazone herbicides in soil as affected by amendment with two contrasting willow biochars.

Anna M. Szmigielski¹, Ryan D. Hangs, Jeff J. Schoenau¹
¹Dept. of Soil Sci., University of Saskatchewan

Introduction
There are multiple environmental and agronomical benefits of biochar addition to soil. Due to their porous structure, biochars sorb and retain a variety of organic compounds from soil including soil-applied herbicides. The degree of sorption may vary depending on the biochar physical and chemical properties and its application rate [1].

Objectives
This study investigated the effect of two willow biochars (Salix spp) produced using either fast (at 400°C) or slow (up to 750°C) pyrolysis on the bioavailability of metsulfuron and sulfentrazone herbicides in soil.

Materials and Methods
- Five rates (0, 1, 2, 3, 4%; w/w) of each biochar (Table 1) were used, along with varying rates of metsulfuron (0 to 3.2 µg ai kg⁻¹) and sulfentrazone (0 to 200 µg ai kg⁻¹).
- To measure herbicide bioactivity in soil with added biochar, a sugar beet bioassay in WhirlPak™ bags was used [2] (Fig. 1).

Table 1. Selected physical and chemical properties of willow biochar produced using slow (at 400°C) or fast (up to 750°C) pyrolysis.

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>H</th>
<th>O</th>
<th>N</th>
<th>Ash</th>
<th>pH</th>
<th>SSA*</th>
<th>CEC</th>
<th>Bulk density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast</td>
<td>70.7</td>
<td>3.6</td>
<td>12.0</td>
<td>1.4</td>
<td>9.5</td>
<td>3</td>
<td>26</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td>Slow</td>
<td>81.3</td>
<td>1.9</td>
<td>3.9</td>
<td>0.7</td>
<td>10.6</td>
<td>9.7</td>
<td>175</td>
<td>20</td>
<td>1.16</td>
</tr>
</tbody>
</table>

*Specific Surface Area

Results
- The fast-pyrolysis biochar had minimal effect (Fig. 2a and 3a), while the slow-pyrolysis biochar decreased the bioavailability of both herbicides (Fig. 2b and 3b).
- Despite using the same feedstock, the two biochars had different physical and chemical properties (Table 1), of which specific surface area was most contrasting (3.0 and 175 m² g⁻¹ for fast- and slow-pyrolysis biochar, respectively).

Fig. 2. Sugar beet root length inhibition in response to metsulfuron in soil amended with increasing concentration of (a) fast-pyrolysis biochar (b) slow-pyrolysis biochar.

Fig. 3. Sugar beet shoot length inhibition in response to sulfentrazone in soil amended with increasing concentration of (a) fast-pyrolysis biochar (b) slow-pyrolysis biochar.

Conclusions
Although increased adsorption associated with the high-surface area biochars is useful from the environmental perspective, further research on how biochars influence the efficacy of soil-active herbicides is needed as biochar may have negative effect on weed control for years to come.


Acknowledgements: Financial support from NSERC and Saskatchewan Ministry of Agriculture is gratefully acknowledged.