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

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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.

Biochar	C %	H %	O %	N %	Ash %	pH	SSA* $m^2\ g^{-1}$	CEC Meq $100g^{-1}$	Bulk density $g\ cm^{-3}$
Fast	70.7	3.6	12.0	1.4	10.9	9.5	3	26	1.39
Slow	81.3	1.9	3.9	0.7	10.6	9.7	175	20	1.16

*Specific Surface Area

Fig. 1. Bioassay performed in WhirlPak bags.

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 $m^2\ g^{-1}$ for fast- and slow-pyrolysis biochar, respectively).

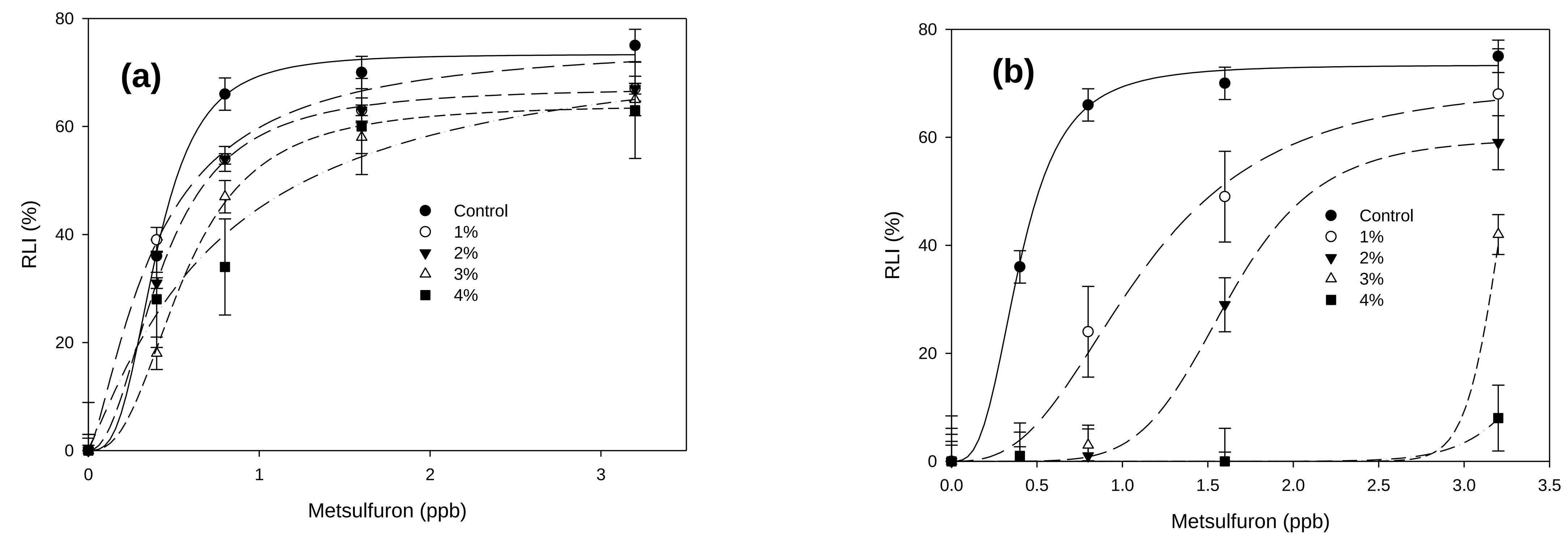

Fig. 2. Sugar beet root length inhibition in response to metsulfuron in soil amended with increasing concentration of **(a)** fast-pyrolysis biochar **(b)** slow-pyrolysis biochar.

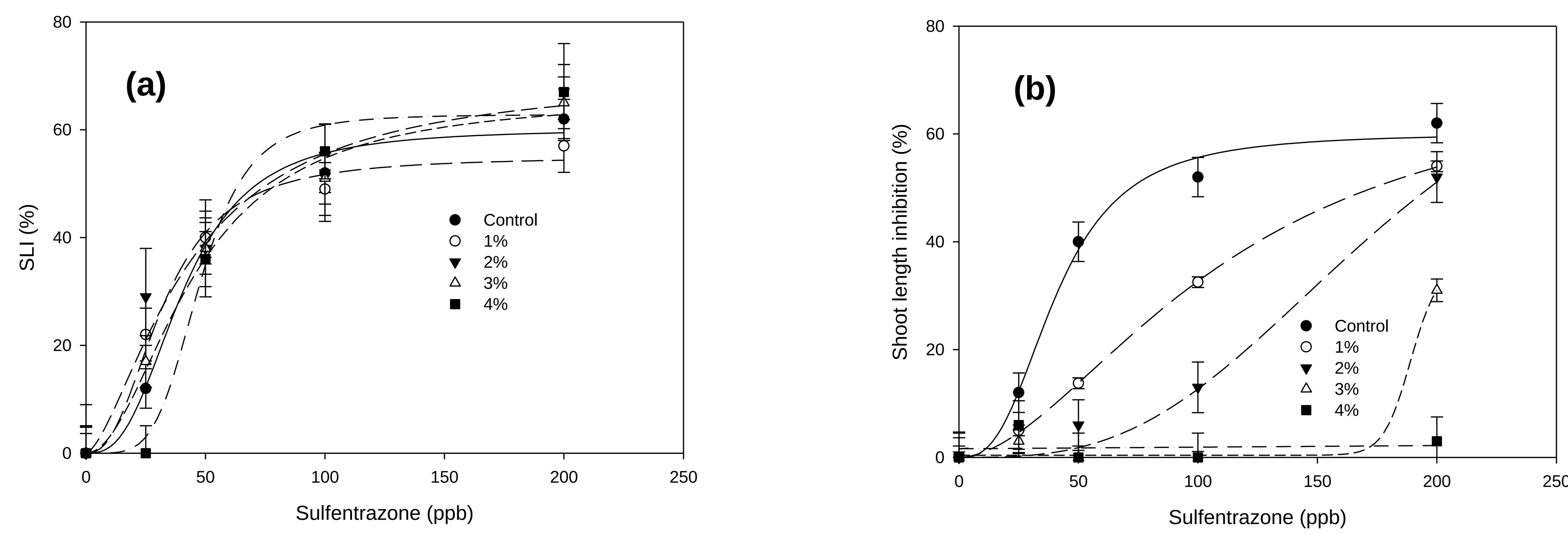

Fig. 3. Sugar beet shoot length inhibition in response to sulfentrazone in soil amended with increasing concentration of **(a)** fast-pyrolysis biochar **(b)** slow-pyrolysis biochar.

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.

References: *[1]Graber et al 2012 Plant Soil 353:95*
[2] Szmigielski et al 2018 Bull Environ Contam Toxic 100:298

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