Using Willow and Wheat Straw Biochar as a Soil Amendment in the Reclamation of Saline Soils

University of Saskatchewan

Blake N. Weiseth[1] and Jeff J. Schoenau[1]
[1]Dept. of Soil Sci.,University of Saskatchewan

Introduction

Excessive amounts of soluble salts within the soil profile represent a significant yield-limiting factor. Plant growth in these soils is inhibited due to 1) osmotic effects, whereby water uptake is reduced, and 2) specific ion effects, in which certain ions become toxic to plants or the uptake of essential ions is impeded (Brady and Weil, 2008).

Biochar is a substance that is produced by pyrolysis of feedstock under oxygen limited conditions at temperatures between 350 and 600°C (Sohi et al., 2010). Several physical properties of biochar support its potential use as a soil amendment in the reclamation of salt-affected soils. Biochar is stable, inert, and possesses a high surface area to adsorb nutrients due to its small particle size (Jiang et al., 2012).

Objectives

The objective of this study was to determine the ability of two biochars derived from two different feedstocks to reduce the adverse effects of salt contamination of a soil.

Materials and Methods

- The soil used was a loamy Brown Chernozem collected from a farm field south of Swift Current,SK.
- Willow and wheat straw biochar were added at two rates (0 and 20 T ha^{-1}) to three soils:

1) a naturally saline soil (Agricultural Saline)
2) a soil affected by NaCl brine from a pipeline leak (Simulated Spill)
3) a non-saline soil (Agricultural Control)

- Canola (*B. napus*) was grown in a four week pot study and biomass yield determined.
- An acid digest of the dry plant matter was completed (Thomas et al., 1967) and an ammonium acetate extraction was conducted on all soil treatments. Sodium and calcium were measured.

References: *Brady and Weil, 2008. Pearson Prentice Hall. Upper Saddle River, New Jersey.*
Chapman and Kelly. 1930. Soil Sci. 30: 391-406.
Jiang et al., 2012. Journal of Hazardous Materials. 229-230: 145-150.
Sohi et al., 2010. Academic Press, Burlington. p. 47-82.
Thomas et al., 1967. Agron. J. 99: 240-243.

Effect of Biochar Addition on Biomass Production

The soil utilized (saline vs non-saline) had a strong influence on canola biomass production, with highest yield on the non-saline Agricultural Control (Figures 1 and 2). Overall, canola biomass production after four weeks was not significantly affected by biochar application.

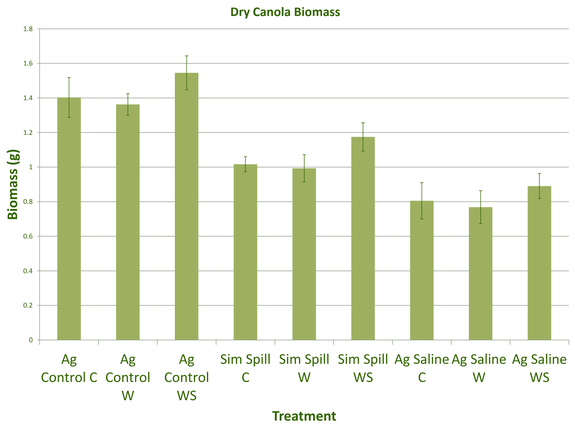

Figure 1. Average canola biomass according to soil and treatment. W denotes willow biochar, WS denotes wheat straw biochar and C denotes Control. Bars are standard error.

Figure 2. Photos of plant treatments one month of growth. Agricultural Control (above left), Agricultural Saline (above right), and Simulated Spill (below).

Effect of Biochar Addition on Na Concentration in Dry Plant Matter

The soil utilized influenced tissue Na concentrations, with greater soil sodium in salt affected soil associated with increased uptake and concentration of Na in canola tissue (Figure 3). Biochar did not signficantly affect canola sodium content.

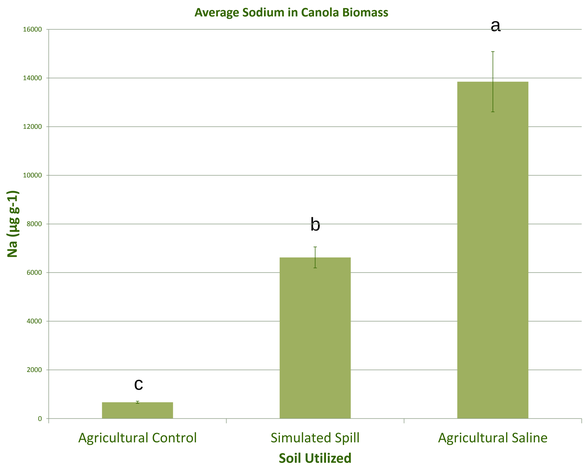

Figure 3. Average sodium concentrations in canola dry biomass (µg Na g^{-1}) by soil utilized. Values followed by a different letter are significantly different at p<0.10.

Effect of Biochar Addition on Ca Concentration in Soil

Higher soil Ca concentrations were observed when willow biochar was applied to the soil compared to either the control treatment or when wheat straw biochar was applied (Figure 4).

This may be expected given the high content of Ca found within the willow biochar compared to the wheat straw biochar (33.74% and 4.81% respectively).

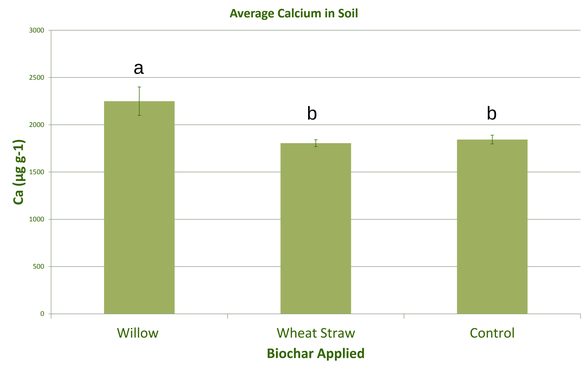

Figure 4. Average exchangeable calcium concentrations in soil (µg g^{-1}) as affected by biochar amendment. Values followed by a different letter are significantly different at p<0.10.

Effect of Biochar Addition on Soil pH and Electrical Conductivity

Treatments receiving the addition of either willow or wheat straw biochar were found to have a higher pH than the control treatment (Figure 5). The liming effect of the biochar is explained by the high content of Ca and Na carbonates and oxides present in the biochar.

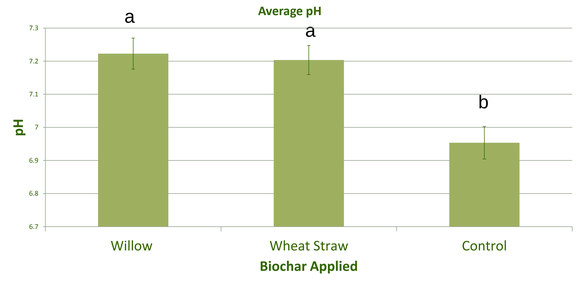

Figure 5. Average soil pH values according to biochar applied.Values followed by a different letter are significantly different at p<0.10.

Biochar addition did not significantly affect soil electrical conductivity.

Conclusion: The two biochars had a liming effect but did not mitigate the effects of high salt load in this prairie soil.

Acknowledgements: Financial support by the Agriculture Development Fund