The Residual Effect of Biochar and Animal Manure Amendments on Soil Properties, Canola Yield, and Fertilizer ^{15}N Recovery

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INTRODUCTION

- Previous research on biochar amendment has concentrated on tropical soils (old and highly-weathered), while the influence of biochar application on the relatively young and fertile soils of Saskatchewan has received less attention.
- The utility of biochar to improve numerous soil physical, chemical, and biological properties (e.g., bulk density (BD), cation-exchange capacity, salinity (EC), pH, and microbial activity) is well known. Aging of the biochar in soil may also influence its behavior.

OBJECTIVE

- Examine the residual effects of two willow (*Salix*) biochar amendments, with and without the addition of animal manures, on soil properties, crop growth, and ^{15}N recovery.

MATERIALS & METHODS

- A split-plot experimental design was used in field trials to grow barley (cv. Austenson; 2013) and canola (cv. LL150; 2014) on two contrasting soils: Orthic Brown Chernozem (Ardill Association; Class 4) and Orthic Humic Vertisol (Melfort Association; Class 1).
- Whole plots: Application in spring 2013 of 100 kg N/ha as solid cattle or liquid hog manure. Split-plots: 8 Mg C/ha as willow 'chunky' or 'powder' biochar (produced using slow and fast pyrolysis, respectively).
- Variables: recovery of broadcast $^{15}NH_4{}^{15}NO_3$ fertilizer; soil pH, EC, BD, SOC, total nitrogen (N) and phosphorus (P); and canola yield.

RESULTS & DISCUSSION

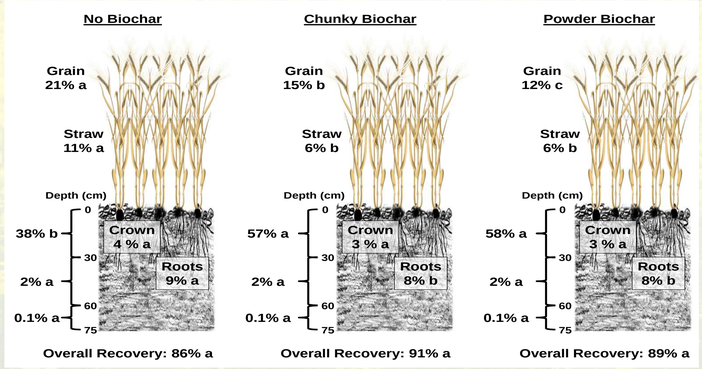

Figure 1. Mean (n = 8) fate of broadcast ^{15}N-labelled fertilizer after the first growing season at Melfort and Central Butte combined. Note: Corresponding fertilizer ^{15}N sink (e.g., barley grain) with the same letter are not significantly different (P >0.05) using LSD.

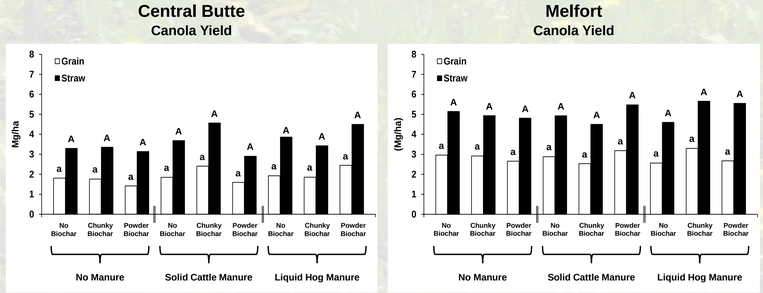

Figure 2. Mean (n = 4) canola biomass (grain + straw) two years after willow 'chunky' and 'powder' biochar additions (8 Mg C/ha), with and without N (100 kg N/ha) added via solid cattle manure or liquid hog manure. For each site, columns with the same letter (and case) are not significantly different (P >0.05) using LSD.

Table 1. Summary of ANOVA examining the residual effects of willow 'chunky' and 'powder' biochar in fall of 2014, two years after addition (8 Mg C/ha), with and without N (100 kg N/ha) added via solid cattle manure or liquid hog manure.

Effect	Total N (kg/ha)	Total P (kg/ha)	SOC[b] (%)	pH	EC[c] (µS/cm)	BD[d] (g/cm³)
Site	<.0001	**<.001**	<.0001	**<.0001**	<.001	<.0001
Manure	0.604	0.184	0.788	0.199	0.008	0.667
Biochar	0.03	0.221	0.013	0.217	0.31	<.0001
Site*Manure	0.059	0.596	0.432	0.909	0.939	0.12
Site*Biochar	**0.027[a]**	0.075	**0.004**	0.24	0.753	0.989
Site*Manure*Biochar	0.181	0.568	0.29	0.799	**0.033**	**0.038**

[a] Significant (*P* <0.05) effects are highlighted; [b] Soil organic carbon; [c] Electrical conductivity; [d] Bulk density

- Less ^{15}N recovery in the grain and straw, and more ^{15}N in the surface soil in biochar-amended soils (Fig. 1), suggests sorption or immobilization of inorganic N by biochar is occurring.
- The greater canola yield at Melfort (Fig. 2), reflects the better soil fertility and precipitation at this site compared to Central Butte.
- The limited residual effects of biochar after two years on soil properties (Table 1), is attributed to the inherently good quality of these soils. For example, biochar increased SOC levels, but the effects were small, and only significant in the Central Butte soil.

CONCLUSION

- Biochar may initially tie-up available N in prairie soils. Biochar and manure amendments had limited residual impact on soil properties and canola yield two years after application. Higher rates (i.e., >10 Mg/ha) may be required to produce large, long-lasting effects.

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