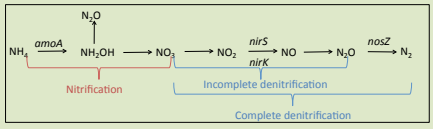
Biochar and fertilization levels on plant production and N losses.

Engil Pereira, Rafaela Conz, and Johan Six
Dept. of Plant Sciences, Univ. of California, Davis, One Shields Ave, 95616 Davis, CA.
email: isapereira@ucdavis.edu

Introduction

The incorporation of biochar in soils has been proposed as an approach to reduce N losses via leachate and nitrous oxide (N_2O) emissions. Alkaline biochars increase soil pH and consequently cation exchange capacity (CEC). Increases in soil CEC can prevent N losses via leachate and therefore, reduce groundwater N contamination.

Concomitantly, an increase in soil pH also leads to complete denitrification of nitrate, where N_2O is reduced to N_2. Therefore, biochar could also decrease N losses via N_2O by promoting the complete denitrification process.



These responses may be limited by the type of biochar and the amount of N applied during the fertilization events. In this study, we will investigate whether biochar alters N losses (i.e.: N leachate and N_2O) and plant growth across a gradient of N fertilization rates. We will also investigate two types of biochar: A walnut shell (WS) biochar produced at high temperatures and a pine chip biochar (PC) produced at moderate temperatures (Table 1).

Hypotheses

- Increases in soil CEC promoted by biochar amendment will decrease N lost via leachate. We predict that this effect will be more pronounced at low N fertilization rates, since soil may reach a saturation of N retention at high fertilization rates.
- We also hypothesize that increases in soil pH will promote denitrification and therefore decrease N_2O emissions.
- WS biochar may induce more pronounced effects compared to PC biochar due to its higher pH and significant effect on soil CEC (Figure 1).

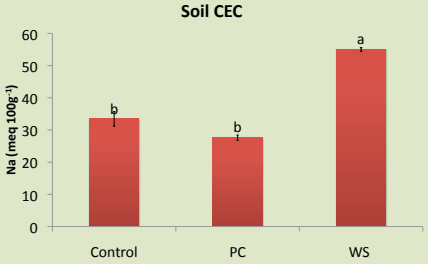


Figure 1: Soil CEC in biochar amended-soil.
*Means with the same letter are not significantly different from each other (Tukey test, p<0.05).

Materials and Methods

Table 1. Soil characteristics:

Yolo Silt Clay Loam	
C (%)	1.22
N (%)	0.13
Soil pH	7.5
Sand (%)	18.8
Silt (%)	47.7
Clay (%)	33.6

We carried out a greenhouse experiment to compare two biochar materials (10 tons per hectare) and five N fertilization treatments. We applied 0%, 25%, 50%, 75%, and 100% of 225 kg of N per hectare. We used feather meal (organic) as N source. The indicator crop was lettuce (*Lactuca sativa*) and was cultivated for two growing seasons.

Table 2. Biochar feedstock origin and production information:

Biochar	Source Material	Pyrolysis T°C	Biochar CEC (meq 100g^{-1})	Biochar pH
WS	Walnut shell	900	33.4	9.7
PC	Wood Chips	550	3.2	7.9

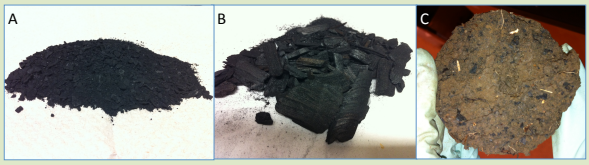


Figure 2: A) Walnut shell biochar. B)Wood chip biochar. C) Soil amended with walnut shell biochar.

N lost via leachate

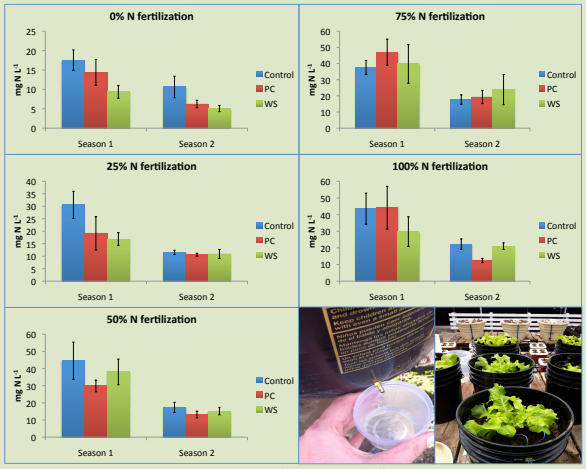
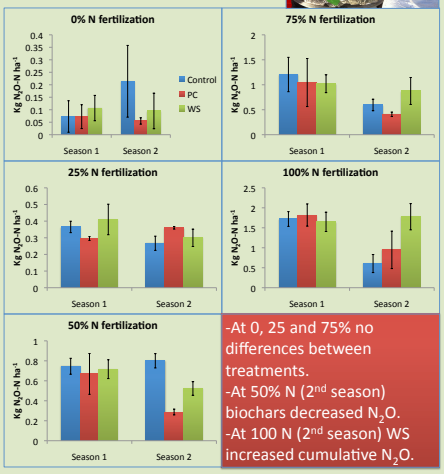


Figure 3: N lost via leachate during two growing seasons of Lettuce across five fertilization rates in biochar amended soil.

- WS biochar decreased N lost via leachate only at 0 and 25% N fertilization rate.

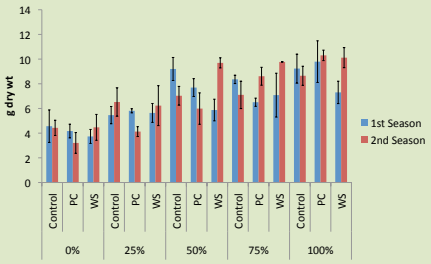
N_2O fluxes

Gas samples were collected weekly and for 7 days after a fertilization event. Here we show the cumulative N_2O fluxes per growing season:



-At 0, 25 and 75% no differences between treatments.
-At 50% N (2nd season) biochars decreased N_2O.
-At 100 N (2nd season) WS increased cumulative N_2O.

Plant Biomass



Plant biomass was minimally affected by biochar treatments.

Conclusions

- Based on our results, biochar can work as an approach to decrease N losses via leachate, but only at low N fertilization rates.
- Under the conditions of this study, biochar had minimal and inconsistent effects on N_2O emissions and plant growth.

Acknowledgements

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