Field maize yield and yield determining factors for four years following biochar application on a Colombian savanna Oxisol

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Introduction

Biochar is known to improve crop yields. However, few field-based, multi-year studies have been published on the topic. Here we report on a field study carried out on an infertile Oxisol of the Colombian savanna. This experiment was undertaken to determine the yield improvement potential of biochar on highly weathered soil, and to monitor soil parameters. The actual field design included plots managed under a perennial *Brachiaria* pasture grass, as well as plots where native savanna vegetation was left to re-colonize. All plots were also monitored for greenhouse gas emission, hydrology and nutrient leaching.

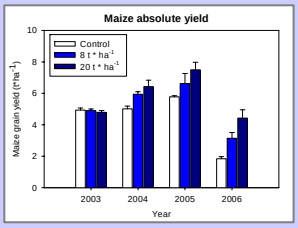
Materials and Methods

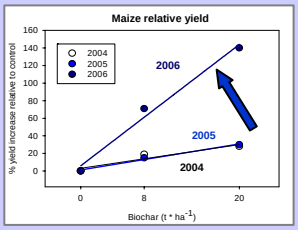
This field experiment was located in the Eastern Savannas of **Colombia** (N 04º10'15.2", W072º36'12.9"). The soil is a Tropeptic Haplustox, and average annual temperature is 26°C. Annual rainfall in the region is 2200mm, and 95% of rain falls in the rainy season which extends from April to November. Initial vegetation consisted of native savanna grasses. Biochar was commercially made using the traditional technique of piling *Acacia mangium* Willd. logs and ground to pass a 5 mm mesh. In December 2002, plots were chisel plowed, **lime** was applied at 2.2 t*ha-1 and incorporated to 30 cm with 2 chisel plough passes. Nine days later **biochar** was applied in a RCBD with 3 replicates and disked in to 5 cm. Application rates were 0, 8 and 20 t*ha^{-1}. **Lime and biochar were applied on only one occasion.** In May 2003, 2004, 2005 and 2006, **maize** (*Zea mays* L.) was seeded by hand and all plots identically fertilized by hand at optimal rates. **Soil** was sampled upon harvesting maize in 2003, 2004 and 2006. Soil **pH** was measured in 1:2.5 soil:1N KCl, available nutrients by extracting with **Mehlich III** followed by **ICP** analysis. Plant tissue nutrient content was determined by digesting tissue with **HNO_3/H_2O_2** on a block followed by **ICP** analysis. C and N contents of all materials were determined by combustion in a **C/N analyzer**.

Results and discussion

Maize yield

Maize yield was increased by up to 140 % by biochar additions

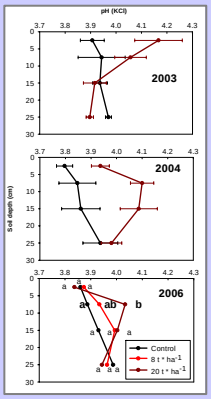




Relative yield was increased most in 2006, when absolute yields plummeted

Soil pH

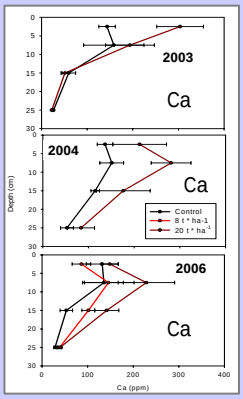
Soil pH was increased by biochar most in 2004



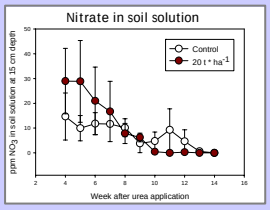
Since the greatest yield increase from biochar was observed in 2006 and the greatest pH increase in 2004, pH is likely not a major determining factor in biochar yield increases

Soil nutrients

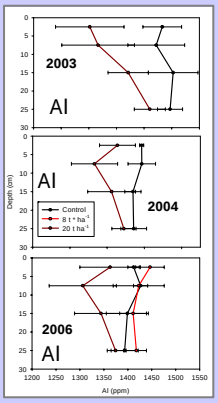
Biochar led to increases in Mehlich III extractable **Ca**, **Mg**, and **Mn**, with greatest differences in 2004



While total soil **N** did not vary among treatments, it is likely that N availability was greater with biochar



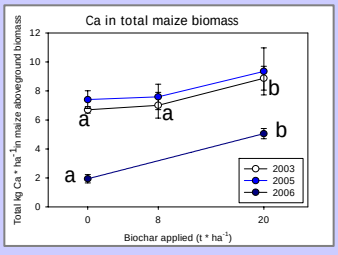
Similarly decreases were observed in extractable **Al** and **Fe**



Nutrients in maize biomass

Total uptake in maize aboveground biomass was increased with biochar additions for most nutrients in all years.

In 2006, this increase was significant ($p<0.05$) for more nutrients than in any other year.



Conclusions

Biochar application led to important increases in maize yield. This was especially true in the 4th year after biochar application, where yield was increased by 140%. While pH increased with biochar, it likely was not the main yield increasing factor since the greatest yield increase occurred 2 years after the greatest pH effect. Increased soil nutrient availability led to greater yields and greater total uptake by maize.