Nitrogen Dynamic in a Nitosol in Ethiopia Applied by Corncob Biochars

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2017 ASA-CSSA-SSSA International Annual Meeting, October 22-25, Tampa, Florida

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Introduction

Biochars are the carbon-rich product obtained when biomass such as wood, manure, and leaves is pyrolysed under limited oxygen, and usually used as soil amendment to improve soil environments. Biochars have high cation exchange capacity (CEC), and can improve soil CEC when applied. CEC-enhanced soils can retain nutrients such as NH_4^+, K^+, and Ca^{2+}, which may be plant available. Recently, designer biochars such as CEC-enhanced biochars have attracted interest to change and improve characteristics of biochars.

Objectives

Evaluating nitrogen dynamics in a Nitosol in Ethiopia applied with biochars with different CEC values

Materials and Methods

- Soil
  - Nitosol (0-15 cm, Jimma, Ethiopia)
  - Oven dried (45°C), 2 mm sieved for experiment

Table 1. Soil chemical characteristics

pH	NH_4^+-N (mg kg^{-1})	NO_3^--N (mg kg^{-1})	CEC (cmol+ kg^{-1})
5.76	5.97	11.8	14.7

- Anaerobic digestion effluent (ADE)
  - Derived from cow manure

Table 2. ADE chemical characteristics

pH	Total N (mg L^{-1})	NH_4^+-N (mg L^{-1})
8.04	3350	1254

- Biochars (feedstock: corncob)
  - Fresh biochar (no treatments; **FB**)
  - Clay-treated biochar (<106 µm sieved Nitosol; **CB**)
  - H_2O_2-treated biochar (15% H_2O_2; **HB**)

Pyrolysis conditions
- Highest treatment temperature (HTT): 500°C
- Heating rate: 10°C min^{-1}
- Retention time: 2h

Table 3. Selected properties of biochars

	pH	NH_4^+-N (mg kg^{-1})	NO_3^--N (mg kg^{-1})	CEC (cmol+ kg^{-1})
FB	8.55	2.36	14.0	20.9
CB	8.81	4.79	19.9	25.4
HB	8.01	8.38	21.3	49.4

- Experimental treatments
  - No amendment (**Cont**)
  - Nitrogen only (Ammonium sulfate (**AS**) and **ADE**)
  - Biochar only (FB, CB, and HB)
  - Combination of N sources and biochars
    - ⇒ Set up four replicate respectively, and fertilizers were applied as 100 kg N ha^{-1}.
- Incubation methods
  - Incubated at 30°C with 30% of water filed pore space
  - Sampling on 0, 1, 3, 5, 7, 14, 21, 28, 42, and 56 d
- Analyses
  - NH_4^+-N (indophenol blue method @640 nm)
  - NO_3^--N (cataldo method @410 nm)
  - pH (glass electrode method)

Results and Discussions

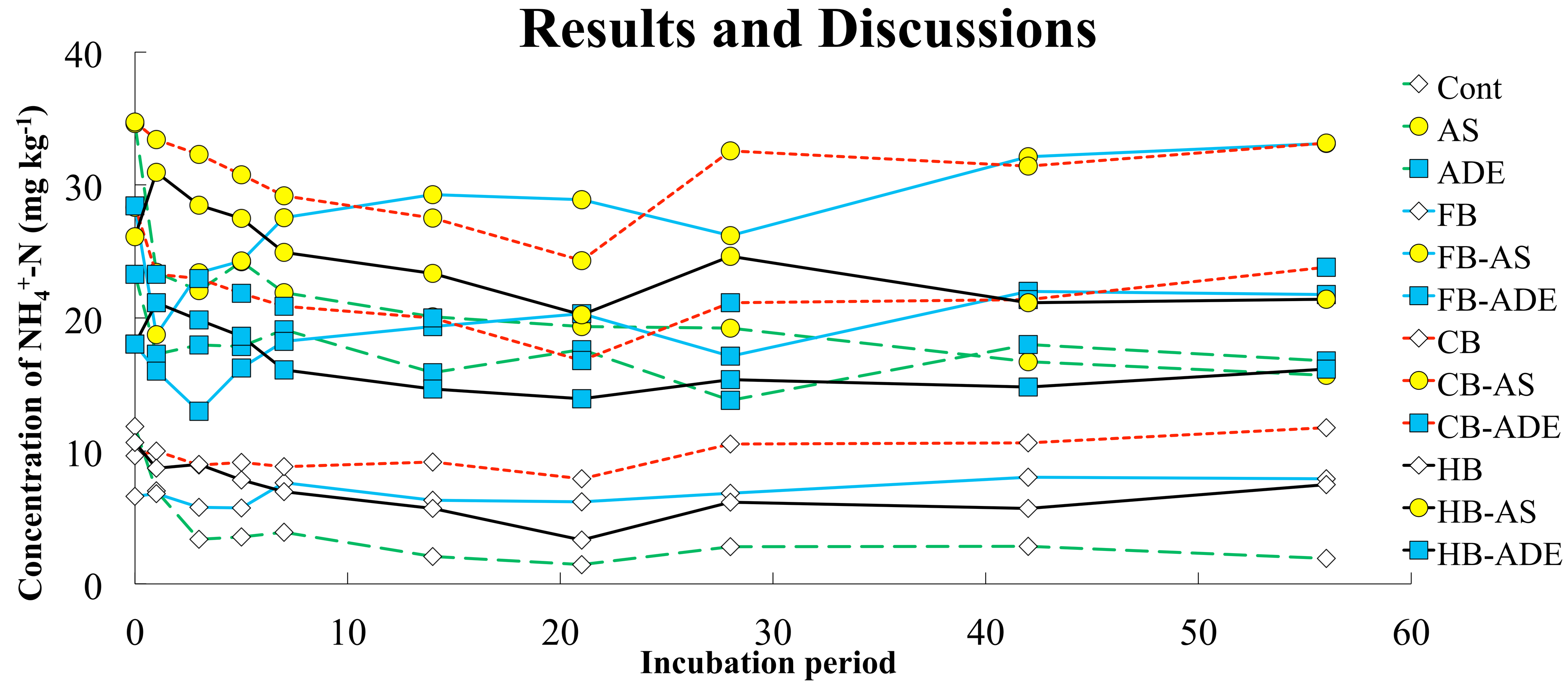

Fig. 1 NH_4^+-N concentration during incubation period

- **NH_4^+-N with FB and CB were increased, but that with HB was decreased.**
  - **→ More NH_4^+-N might be adsorbed strongly by HB with the highest CEC than FB and CB.**
  - **→ NH_4^+-N adsorbed on biochars might be released slowly over time.**

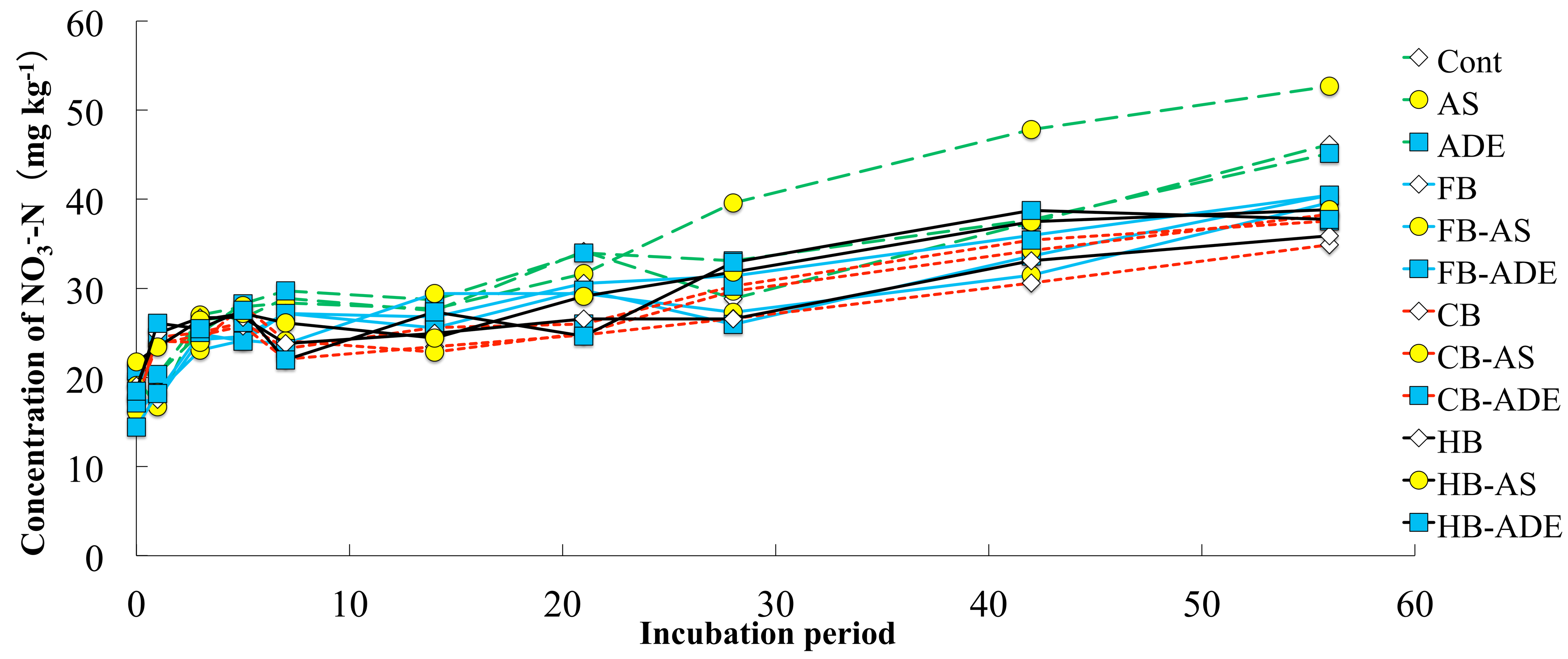

Fig. 2 NO_3^--N concentration during incubation period

- **NO_3^--N with biochar treatments were smaller than that of no-biochar treatments.**
  - **→ Nitrification might be inhibited by biochar amendment.**

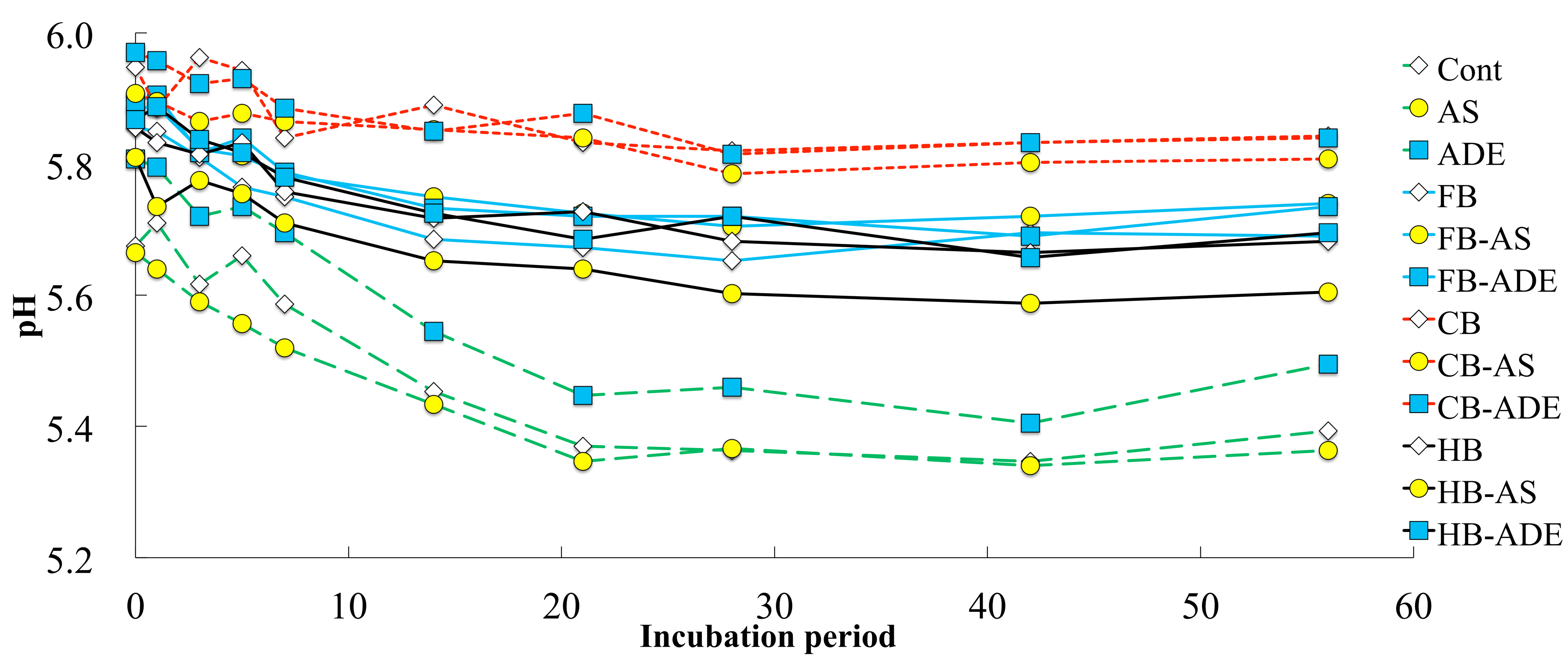

Fig. 3 pH changes during incubation period

- **pH with no-biochar treatments were decreased compared to that with FB, CB, and HB.**
  - **→ Biochars with high pH resulted in high soil pH.**
  - **→ Due to nitrification inhibited, pH with biochar treatments were higher than that of non-biochar treatments.**

Conclusions

- Biochar application caused higher NH_4^+-N and lower NO_3^--N compared with no-biochar treatment.
- Biochars might have retained NH_4^+-N and inhibited nitrification in the soil.
- Biochar application might be beneficial for nitrogen plant uptake in Ethiopian Nitosol.