Effects of biochar on gaseous carbon and nitrogen losses during composting of farm residues in northern Ghana

Delphine Manka'abusi[1], Christoph Steiner[1], Volker Haering[2], Abdul-Halim Abubakari[3], Bernd Marschner[2] and Andreas Buerkert[1]

[1]Universität Kassel, Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics (OPATS), Steinstrasse 19, D-37213 Witzenhausen, Germany

[2]Ruhr Universität Bochum, Soil Science and Soil Ecology, Germany; [3]University for Development Studies, Tamale, Ghana

Introduction

Adding biochar to nutrient rich organic matter during composting reportedly reduces nitrogen (N) volatilization and carbonization of feedstock stabilizes organic carbon (C). A biochar-compost may foster long-lasting soil organic matter buildup while providing nutrients to crops. We studied the effects of biochar, produced from agricultural residues as compost additives on gaseous C and N fluxes in northern Ghana.

Highlights

- Compost mixtures containing biochar showed lower decomposition rates
- Rice husks biochar most strongly reduced CO_2-C and N_2O-N emissions
- Carbonization of feedstock is an option to reduce C and N losses

Methods

- Three biochar types (corn cobs, cCC; rice husks, cRH; and wood cWO) or their uncharred feedstocks (CC, RH and WO), were co-composted at 25 vol.% addition with poultry manure (15 vol.%) and rice straw (60 vol.%) at 3 replicates.
- During the 34-day experiment, compost was regularly mixed and water content adjusted.
- During composting, losses of CO_2-C, N_2O-N and NH_3-N were measured using a closed chamber system (INNOVA 1312-5).

Figure 1 Initial filing of compost bins at UDS Nyakpala campus

Figure 2 Photo-acoustic infrared gas analyser (INNOVA 1312-5)

Figure 3 Un-carbonized and carbonized feedstocks used for composting

Results

CO_2 emission rates

- CO_2 emission rates were higher during initial composting phase in biochar amended composts, then dropped below the feedstock composts (Fig. 4)
- Thermophilic phase lasted longer in composts without biochar (Fig. 6)
- Emission rates and temperature were positively correlated (r = 0.519, *p < 0.001*).

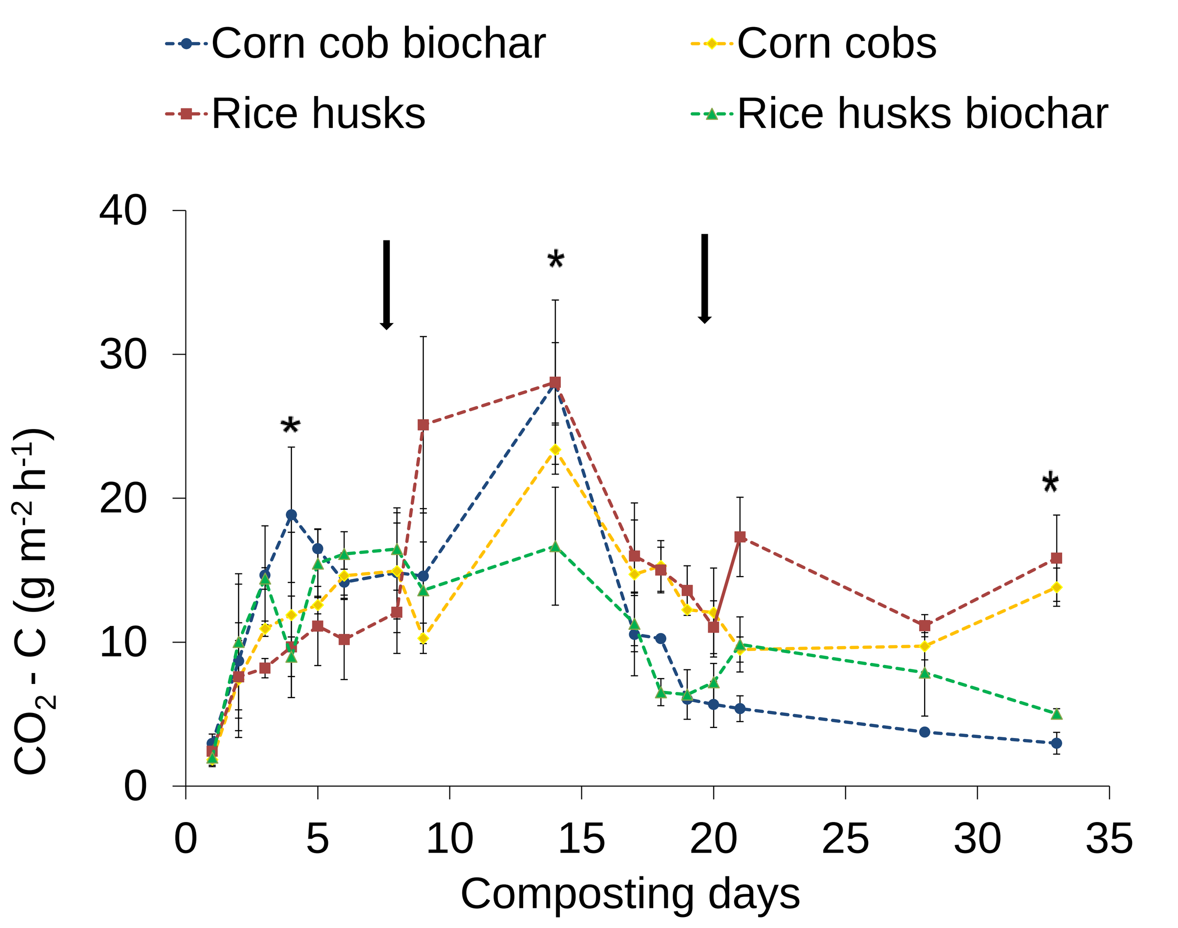

Figure 4 Fluxes of CO_2-C for different feedstocks during composting. Data show mean (n=3) ± one standard error. Arrows indicate water input, * indicate a significance level of *p<0.05*

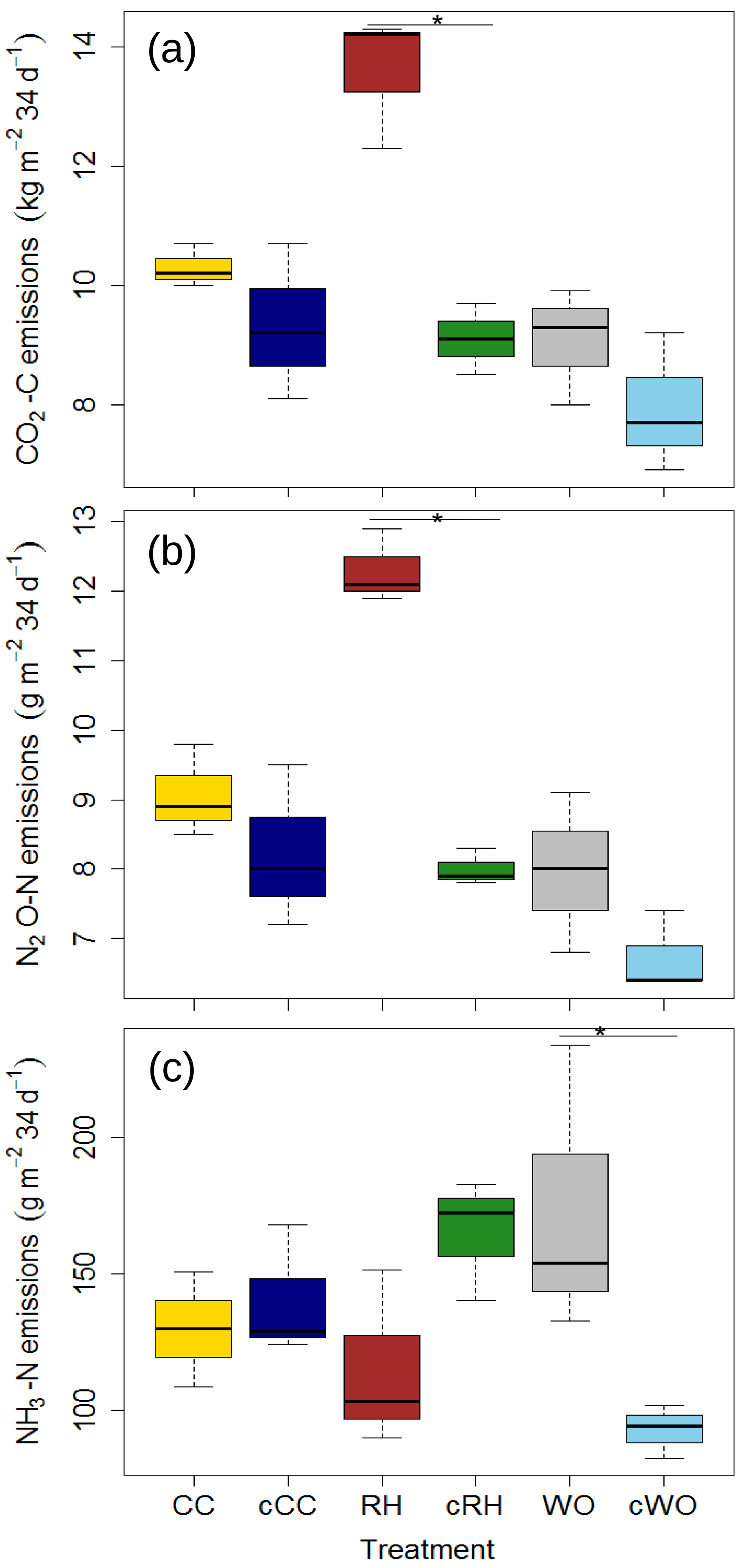

Figure 5 Cumulative emissons of (a) CO_2-C (b) N_2O-N and (c) NH_3-N after 34 days of composting different compost mixtures (n=3) * indicate a significance level of *p<0.05*

Cumulative C and N losses

- Total CO_2-C losses always lower in biochar composts than in the respective feedstock composts (Fig. 5a)
- Reduced turn-over, likely a consequence of biochemical stability of biochar-C
- N_2O-N emissions also lower in cRH (35%), cCC (9%), and cWO (16%) compared with the uncharred feedstock (Fig. 5b)
- No consistent effects of biochar on the volatilization of NH_3-N (Fig. 5c)

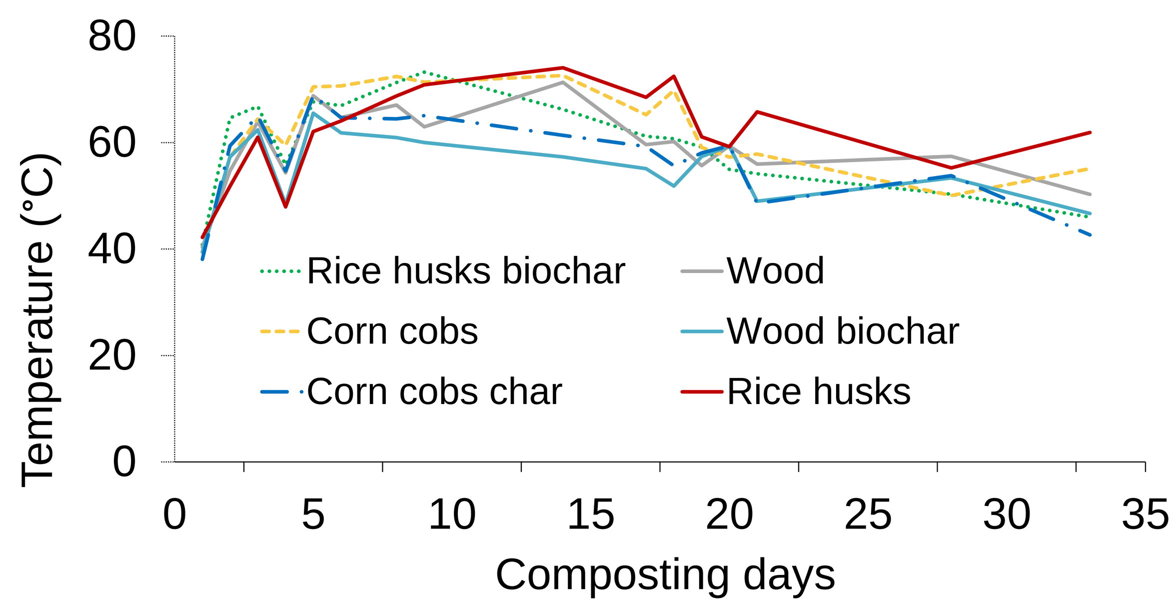

Figure 6 Temperature measured in composts at 0.10m depth during a composting period of 34 days for different compost mixtures. Data show mean (n = 3)

Acknowledgements This work was carried out within the UrbanFood[Plus] Project, funded by the German Federal Ministry for Education and Research and the German Federal Ministry for Economic Cooperation and Development under the initiative GlobE – Research for the Global Food Supply, grant number 031A242-A,B. We also thank our African partners.

www.urbanfoodplus.org