Tropentag, September 10-12, 2025, hybrid conference

"Reconcile land system changes
with planetary health"

Development of a pilot kiln and biochars characterisation for agriculture and carbon sequestration in Benin

Kocou Fortuné Adoko[1], Pocoun Damè Kombienou[1], Hessou Anastase Azontonde[1], Wim Cornelis[2]

[1] *National Institute of Agricultural Research of Benin (INRAB), Laboratory for Improving Soil Health, Water Quality and Environmental Protection (L2A2S2E), Benin*
[2] *Gent University, Dept of Evironment, Belgium*

Abstract

This study examines the production efficiency and agronomic quality of two biochars derived from agricultural residues common in Benin, rice husks (RH) and corn cobs (CC), using a low-cost, locally fabricated pilot kiln. The pilot kiln, which is fully manufactured from recovered materials, can be used as a top-lit updraft kiln or as a double drum kiln, using internal or external heat transfer (IHT & EHT), respectively. Using these two heat transfer modes and two types of biomass, four treatments were tested. Eighty production trials were carried out, and sixteen composite biochar samples were taken and analysed in the laboratory. Pyrolysis temperatures (PT) and biochar yield and properties were determined to assess kiln performance and biochar quality. The average PT recorded differed significantly between the two heat transfer modes, with 326.43 °C in EHT mode and 423.72 °C in IHT mode. Using the kiln in IHT mode significantly reduced the duration of pyrolysis process compared to EHT mode. Pyrolysis in EHT mode led to higher relative biochar yields (37.23 %) than in IHT mode (31.40 %). Using the kiln in IHT mode produced biochars with higher contents of organic C, P and minerals (Ca, K, Mg, Na, Fe, Al, Mn, Cu and Zn) than in EHT mode. Pyrolysis temperatures had no significant effect on most physical biochar properties except bulk density and particle density. Whatever the PT, both biochars showed good agronomic properties and met key quality criteria for soil carbon sequestration according to European Biochar Certificate and International Biochar Initiative standards. Both biochars had contents below 35 % and 40 %, respectively, corresponding to of over 35 %. A highly significant effect of feedstock and PT was observed on ash and volatile matter and fixed carbon content. The sum of exchangeable cations, Cation Exchange Capacity (CEC) and mineral content of the biochars differed non-significantly between feedstocks and PT. Given that one of the major constraints of tropical soils is their inherently low CEC, we expect better positive effects of RH biochar on soil and agricultural productivity, while CC biochar could generate greater long-term effects on soil carbon sequestration, due to its more recalcitrant nature.

Keywords: Biochar, carbon sequestration, heat transfer mode, kiln, pyrolysis temperature, soil quality

Contact Address: Kocou Fortuné Adoko, National Institute of Agricultural Research of Benin (INRAB), Laboratory for Improving Soil Health, Water Quality and Environmental Protection (L2A2S2E), Route iita, Abomey-calavi, Benin, e-mail: kocfor@yahoo.fr