Geophysical Research Abstracts
Vol. 16, EGU2014-6277, 2014
EGU General Assembly 2014

Biochar application to sandy and loamy soils for agricultural nutrient management

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Soil fertility of agricultural soils is challenged by nutrients losses and increasing soil acidification. Furthermore, leached nutrients negatively affect the quality of ground and surface water [1]. In addition to the possible soil carbon sequestration by applying biochars, many positive soil-improving properties are attributed to biochars. The application of biochars to agricultural – especially sandy – soils could reduce leaching of nutrients and may improve their availability [1,2]. Thus, biochar application to agricultural fields could be an ecologically and economically viable option to improve soils' fertility.

However, biochar properties strongly depend on their feedstock and production process [3]. Various types of biochars (pyrolysis char, hydrochar (produced at 200 and 250°C); feedstocks: digestate, Miscanthus and wood chips) were used to determine sorption kinetics and sorption isotherms for the major nutrients Ca, Mg, K, NH_4 and NO_3 as a function of biochar types in different soil substrates (sand, loess). In addition, the biochars were washed to create free binding sites on the chars' surface that simulate aged char. We compared the simulated aged char with biochars that was aged in-situ at a field experiment for seven months.

The first results showed that pyrochars have the largest retention potential for NO_3 and hydrochars have retention potential for NH_4. Washing of biochars turned them from a PO_4 and NH_4 source into an adsorber, especially for hydrochars. Highest leaching was observed for biochars from digestates likely due to the high nutrient content of digestates. But the different ions may lead to pH-dependent interactions between each other and the chars' surface that override the adsoption effects. In this context, cation-bridge and ligand bindings [4,5] need to be further investigated. Most of the fresh, unwashed biochars were a source of nutrients with hardly any detectable nutrient retention.

Pyrochars showed the highest potential for anion-retention and hydrochar was effective in cation-retention. The experiments provide first information on the uses of biochar for soil nutrient management in agriculture but observed effects were mostly minor under realistic char application rates.

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