Improvement of fertilizing efficiency and reduction of ammonia emissions from slurry by means of biochar and hydrochar

Kupper Thomas[1*], Brassel Hansueli[1], Graf Kurt M.[2], Bader Severin[1], Haeni Christoph[1], Mayer Jochen[3]

(1) Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences, 3052 Zollikofen, CH

(2) Bern University of Applied Sciences, Engineering and Information Technology, 3400 Burgdorf, CH

(3) Research Station Agroscope Reckenholz-Tänikon ART, 8046 Zürich, CH

*Corresponding author: thomas.kupper@bfh.ch

Introduction

Pyrolysis and hydrothermal carbonization (HTC) are thermochemical processes used for the treatment of organic residues allowing the sequestration of carbon. These processes require for low energy inputs or are self-sufficient. The chars derived from pyrolysis (biochar) and HTC (hydrochar) exhibit a porous structure and a vast specific surface. This structure provides the potential to sorb plant nutrients such as nitrogen (N). Application of biochars to soil revealed promising effects: carbon sequestration, improvement of soil fertility, reduction of greenhouse gases and pollutants such as heavy metals and pesticides [1].

Animal production produces emissions of reactive nitrogen (e.g. ammonia). Recent investigations have shown that biochars and hydrochars exhibit the potential to reduce such emissions [2,3].

Thus, the present study has the following targets:

- Production and physical-chemical characterization of specific biochars and hydrochars derived from different feedstock materials,
- Investigation of their capacity for sorption of ammonia in slurry,
- Study of ammonia emissions after application of slurry amended with biochars and hydrochars compared to non-amended slurry.

Material and Methods

The study includes the following steps:

- Production at the laboratory scale of biochars and hydrochars with a high capacity for the sorption of ammonia. Influencing parameters for the properties of the chars which include process temperature and duration, feedstock materials and conditioning of the chars (e.g. acidification, [4]) will be varied for the lots to be produced.
- Investigation of the sorption capacity for ammonia by means of batch tests for a series of the most promising chars mixed with the liquid phase of slurry derived from solid-liquid separation. Influencing parameters to be studied will be the dosage of the chars and the exposure time.
- Ammonia emissions after application of slurry amended with the biochars and/or hydrochars that exhibit the highest sorption capacity for ammonia will be compared with the emissions from non-amended slurry. These experiments will be carried out using wind tunnels and impinger sampling systems.

Results

Preliminary results of sorption experiments will be presented.

References

[1] Libra JA, Ro KS, Kammann C, Funke A, Berge ND, Neubauer Y, Titirici M-M, Fühner C, Bens O, Kern J, Emmerich K-H, 2012. Hydrothermal carbonization of biomass residuals: a comparative review of the chemistry processes and applications of wet and dry pyrolysis. Biofuels 2, 71-106

[2] Haeni C, Kupper T, Jocher M, Neftel A, Sintermann J, 2012.Amendment of biochar to slurry: a possibility to mitigate ammonia emissions? International Symposium on Emissions of Gas and Dust from Livestock, 10-13 June 2012, Saint-Malo, F

[3] Doydora SA, Cabrera ML ,Das KC, Gaskin JW, Sonon LS, Miller WP, 2011. Release of nitrogen and phosphorus from poultry litter amended with acidified biochar. International Journal of Environmental Research and Public Health 8, 1491-1502
[4] Vassileva, P., Tzvetkova, P., Nickolov, R., 2009. Removal of ammonium ions from aqueous solutions with coal-based activated carbons modified by oxidation. Fuel 88, 387-390.