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Potential of high organic carbon soil amendments to mitigate greenhouse gas and ammonia emissions from pig and cattle slurry treated soils

Xinyue Cao, Rüdiger Reichel, and Nicolas Brüggemann

Institute of Bio- and Geosciences, Agrosphere (IBG-3), Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

Nitrogen excess after animal slurry application is a persistent problem of intensive agriculture, with consequences for environmental pollution by ammonia (NH3), nitrous oxide emissions (N_2O), and nitrate (NO_3^--) leaching. High-carbon organic soil amendments (HCA) with large C:N ratio, such as wheat straw, already showed the potential to mitigate unintended N losses from soil without any slurry application (Reichel, Brüggemann et al. 2018). In this static laboratory incubation study with soil columns (25 cm in height and 5 cm in diameter), we tested the potential of wheat straw, sawdust, and two brown coal-related substrates (leonardite and humic substances) to mitigate N loss after amendment of soil with animal slurry. We compared pig and cattle slurry, and two application treatments: (1) mixing slurry and HCA overnight before application to soil, (2) adding slurry directly to HCA amended soil. We used a haplic Luvisol with a silty loam texture, a pH of 7.1, and an organic carbon content of 1.13 %. Both slurries were alkaline, with an average N content of 6.2 % dry matter. Application rates of slurry and HCA was in accordance to typical agricultural practice. The experiment was conducted over more than 60 days. An infrared laser gas analyser (PICARRO G2308) was used to quantify the emission of CO_2, N_2O, NH_3, and CH_4. N fractions such as NH_4^+, NO_2^-, and NO_3^- were extracted with 0.01 M $CaCl_2$ solution and quantified by flow injection analysis (FIA) and ion chromatography. P was extracted the same way and measured via inductively coupled plasma optical emission spectrometry (ICP-OES). A TOC/TN analyser was used to determine the DOC and N in $CaCl_2$-extracts before and after incubation with chloroform to quantify the microbial biomass. According to first results, leonardite clearly reduced NH_3 emissions of both slurries, with particular significance for pig slurry, where mixing of leonardite with slurry before soil application reduced the total NH_3 emission by 63% compared to the control treatment (soil + pig slurry). Most times, also the total N_2O emissions were reduced by leonardite. This effect was most significant if pig slurry and leonardite were added separately to soil, reducing the N_2O emission by 58% compared to the according control treatment. Mitigation of N loss was also observed for other HCA substrates, but less consistent compared to leonardite. Overall, the application of pig slurry led to a higher release of greenhouse gases than cattle slurry, emphasizing the need of strategies like HCA to reduce unintended N_2O and NH_3 emissions from animal slurry amended soils.

Reichel, R., N. Brüggemann, P. Schröder, M. Schloter, M. S. Islam, C. Schmid, J. Wei and H. J. F. i. P. S. Wissel (2018). "Potential of Wheat Straw, Spruce Sawdust, and Lignin as High Organic Carbon Soil Amendments to Improve Agricultural Nitrogen Retention Capacity: An Incubation Study." 9: 900.