Geophysical Research Abstracts
Vol. 19, EGU2017-5326, 2017
EGU General Assembly 2017

Enhanced plant growth at reduced N2O emissions: 15N dynamics confirm nitrate capture and release of co-composted biochar

Claudia Kammann (1), Hans-Peter Schmidt (2), Anne Williams (3), Nikolas Hagemann (4), Sven Marhan (5), Tim Clough (6), and Christoph Mueller (3)

(1) Hochschule Geisenheim University, Applied Biology, Soil Science and Plant Nutrition, Geisenheim, Germany (claudia.kammann@hs-gm.de), (2) Ithaka Institute for Carbon Strategies, Arbaz, Switzerland, (3) Justus-Liebig University, Department of Plant Ecology, Giessen, Germany, (4) University of Tuebingen, Geomicrobiology, Center for Applied Geoscience, Tuebingen, Germany, (5) University Hohenheim, Institute of Soil Science and Land Evaluation, Soil Biology, Stuttgart, Germany, (6) Lincoln University, Department of Soil & Physical Sciences, Canterbury, New Zealand

Pyrogenic carbon (biochar) produced from biomass may be used as a soil amendment to sequester biomass-C and to mitigate climate change. Moreover, biochar may increase soil fertility and optimize nutrient cycling in agro-ecosystems. However, according to meta-studies large additions (>10 t ha-1) of pure biochar, may only lead to moderate yield increases. Thus, there are no economic benefits for farmers to use biochar. Recently, it has been suggested that biochar may be used as an on-farm nutrient management tool (feed additive, liquid manure treatment, composting) to deliver small doses of nutrients and biochar to the soil each year. It may also be used as a carrier for (organic) nutrients in small doses (0.5 – 2 t ha-1) in the root zone; recent studies reported considerably increased yields. The mechanisms, however, are not well understood. Co-composted biochar was recently shown to promote plant growth due to its nutrient delivery and release capabilities, particularly nitrate (NO_3-). To gain further insights into biochar-nitrogen (N) interactions, we conducted a 15N labelling-tracing study under controlled conditions with treatments consisting of a non-biochar amended control, 2% (wt/wt) of untreated biochar particles (BCpure ,no intrinsic content of nitrate) and a 2% co-composted biochar (BCcomp, 5.3 g NO_3-N kg-1 as a result of composting), replicated thrice. Biochars were added to a sandy loam soil in jars (200 g) planted with barley (Hordeum vulgare L.) seedlings. Fertilizer (NH4NO_3) was homogenously added with either the ammonium (NH4+) or the nitrate (NO_3-) pools 15N labelled (60 atom% 15N) hours before planting the seedlings. Sets of 18 jars were harvested on days 1, 3, 8, 15 and 29 and nitrogen pools were analysed to trace 15N fertilizer fate (soil mineral N, plant biomass, biochar particles, nitrous oxide (N2O) emissions). Interestingly, both BCpure and BCcomp captured fertilizer 15N from the soil matrix within hours of addition, with higher capture of 15N-NO_3 than 15N-NH4. Surprisingly, the already nitrate-enriched BCcomp captured significantly more 15N than the non-enriched BCpure. Plant biomass increased significantly in the BCcomp compared to both BCpure and control treatment, because BCcomp still delivered N to the growing plants when soil mineral N was already depleted. N2O emissions were lower in the BCcomp treatment (by 60%) and the BCpure treatment (by 67%) compared to the control, despite higher levels of mineral N introduced with BCcomp. The 15N-N2O enrichment suggested that with biochar a relatively larger proportion was contributed by nitrification (although denitrification still dominated); and that accelerated mineralization-nitrification from unlabelled soil organic N pools diluted the 15N-nitrate label. Our results suggest that nitrate capture in biochar particles may be one of the mechanism among others reducing N2O emissions. In conclusion, modifying and designing biochars by organic pre-treatments may promote plant growth while N2O emission reduction is still possible. However more research is needed to achieve the envisaged economic and environmental benefits of C-sequestering biochar use in agriculture.

Acknowledgement: CK gratefully acknowledges the financial support of DFG grant no. Ka3442/1-1.