Geophysical Research Abstracts
Vol. 16, EGU2014-15635, 2014
EGU General Assembly 2014

Co-composted biochar can promote plant growth by serving as a nutrient carrier: first mechanistic insights

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Pyrogenic carbon (biochar) offers considerable potential for carbon capture (CCSS) and soil storage and meta-analysis suggests that it can significantly reduce soil N2O emissions. Freshly produced biochars, however, do not always have yield-improving effects; pure, production-fresh biochar seems to 'claim' some nutrients initially from soil, particularly nitrogen, although the mechanisms are unclear to date. Hence, combining biochar with organic nutrient-rich materials and waste streams may be a promising strategy to enable CCSS by yield improvements, which may enable economically feasible biochar use in agriculture.

We explored the potential of organically post-treated biochar to act as a nutrient carrier and thus to increase its socio-economic value as beneficial soil amendment with associated CCSS value. In a first proof-of-concept study the effects of untreated biochar were compared to those of co-composted biochar, combined with stepwise improved nutritional regimes (+/- compost; +/- mineral-N application). While the untreated biochar reduced plant growth under N-limiting conditions, or at best did not reduce it, the co-composted biochar always significantly stimulated plant growth. The relative stimulation was largest with the lowest nutrient additions (305% versus 61% of control with untreated biochar). Subsequent electro-ultra-filtration analyses revealed that the co-composted but not the untreated biochar carried considerable amounts of easily extractable as well as more strongly sorbed plant nutrients, in particular nitrate and phosphorus. Nevertheless the co-composted N-rich biochar still sorbed 15N labelled NH4+ or NO_3- when present in the soil, and again released it to growing barley plants. We will report on the relationship between particle size, increased nutrient content, and plant accessibility of the nutrients associated with the co-composted biochar, and analyse the extent to which the strongly sorbed nutrients on the biochar may be 'invisible' to conventional soil extraction methods.