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Potential of biochar soil amendments to reduce N leaching in boreal field conditions estimated using the resin bag method

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Addition of biochar to soil has been shown to reduce N leaching in pot experiments, but direct field measurements are scarce, and data is lacking especially from colder, boreal conditions. We measured the effect of biochar soil amendment on nitrate (NO_3-) and ammonium (NH4+) leaching in field conditions using the resin bag method. Bags containing ion-exchange resins (6g of Amberlite, IR 120 (Na+- ion exchanger resin), and 6g Dowex 1x8 (Cl- - ion exchanger resin)) were placed under the plough layer (under ca. 20 cm deep intact soil columns that were cored out using a 10 cm diameter PVC tube, one resin bag per plot, n=3). In the summer 2017 resin bags were changed monthly between the end of May and beginning of September, extracted with 1 M NaCl and analyzed for inorganic N, to allow the comparison of N leaching in five different treatments at the PäästöSäästö project site (Soilfood Oy) in Parainen, SW of Finland.

The field site was established in 2016 on a silty clay soil. The treatments selected for N leaching measurements in the summer 2017 were: non-fertilised control, N-fertilised control (80 kg N ha-1), and three treatments with organic amendments (which also received the same level of N-fertilisation as the N-fertilised control plots): salix biochar, spruce chip biochar and nutrient-rich fibers. The clearest difference was observed during the first month (May-June) before the active growth of plants: NH4+ leaching was reduced on average by 64 % in the spruce chip biochar treatment compared to the N-fertilised control, and NO_3- leaching was reduced on average by 46 %. Later during the growing season the differences were less clear due to higher variability within both the control and organic amended plots.

In October 2017 resin bags were again placed under soil columns at these treatments and left in the soil over the winter to accumulate N leached during the plant free period. Additionally, we also placed resin bags in biochar and control treatments of two other Finnish biochar field sites: the Mobile Flip project (LUKE) site in Jokioinen (biochar made from chipped forest residues, applied at 30 t-1 ha-1, field site established in 2016 on a clay soil), and two unique long-term experiments running since 2010 and 2011 in Viikki (University of Helsinki, spruce and pine chip biochar, applied at 10 or 30 t-1 ha-1, at two fields having loamy sand and sandy loam clay texture). The higher than average rainfall during autumn and winter 2017 in Finland has already been reported to have increased leaching of nutrients from agricultural fields, making this an interesting field trial for the potential to mitigate N leaching in future warmer and wetter conditions using biochar soil amendments.