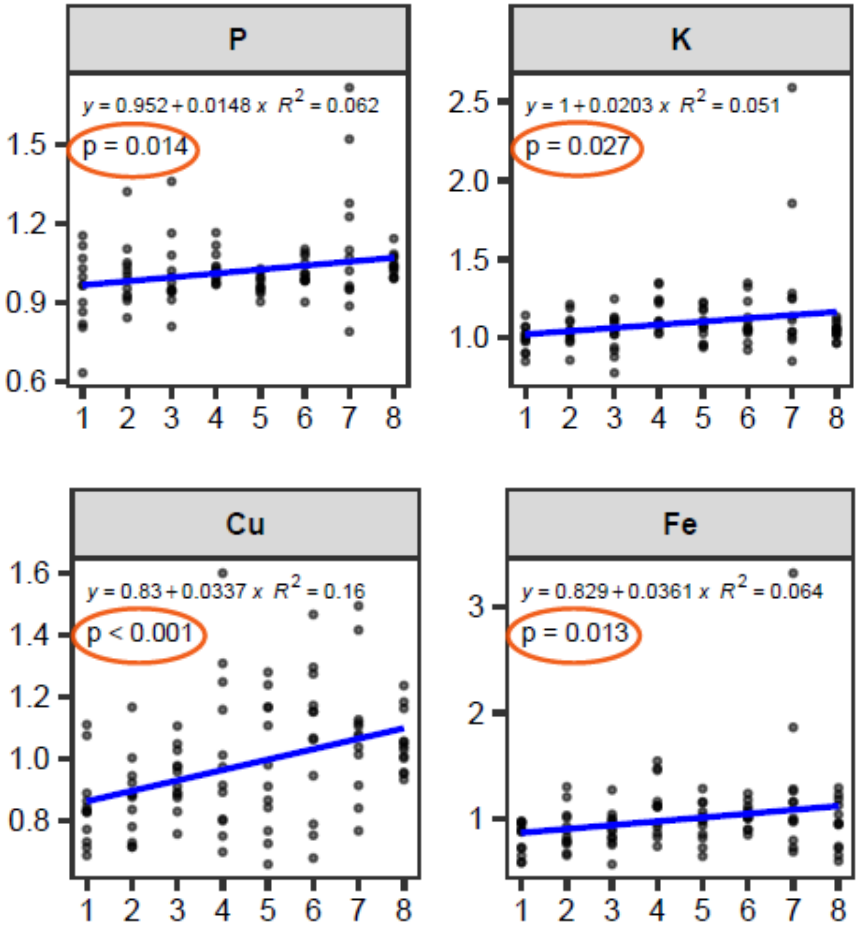
Wood biochars as soil amendment materials for improving nutrient use efficency [Stagnosol, Helsinki, Finland]

EXPERIMENT GOALS

To study the long-term potential of biochars in improving the nutrient use effiency and soil water retention capacity in boreaal soils.

Stagnosol experiment started in 2010, ongoing at least to 2025



BC effect to crop biomass nutrient concentration over 8 years, Stagnosol

Kalu et al. 2021

SITE DESCRIPTION

Example: Boreal climate, a fertile Stagnosol with a sandy clay loam texture at the Viikki Research Farm, University of Helsinki, Finland where all major Finnish crops were grown. The long-term biochar experiment was started in 2010 with single-dose additions of softwood biochar (Tammeorg et al., 2014a). Prior to the biochar application, field was cropped with small grains and the soil was tilled with conventional annual moldboard ploughing up to a depth of 25 cm for the preceding five years. In Stagnosol field, the experimental setup consists of three identically designed sub-experiments, which have different crops in 2010-2012 and 2016-2018, in 2013–2015 and 2019-2022, grasses were undersown to barley. The experimental factor in the main-plot was the biochar application rate [0, 5 and 10 Mg dry matter (DM) ha 1]. The experimental factor in the sub-plot was the application rate of the compound fertilizer with three different levels [30%, 65% or 100% of the fertilizer levels recommended for the individual crops according to Viljavuuspalvelu Oy (2000)]. Crops: faba bean, turnip rape, spring wheat rotating in 2010-2012, then barley undersown to grasses on 2013-2015. Then oats, peas and barley rotating in 2016-2018 followed by grasses again since 2020.

BIOCHAR AND ITS APPLICATION IN THE FIELD

Type of biochar and matrices used: Wood, slow pyrolysis

Biochar description (where it comes from, production technique, feedstock): debarked spruce and pine, 550–600 ◦C. Air dried wood chips were fed into the reactor tube via an airtight system and subsequently moved by a screw conveyor through the hot region of the reactor tube in 10–15 min. Moistened.

Supply: Dosages (tons$_{dm}$ / ha), frequency of ap., single application applied 0, 5 and 10 t/ha.

Distribution method: Spread by sand spreader, uppermost 10 cm soil layer by two opposite passes with a rotary power harrow

MEASURED PARAMETERS

List here the parameters that you periodically measure in relation to the purpose of the experiment.

AIR

GHG emissions measured 2015, 2017, 2018

WATER

Biochar interaction with water: leaching measured in 2018 with resin bags

SOIL

Soil analysis and interactions with biochar: soil pH and available nutrients, total C and N at T0, then measured again in annually in autumns 2010-2013, 2015-2019, Water retention measured in 2010-2012 annually, 2015, 2017 and 2018. Soil moisture content measured all years from most extreme plots (years 2010-2022).
Plant-soil dynamics and interactions: carbon and nitrogen soil-plant dynamics, microbiological and –omics measured all years 2010-2018. Earthworm community studies in 2015.

OTHER

Field conditions: rainfall / meteorological data
Production data: nutritional status of the plant 2010-2017, yield formation

KEY FINDINGS

Improved nutrient concentration in crops over the years, n.s. Effects on yields (most promising trends after legumes), improved soil moisture content and WRC.

PLANNED ACTIVITIES OR POTENTIAL EXPERIMENTAL ACTIVITIES

New nutrient-enriched biochars addition to 5 t/ha plots in 2023, intense measuring campaign afterwards.

PRESENTATION OF THE WORKING GROUP

AgriChar research group of University of Helsinki ise led by Adj. Prof. Priit Tammeorg. Regarding this experiment, main people active have been Dr. Subin Kalu (nutrient cycles) and doctoral student Jure Zrim (soil biota).
Website: http://biochar-hy.blogspot.com
Publications:

•Tammeorg, P., Simojoki, A., Mäkelä, P., Stoddard, F. L., Alakukku, L., & Helenius, J. (2014). Biochar application to a fertile sandy clay loam in boreal conditions: effects on soil properties and yield formation of wheat, turnip rape and faba bean. *Plant and Soil*, 374, 89–107. doi: 10.1007/s11104-013-1851-5. Erratum *Plant and Soil,* 379, 389–390.
•Tammeorg, P. (2014). Softwood biochar as a soil amendment material for boreal agriculture. Doctoral thesis. University of Helsinki.
•Kalu, S., Simojoki, A., Karhu, K., & Tammeorg, P. (2021). Long-term effects of softwood biochar on soil physicalproperties, greenhouse gas emissions and crop nutrient uptake in twocontrasting boreal soils. *Agriculture, Ecosystems & Environment*. 316: 107454.
•Kalu, S., Kulmala, L., Zrim, J., Peltokangas, K., Tammeorg, P., Rasa, K., ... & Karhu, K. (2022). Potential of biochar to reduce greenhouse gas emissions and increase nitrogen use efficiency in boreal arable soils in the long-term. *Frontiers in Environmental Science*. https://doi.org/10.3389/fenvs.2022.914766
•Kalu, S. (2022). Long-term effects of biochars as a soil amendment in boreal agricultural soils. Doctoral thesis. University of Helsinki.

Contacts: Priit.tammeorg@helsinki.fi