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Impact of hydrochar application on soil nutrient dynamics and plant availability

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In order to investigate potentials for the use of HTC-products (hydrochar) in agriculture, the influence of soil application of different hydrochars on soil nutrient dynamics as well as on plant growth and plant nutrient uptake was determined. Hydrochars were produced from sugar beet pulps and brewer's grains by carbonization at 190°C for 4 respectively 12 hours each.
Incubation experiments with two soil types showed an increase of soil pH by 0.5 to 2.5 pH units, depending on the amount of hydrochar added and the process conditions (i.e. addition of calcium carbonate during production). The application of HTC to soil decreased the plant available nitrogen to almost zero in the first week after HTC-addition, followed by a slow re-release of nitrate in the following weeks. A similar immobilization of soluble phosphate was observed for one soil type, although to a lower extent. The plant availability of phosphorus in hydrochars and biochars is subject of current trials. Furthermore it is actually investigated to what extend the N immobilization is related to soil microbial activity.
Germination tests with barley showed toxic effects of hydrochar application on germination, both by direct contact of grains with HTC as well as by release of gaseous compounds from HTC. Effects differ significantly for different parent materials and pretreatments (washing, drying, storage).
The influence of HTC-addition to soil on plant growth and nutrient uptake was investigated in pot experiments with various crop species (barley, phaseolus bean, leek), comparing HTC from different parent materials and process parameters such as carbonization time. With increasing addition of HTC, the N availability was decreased and N contents in the plant were significantly lower compared with the untreated control. The plant growth response was different for each tested crop. On barley, leaf tip necroses were observed, but not on phaseolus. Biomass yield of barley and beans was generally increased by HTC application. In contrast, leek biomass production was reduced.
Our experiences show that HTC-materials should be incorporated into soils several weeks before planting/sowing, similar as it is widely recommended for straw incorporation. Alternatively, HTC can be pretreated by composting or fermentation with fresh organic material to destroy toxic compounds microbially.