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Does Miscanthus cultivation on organic soils compensate for carbon loss from peat oxidation? A dual label study

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Agricultural use of organic soils requires drainage and thereby changes conditions in these soils from anoxic to oxic. As a consequence, organic carbon that had been accumulated over millennia is rapidly mineralized, so that these soils are converted from a CO_2 sink to a source. The peat mineralization rate depends mainly on drainage depth, but also on crop type. Various studies show that Miscanthus, a C4 bioenergy plant, shows potential for carbon sequestration in mineral soils because of its high productivity, its dense root system, absence of tillage and high preharvest litterfall. If Miscanthus cropping would have a similar effect in organic soils, peat consumption and thus CO_2 emissions might be reduced. For our study we compared two adjacent fields, on which organic soil is cultivated with Miscanthus (since 20 years) and perennial grass (since 6 years). Both sites are located in the Bernese Seeland, the largest former peatland area of Switzerland.

To determine wether Miscanthus-derived carbon accumulated in the organic soil, we compared the stable carbon isotopic signatures of the experimental soil with those of an organic soil without any C4-plant cultivation history. To analyze the effect of C4-C accumulation on peat degradability we compared the CO_2 emissions by incubating 90 soil samples of the two fields for more than one year. Additionally, we analysed the isotopic CO_2 composition (13C, 14C) during the first 25 days of incubation after trapping the emitted CO_2 in NaOH and precipitating it as $BaCO_3$.

The ∂13C values of the soil imply, that the highest share of C4-C of around 30% is situated at a depth of 10-20 cm. Corn that used to be cultivated on the grassland field before 2009 still accounts for 8% of SOC. O/C and H/C ratios of the peat samples indicate a stronger microbial imprint of organic matter under Miscanthus cultivation. The amount of CO_2 emitted was not affected by the cultivation type. On average 57% of the CO_2 was C4 derived in the Miscanthus field, whereas 38% was C4-derived in the Grassland field. According to our radiocarbon data, 38% of the CO_2 must have originated from peat-derived OM on the Miscanthus field, whereas 57% of the CO_2 was derived from peat in the grassland. Although peat minerlaization seems to be smaller and a significant amount of C4-C accumulated under Miscanthus, peat mineralization nonetheless contributed substantially to soil respiration. Together, our data do not support the hypothesis that Miscanthus cultivation can fully compensate for organic matter loss in drained peatlands.