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Influence of soil moisture on plant biosynthesis, C incorporation and storage in soils at a molecular level

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Soil moisture influences several soil properties like e.g. pH, oxygen availability and C storage. Especially water-logged and peaty soils can be characterized by large amounts of organic C and provide opportunity for improved preservation of total organic matter and at a molecular level like e.g. for lipids including alkanes and fatty acids. However, long term effects of different soil moisture on identical soils are investigated seldom and therefore it remains unknown, if even low differences in soil moisture (10-30 %) might have an effect on C incorporation and preservation in soils.

A long term field experiment on drained vs. undrained grassland plots from the Rowden plots (North Wyke Research, Okehampton, UK) provides the unique opportunity for studying long term influences of different soil moisture on biodiversity of plants and soil C storage. After establishment of drainage the plants community changed within several decades from predominant species adopted to wet conditions like Juncus effusus towards predominant grasses that are more tolerant to lower soil moisture like Lolium perenne. Due to the lower soil moisture in the drained plots, Corg and extractable lipid contents decreased throughout the soil profile by $\sim$20 %. However, it remains unknown, if this change in drained vs. undrained plots is related to a modified plant biomass input due to changing plant community or an improved degradation of organic matter in drained plots.

To investigate these effects in detail, we carried out laboratory experiments, where identical plants (Lolium perenne and Juncus effuses) are kept under controlled conditions at two different soil moisture levels, which were adjusted daily to 70% and 100% of WHC, respectively. Short and medium term responses of plants and C incorporation in soil are followed by combining lipid and Corg analyses with the 14C pulse labeling technique. The 14C label is determined several times after the labeling in plants and soils for bulk Corg and at a molecular level (for total extractable lipids, fatty acids and alkanes).

High soil moisture resulted in an improved growth of biomass, which was 30-70% higher than under low moisture, depending on sampling date. This was almost identical for shoot and root biomass, and for both investigated plant species. Lipid contents and distribution patterns in plants were almost identical for both moisture variants, whereas previous studies demonstrated an effect of moisture on the lipid content and composition of plants. The 14C data reveals an improved re-utilization of C within plants under low moisture due to lower stomatal conductance. Laboratory and field experiments provide evidence that especially the difference in biomass production under different soil moisture levels is the predominant factor influencing soil C incorporation and storage, even at a molecular level.