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Application of Different Fractions of Anaerobic Digestate Significantly Influences the Carbon Cycle in Grassland Soils

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Applying digestate to soil is of growing interest in agriculture. However, the impacts of digestate on soil biogeochemical cycles often remain unclear, especially after solid-liquid separation of whole digestate (WD). We used a 21 d incubation to examine the effects of WD and solid digestate (SD) on CO_2-C efflux, dissolved organic carbon (DOC), microbial biomass C (C_{micro}), phospholipid fatty acid (PLFA) and carbon use efficiency (CUE) within two grassland soils of contrasting nutrient status. Application rates for SD and WD were based on recommended N inputs to grassland soils for these organic materials. Compared to un-amended controls, cumulative CO_2-C efflux, C_{micro} and the fungal:bacterial in soils increased significantly following SD application, regardless of the soil nutrient content (+20% CO_2-C, +29% C_{micro}, +58% fungal:bacteria for high nutrient soil; +563% CO_2-C, +36% C_{micro}, +18% fungal:bacteria for low nutrient soil). In contrast, WD produced a significant effect on CO_2-C efflux and fungal:bacterial only in the low nutrient soil. Our results also indicated that both digestate fractions and the initial soil nutrient status affected CUE. Applying both SD and WD to a low nutrient soil potential leads to decreases in soil C stocks, whilst the application of SD to a high nutrient soil can potentially enhance soil C stocks. Digestate application must be carefully planned, accounting for both the nature of the digestate and of the soil, in order to avoid adverse impacts on soil C stocks.