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Redox conditions and root exudate composition affect soil carbon cycling in mineral and organic salt marshes

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Coastal wetlands store a disproportionate amount of the Earth’s total soil carbon due, in part, to highly productive plants and slow decomposition rates in waterlogged, anoxic soils. Roots contribute to soil building but also affect decomposition by releasing carbon exudates and oxygen. Exudates may indirectly affect the long-term persistence of existing soil organic matter (SOM) by fueling the activity of nearby heterotrophic microbes (i.e., co-metabolism) and disrupting mineral-organic matter associations. How these processes operate in coastal marshes and are affected by redox conditions are open questions. We conducted an experiment in which mineral and organic salt marsh soils were supplied with ^{13}C-glucose, ^{13}C-oxalic acid, or unamended artificial seawater under oxic or anoxic conditions. Both compounds are common in root exudates, but glucose is bioavailable whereas oxalic acid can act as a ligand and liberate OM from minerals. Soils were incubated in flow-through reactors which simulate porewater percolation and allow for continuous biogeochemical rate measurements. As expected, glucose amendments stimulated respiration more than oxalic acid, resulting in higher rates of dissolved inorganic carbon (DIC) production and lower redox and pH levels in oxic treatments, but increased pH in anoxic treatments. Surprisingly similar DIC production rates under oxic and anoxic conditions but lower d^{13}C-DIC enrichment in oxic treatments are suggestive of lithoautotrophy, likely by sulfur oxidizing bacteria. Oxalic acid increased DIC production and d^{13}C-DIC values, relative to controls, suggesting direct or indirect effects on microbial metabolisms. Differences between glucose and oxalic acid treatments were stronger in mineral soils, particularly under anoxia, potentially suggesting greater reliance on exudates when pre-existing SOM content is low. Slightly stronger oxalic acid effects on carbon respiration in mineral vs. organic soils provide some of the first clues about potential abiotic priming mechanisms in salt marshes.