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Plant Water Status Mediates Sorption of Root Exudate Carbon to Iron Oxides and Clay Minerals

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The impact of global warming has led to various environmental changes, such as increasing incidence of drought conditions that influence belowground carbon input through processes like root exudation. Plants release carbon-rich root exudates that contribute to cycling of soil organic matter in the soil environment. An interaction that has received considerable focus is the formation and destabilization of mineral associated organic carbon (MAOC), an important carbon pool in soil. As drought conditions persist, the root exudate profile changes composition, which could have lasting effects on the MAOC formation process. Though root exudates have been shown to stabilize MAOC, it has also been noted that they can promote destabilization to preexisting carbon pools. To examine the impact of drought on root exudate interactions with soil minerals, wheat plants were cultivated in an aeroponic system. After 3.5 months of growth, half of the plants were subjected to drought stress, while the remaining half received consistent watering. Root exudates were collected by rinsing the roots with a 0.05 mM $CaCl_2$ solution and analyzed using a Shimadzu TOC-L and Q-Exactive Orbitrap LC-MS to characterize differences between treatments. Exudate analysis revealed a significant increase in total root exudation as well as organic acid exudation under drought conditions compared to well-watered plants. Batch adsorption experiments using drought and well-watered exudates with montmorillonite and hematite showed that exudates from drought-stressed plants had a stronger affinity for both minerals, suggesting an enhanced potential for direct root exudate mineral associations. These findings indicate that drought-induced shifts in root exudate composition may influence the formation of MAOC. Future work will focus on evaluating the stability of these MAOC formations, as well as assessing the destabilization potential of drought induced exudates on stable carbon pools.