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Trade-offs between hydrolytic and oxidative extracellular enzyme activity under climate change: Implications for soil carbon cycle

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Soil extracellular enzymes (EEs) catalyze rate-limiting steps in soil carbon (C) decomposition, which may have important implications for soil C cycling. Hydrolytic and oxidative EEs are targeting the decomposition of different soil C pools with distinct microbial C use efficiency. Here, we analyzed the responses of hydrolytic and oxidative EEAs to experimental warming, enhanced N deposition and altered precipitation. Experimental warming profoundly increased oxidative EEAs by 21%, while having no effect on hydrolytic EEAs. Enhanced N addition significantly decreased oxidative EEAs by 21% but enhanced hydrolytic EEAs by 15%. Increased precipitation substantially stimulated oxidative EEAs by 21%, while having no effect on hydrolytic EEAs. On the contrary, decreased precipitation significantly suppressed oxidative EEAs by 11% but enhanced hydrolytic EEAs by 26%. Those results together showed that hydrolytic and oxidative EEAs generally responded asymmetrically to the experimental treatments, representing the trade-offs between microbial hydrolytic and oxidative EEs production. Moreover, experimental treatments were more likely to have positive effects on soil C stock when oxidative EEAs respond negatively, and vice versa. One explanation might be that degradation of soil C pools that targeted by oxidative EEs were typical with lower microbial C use efficiency, since additional energy was required for the deconstruction of those complex and recalcitrant soil C pools. Altogether, our results highlight that soil EEAs can potentially be harnessed towards soil C sequestration if we can better understand the underlying mechanisms associated with the trade-offs between hydrolytic and oxidative EEAs.