Fungal Community Composition and Soil Nitrate affect Bioavailability of Dissolved Organic Carbon in Soil

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Recent evidence suggests that atmospheric NO_3^- deposition can alter soil C cycling and storage by directly affecting the activity of lignin degrading soil fungi. In a laboratory experiment, we studied the direct influence of increasing soil NO_3^- concentrations on microbial activity in the black oak-white oak (BOWO), sugar maple- red oak (SMRO) and sugar maple- basswood (SMBW) ecosystems. These ecosystems span a broad range of litter biochemistry and recalcitrance, with BOWO ecosystem containing the highest litter lignin content, SMRO with intermediate lignin content, and SMBW leaf litter the lowest lignin content. We hypothesized that increasing soil solution NO_3^- will reduce lignolytic activity in the BOWO ecosystem, due to a high abundance of white rot fungi and lignin-rich leaf litter. Due to the low lignin content of litter in the SMBW ecosystem, we further reasoned the NO_3^- repression of lignolytic activity would be less dramatic due to a lower relative abundance of white rot basidiomycetes; the response in the SMRO ecosystem should be intermediate. In the BOWO ecosystem, increasing NO_3^- significantly decreased oxidative enzyme activities and increased DOC and phenolic concentrations. In the SMRO ecosystem, we observed a significant decrease in phenol oxidase enzyme activity and an increase in soluble phenolic concentrations in response to increasing NO_3^- in soil solution, but no significant change in DOC concentrations. In contrast to these patterns, increasing soil solution NO_3^- in the SMBW soil resulted in significantly greater phenol oxidase activity and a trend toward lower DOC production.

Taken together, our results demonstrate that oxidative enzyme production by microbial communities responds directly to NO_3^- deposition, controlling bioavailability of DOC. The regulation of oxidative enzymes by different microbial communities in response to NO_3^- deposition highlights the fact that the composition and function of soil microbial communities directly controls ecosystem-level responses to environmental change.