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Differential responses of needle and branch order-based root decay to nitrogen addition: dominant effects of acid-unhydrolyzable residue and microbial enzymes

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Both chemical differences between foliage and different orders of fine roots and their contrasting decomposing microenvironments may affect their decomposition. However, little is known about how foliage and branch order-based root decomposition responds to increased N availability and the response mechanisms behind. The effects of different doses of N addition on the decomposition of needles and order-based roots of Pinus elliottii (slash pine) were monitored using the litterbag method for 524 days in a subtropical slash pine plantation in south China. The acid-unhydrolyzable residue (AUR) concentration and microbial extracellular enzymatic activities (EEA) in decomposing needles and roots were also determined. Our results indicate that the responses of needle and order-based root decomposition were N-dose-specific. The decomposition of both needles and lower-order roots was inhibited under the high N dose rate. The retarded decomposition of lower-order roots could be explained more by the increased binding of AUR to inorganic N ions, while the retarded decomposition of needles could be explained more by the reduced microbial EEA. Further, in contrast to lower-order roots, N addition had no effect on the decomposition of higher-order roots. We conclude that the decomposition of foliage and fine roots may fail to mirror each other at ambient conditions or in response to N deposition due to their contrasting decomposition microenvironments and tissue chemistry. Given the differential effects of N addition on order-based roots, our findings highlight the need to consider the tissue chemistry heterogeneity within branching fine root systems when predicting the responses of root decomposition to N loading.