Fine root dynamics responses to nitrogen addition depend on root order, soil layer, and experimental duration in a subtropical forest

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Abstract

Elevated atmospheric N deposition has been well documented to enhance fine root production in N-limited temperate forests, but how fine roots respond to N deposition in N-rich tropical and subtropical forests remains poorly understood. The sequential coring and minirhizotron methods were applied to quantify fine root biomass, production, and turnover of a N-rich but P-limited subtropical forest in southern China and to assess the responses of these root variables to a gradient of N additions (control (0), low-N (35), medium-N (70), and high-N (105 kg N ha^{-1} $year^{-1}$)) during the first 3 years of experimentation. The high- and medium-N additions significantly reduced fine root diameter by about 30% but increased the specific root length by 20–105%, i.e., fine roots became thinner and longer under the experimental N addition. Both low- and medium-N additions generally stimulated fine root production (10–88%) and turnover (3–40%), whereas high-N suppressed them by 32–70% and 8–54%, respectively,

varying with sampling season and estimation method. The stimulatory effects were presumably ascribed to the increased fine root growth for P acquisition, the suppressive effect, to the deleterious damage to the root health and micronutrient availability. Overall, the N effects were more pronounced in the surface (0–10 cm) than in the deeper (10–40 cm) soil layers and for the first-order than the higher-order fine roots. Our results indicate that lower-order absorptive fine roots are responsive to elevated N deposition, and complex responses could emerge due to the interactive influences of the N deposition rate, seasonality, and soil depth.

Keywords

Fine root biomass Fine root production Fine root turnover N deposition Tropical forest

Electronic supplementary material

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Notes

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Authors' contributions

WS and WW conceived the ideas and designed the study; WW, QM, and XH collected the samples and analyzed the data; DH took part in writing and data analysis; all authors contributed to the writing and revision of the manuscript.

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Supplementary material

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