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Competition between roots and microorganisms for nitrogen: mechanisms and ecological relevance

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Demand of all living organisms on the same nutrients forms the basis for interspecific competition between plants and microorganisms in soils. This competition is especially strong in the rhizosphere. To evaluate competitive and mutualistic interactions between plants and microorganisms and to analyse ecological consequences of these interactions, we analysed 424 data pairs from 41 15N-labelling studies that investigated 15N redistribution between roots and microorganisms. Calculated Michaelis–Menten kinetics based on Km (Michaelis constant) and Vmax (maximum uptake capacity) values from 77 studies on the uptake of nitrate, ammonia, and amino acids by roots and microorganisms clearly showed that, shortly after nitrogen (N) mobilization from soil organic matter and litter, microorganisms take up most N. Lower Km values of microorganisms suggest that they are especially efficient at low N concentrations, but can also acquire more N at higher N concentrations (Vmax) compared with roots. Because of the unidirectional flow of nutrients from soil to roots, plants are the winners for N acquisition in the long run. Therefore, despite strong competition between roots and microorganisms for N, a temporal niche differentiation reflecting their generation times leads to mutualistic relationships in the rhizosphere. This temporal niche differentiation is highly relevant ecologically because it: protects ecosystems from N losses by leaching during periods of slow or no root uptake; continuously provides roots with available N according to plant demand; and contributes to the evolutionary development of mutualistic interactions between roots and microorganisms.