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Plant effects on soil denitrification – a review of potential mechanisms

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Denitrification is a microbial process occurring in soils, both producing and consuming the potent greenhouse gas nitrous oxide (NO), competing for nitrate with plants and hydrological leaching pathways, removing nutrients and reactive nitrogen from the biosphere, and closing the global nitrogen cycle. Despite its obvious importance, denitrification remained among the least well quantified biogeochemical processes in soils. This is due to enormous methodological difficulties involved in the direct quantification of soil microbial denitrification rates (mainly with regard to the terminal product N2) and the denitrification nitrogen gas product ratios (NO:N2O:N2), Plants may affect denitrification through a myriad of mechanisms such as e.g., competition for nitrate and water, through oxygen consumption, by regulating litter quality and changing soil pH, and via the exudation of labile carbon or secondary plant compounds involved in shaping the rhizospheric microbial community. However, plant effects on denitrification so far hardly were quantified so that the actual extent of plant control on denitrification is largely unknown. Here, we summarize the current knowledge on mechanisms how plants can affect denitrification rates and N gas product ratios in soils at temporal scales from hours to days and years. We review earlier research to quantify plant effects on denitrification as well as critically discuss the limited methods currently available to quantify plant-soil-denitrifier interactions. Finally, we provide pointers to use plants as tools to manage denitrification, e.g. to improve N use efficiency in agricultural ecosystems and to minimize soil nitrous oxide emissions.