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The effects of drip irrigation with nanobubbles aerated water on soil N transformation

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In recent years, irrigation with nanobubbles aerated water (NB-water) [i.e., air or oxygen-NB (ONB)] has emerged as a new method to alleviate transient hypoxic conditions in the rhizosphere. We aimed to study the effect of surface and subsurface drip irrigation with ONB aerated waters [i.e., fresh (0.4 dS/m), secondary urban treated wastewater (TWW; 1.3 dS/m), saline (3dS/m)] on soil nitrogen transformations. Greenhouse lysimeter experiments were conducted in vertisol (58% clay), sand (98% sand), compost, and sand:compost (1:1) mixture, under well aerated and poorly aerated conditions. Ammonium-N to nitrate-N ratios in the irrigation waters ranged from 15% to 50%. In all the experiments, irrigation with ONB water, with dissolved oxygen (DO) concentrations of 11 to 35 mg/L, increased the transient buildup of nitrite in the porewater, even under well-aerated conditions (soil air O₂ > 19%). The most significant effects were observed in the sand, sand:compost, and compost media, where nitrite concentrations were 2 – 8 times greater than the controls and reached over 65 mg/L. Despite the increased nitrite concentrations, irrigation with ONB waters reduced the nitrous oxide fluxes by 4 – 85%. Both phenomena suggested higher oxygen availability in the soil. Nitrite buildup implies that ammonia (NH₃) oxidation may not be the rate-limiting step of nitrification under irrigation with ONB aerated water.