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Why does irrigation with hyperoxic water alter soil biochemistry?

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In the published literature, irrigation with hyperoxic (dissolved oxygen > 15 mg/L) nanobubbles aerated water (NB-water) has a significant impact on bio-geo-chemical processes in soils. Yet, simple mass balances show that the amount of oxygen added to soils with such waters provides less than 1% of the oxygen respired. Further, such practices only slightly increase (0.1-0.5%) the oxygen concentration in the soil air. These minor contribution to the soil's oxygen pool raises questions about the mechanisms that drive the impact on the bio-geo-chemical processes in it. Specifically on the soil's microbial population and activity, greenhouse gasses emissions, and plant growth. Soil respiration and nutrient uptake require a continuous supply of oxygen (O2) to the rhizosphere. However, in reality, in most soil, the rate of O2 diffusion into the soil is lower than the rate of its consumption. Hence, O2 concentrations in the rhizosphere are lower than in ambient air (20-21%; normoxia), and often sub-optimal or anoxic conditions develop. To date, the definition of sub-optimal O2 concentrations is not clear, and the general perception is that in most soils, O2 is not a crop-limiting factor. However, in recent years, more and more studies have shown that even small changes in the O2 concentration of the soil air (i.e., >0.2%) positively impact plant growth, metabolism, and yield. Results from studies with various soil aeration methods, such as the dissolution of micro- and nanobubbles and peroxides, show a positive response to O2 additions, even when the additions contributed a mere 0.01-1% of the soil respiration fluxes. The governing mechanisms for such positive responses are unclear, and further study is needed.