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Soil Oxygen Dynamics: A Key Mediator of Tile Drainage Impacts on Coupled Hydrological, Biogeochemical, and Crop Systems

Background/Objective

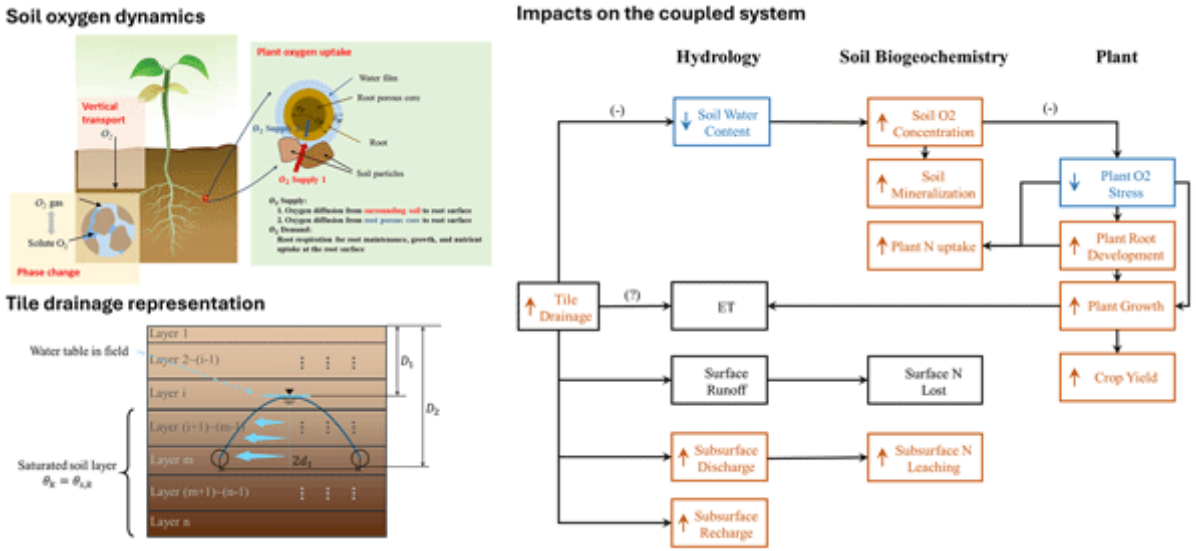
Tile drainage is a critical management practice in the U.S. Midwest for removing excess water from agricultural fields. Soil oxygen dynamics are essential for understanding tile impacts on the coupled hydro-biogeochemical agriculture system, which are often ignored or oversimplified. This study uses a model with an advanced representation of soil oxygen dynamics to quantify how tile drainage impacts these coupled systems.

Approach

This study used the *ecosys* model, which includes first-principle soil oxygen dynamics. The model was validated against data from tile-drained and undrained plots from a multi-year corn-soybean rotation experiment in Washington, Iowa. The impact of tile drainage was further assessed by comparing simulations with various precipitation levels.

Results

We find that soil oxygen dynamics are the key process through which drainage impacts the system. Tile drainage lowers soil water content and increases soil oxygen levels, helping crops grow during wet springs, which in turn helps mitigate drought stress during dry summers. Tile overall increased crop yield by ~6% at the study site.



Left: Soil oxygen dynamics. Right: Impact of tile drainage on hydrology, soil biogeochemistry, and crops in U.S. Midwest agroecosystems with sufficient spring precipitation.

Significance/Impacts

Study results indicate the potential for tile drainage to bolster crop resilience to climate change, and of the *ecosys* model for large-scale assessments of tile drainage. This exercise underscores soil oxygen dynamics as an underlying mechanism driving agroecosystem response to drainage via hydrology, biogeochemistry, and crop system dynamics.

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