Controlled Drainage Reduces Tile Nutrient Losses

High nutrient loads to streams, lakes, and oceans are known to adversely affect water quality and may potentially cause algal blooms. Agricultural subsurface drainage systems provide a more or less direct conduit for excess water and nutrients from fields to surface water. Therefore, in-field, as well as edge-of-field mitigation measures that can assist in reducing the loss of nutrients, are needed.

In an article recently published in the *Journal of Environmental Quality*, results from a three-year-long Before-After Control-Impact study of controlled drainage as a mitigation measure on four fields plots were reported.

The study showed that controlled drainage significantly reduced the drain outflow and nitrogen and phosphorus loss by 37–54%, 38–51%, and 43–46%, respectively, relative to conventional drainage, when elevating the outlet to 70 cm above conventional drainage depth. Denitrification in the root zone, as measured with stable isotopes, was not markedly enhanced at the plots with controlled drainage, except on a few occasions.

Even though controlled drainage effectively reduced the loss of nutrients via tile drainage systems, potential water quality trade-offs (e.g., increased nitrogen loss to groundwater) need to be more thoroughly investigated before implementing controlled drainage as a mitigation measure in Denmark.


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Plants and Bacteria Engineer Soil Hydraulic Properties

Plants and bacteria are exposed to fluctuations in soil water content and accompanied shifts of soil hydraulic properties. To delay or prevent negative effect, they alter the physical properties of the soil solution by release of highly polymeric blends (root mucilage and bacterial EPS). The impact of these blends on macroscopic soil properties is known, yet related pore-scale mechanisms are still unknown.

In an article recently published in *Vadose Zone Journal*, existing evidence, new measurements, and recent imaging techniques were combined to shed light on these mechanisms, allowing the creation of microhydrological niches in soils. The polymer network formed by mucilage and EPS absorbs water, increases the viscosity of the soil solution, and lowers its surface tension. This delays the retreat of water in drying soil, prevents the breakup of the liquid phase, and finally results in the formation of polymeric surfaces reaching across multiple pores. By enhancing liquid connectivity, water transport in drying soil is facilitated. Thin surfaces formed in dry regions reduce soil drying by limiting vapor diffusion, and the delay of liquid retreat enhances water retention.

Knowledge of the pore-scale mechanisms by which mucilage and EPS improve local growth conditions could allow for the selection of more stress resistant crops and associated microbial communities.


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Left: Hydrated mucilage at the tip of a maize crown root. Right: Cross section of X-ray computed tomography through dry mucilage structures in fine sand.