INSTALL ARTIFICIAL DRAINS

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Description

Phosphorus is mainly transported to surface water by water transport. The pathway of the water flow can be changed in such a way that phosphorus rich components in solution will be reduced. Depending of the main pathway of P losses (e.g. overland, subsurface, artificial drains etc) and the main P component in soil solution (particulate P material, colloids, inorganic soluble P, organic soluble P) specific measures will reduce the P losses. In this specific fact sheet the impact of installing artificial drains on the subsurface flow (without artificial drains) will be discussed in more detail.

The phosphorus transport through subsurface drainage is often supposed to be small or negligible because of its low mobility in soils due to high phosphate sorption capacity of the subsoil (buffering capacity) (Heathwaite and Dils, 2000) and (Hansen et al., 2002). However P transport could also occur by subsurface drainage if P levels in the soil are high and shallow groundwater tables frequently occur, like in flat areas (Chardon and Schoumans, 2007).

Rationale, mechanism of action

In areas where P losses are also, or mainly, caused by subsurface drainage water, management measures are also possible by changing or blocking the pathway of the water flow in such a way that

- The pathway of water located nearby the trenches or ditches is increased (fast subsurface flow will be reduced)
- and/or the flow rate is reduced (sufficient reaction time fro sorption to the soil)

This will reduce the amount P loss to surface water.

A measure to realize this effect is to regulate groundwater levels in such a way that frequently high groundwater levels in soils that reach into the layers with high P contents are significantly reduced. This can be done by implementing artificial drainage. This option is visualized in figure 1.

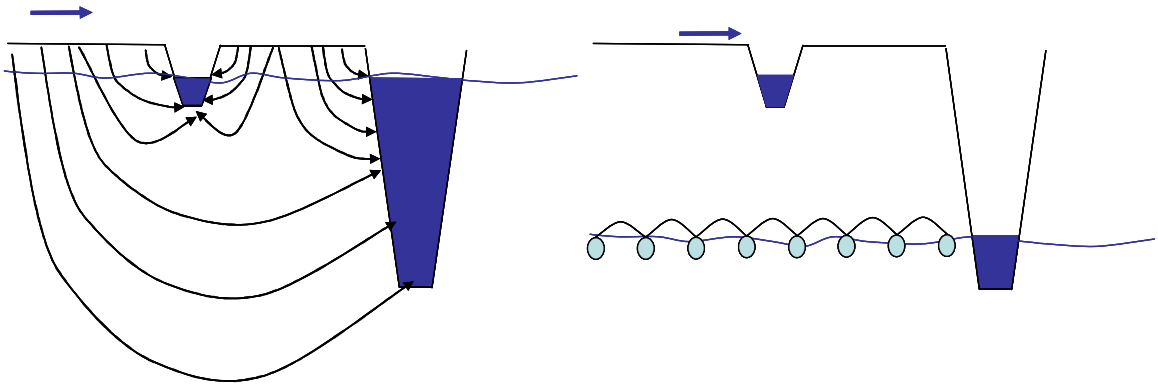

Figure 1. Schematic visualization of the impact of measure "implementing artificial drains" on the water flow

An additional reduction of P losses can be obtained if after digging for tile drains the backfill is mixed with reactive material like reactive iron- or aluminum(hydr)oxides or lime (CaO) depending on the pH of the soil.

a) soluble P components

The impact of such measures on the P losses caused by inorganic and organic P components in soil solution is much better known for inorganic phosphorus than for organic P. Soluble components are defined as material that is still in solution after filtering by 0.45 μm.

The general idea of this measure is to reduce high groundwater levels by building / construct artificial drains in soils. Since phosphorus is mainly adsorbed in the top soil (most situations less than 0.5 m) high P losses can occur if groundwater levels reach the enriched P layers in the top soil. By implementing artificial drains at greater depth (e.g. 0.8 – 1.2 m) the groundwater will not reach the enriched layers anymore and the water surplus (precipitation surplus) will be drained to surface waters at greater depth. The inorganic P equilibrium concentrations at depths one meter below surface will be rather low. Since also the organic P concentrations are often higher in the root zone than at 1 meter below surface also the P losses caused by organic P losses will be reduced (Ulén and Mattsson, 2003); (Turner and Haygarth, 2000).

b) particulate P / colloidal P

The P losses caused by transport of detached soil particles components in soil solution through the soil is not well known. Particle components in soil solution are defined as material that is filtered by a 0.45 μm filter. Only in artificial drained soils some measurements of the transported particulate material through the soil to tile drains are available (Ulén and Mattsson, 2003) (Turner and Haygarth, 2000). There are no data from non-artificial drained clay soils. Therefore, it is hard to tell if the P losses of particulate P from artificial drained (clay) soils to surface waters are greater or less than those from non-artificial drained (clay) soils. However, intensive agriculture is often accompanied by subsurface drainage especially in clay-based soils.

Applicability

The measure will be most effective when applied under field conditions where transport by subsurface flow of soluble (in)organic P components causes the main P loss to surface water. Most of the time these situations occur in rather flat areas where many trenches and ditches were constructed to improve the water discharge from the fields at high groundwater levels (e.g. in delta's or brook/river stream areas where upward seepage of groundwater appear). The measure is mainly suitable in sandy or loamy soils.

In peat areas this measure should not be applied, because lowering the groundwater level and or reducing the groundwater fluctuation will result in an increase of the mineralization of peat and therefore, the nutrient losses will be high (Miller, 1979; Tiemeyer et al., 2009).

In heavily clay soils the installation of artificial tile drainage can lead to additional losses, especially when cracks in field occur in dry periods (Sims et al., 1998).

Effectiveness, including certainty

The effectiveness of implementation artificial drains will have the highest impact in flat areas where shallow groundwater levels frequently occur. In flat areas of the Netherlands reductions of 25% have been calculated for sandy areas (Jeurissen and Verhaegh, 1990). Such evaluations have not been made for clay areas (and are not recommended for peat areas). Some field studies addressed a reduction in P loss from 90 % to 95 % when drains at 2.5 below surface were used in sandy soils (Schoumans et al., 1995). Yet, research on the effectiveness of adding phosphate fixing material nearby the artificial drain has not been found.

Time frame
Increasing the length of the pathway of P transport through the soil to deeper layers will have an impact on the travel time and therefore on the timeframe. However, the impact of the measure will turn out at the short term (within a year).

Environmental side-effects / pollution swapping
As a result of this measure the top soil will be less wet during the autumn and early spring because high groundwater levels are prevented. Consequently, also denitrify-ication will be reduced and therefore the nitrate concentration in soil solution will increase. So, depending on the hydrological situation an optimum should be found between the reduction of P losses and the increase of nitrate concentration in soil solution and subsequently, probably also increase of nitrogen losses to surface water.

Relevance, potential for targeting, administrative handling, control
The option can be relevant for those fields that mainly cause the diffuse P losses by subsurface transport at local scale. Selection of such fields by modeling approaches or by local experiences are highly recommended.

Costs: investment, labor
The main costs are caused by labor and the installation of the artificial drains. No special investments are necessary.

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