Cornell University
Cooperative Extension

Agronomy Fact Sheet Series Fact Sheet 58

Subsurface (Tile) Drainage Best Management Practices

Introduction

Subsurface drainage (also referred to as artificial or tile drainage) is the practice of placing slotted drain tubes beneath the soil surface, well below tillage depth, to help lower the water table of poorly drained fields and/or wet areas within fields. In agronomy fact sheet 57, benefits and guidance for installation of subsurface drainage are presented. In this fact sheet, we discuss currently recognized best management practices to reduce the risk of manure nutrients exiting tile lines.

Nutrient Loss through Preferential Flow

The main nutrients of concern are nitrogen (mainly nitrate-N) and phosphorus (P) although pathogens can also be a concern in some cases. Nitrate-N is water soluble and can be lost through leaching and runoff. Phosphorus is typically bonded to soil particles and can be lost when erosion occurs. However, a fraction of P is also water soluble and this dissolved P fraction can be lost through leaching and runoff as well. Installation of tile drains can reduce overland flow and hence reduce the loss of nutrients through runoff and erosion. When nutrient rich water is filtered through the soil, less N and P will exit the soil profile and enter the groundwater. However, when cracks in the soil and/or wormholes (called "macropores") create a direct link between the surface of the field and the tile lines (called "preferential flow"), nutrient losses can be large. There are no one-size-fits-all answers to dealing with preferential flow but there are some mitigation options that could be considered.

Mitigation Options

Nutrient loss through preferential flow is most likely to be an issue if manure is being spread within about 10 feet to either side of subsurface drainage lines and tiles are running. Currently, there is no application equipment that allows for manure application with the level of accuracy needed to avoid application directly over tile lines. In addition, the exact location of those tiles might not be known for older subsurface drainage systems.

More practical approaches to addressing preferential flow include avoiding manure application when tiles are actively flowing and to increase soil-manure contact at the time of application. The latter can be done through either (partial) incorporation of the manure (as opposed to surface application without incorporation) or through the installation of water table control technologies.

A promising approach that involves manure incorporation is to use aerators for (shallow) incorporation (Figure 1). The aerator will break preferential flow patterns with minimal soil carbon loss, reduce N volatilization from the manure as compared to surface application, and reduce erosion risk (greater surface residue) as compared to chisel or moldboard plowing.

Figure 1: Incorporating manure with an aerator.

Management of the water table through control structures at drain outlets is also a promising approach to reducing the amount of nutrients that exit the tile lines. Research has shown that if water is stored in the soil (by plugging the outlet) for 7-10 days after manure application, much of the manure nutrients that would otherwise be lost can be retained in the soil. This practice requires installation and management of a water control structure on each outlet (Figure 2). Some new

drainage systems for flat landscapes are being designed to reduce water flow through outlets with this in mind.

Figure 2: Installation of a water control structure in a field at the Miner Institute.

In addition to addressing the loss of manure nutrients into tile lines, capturing of the nutrients at the tile outlet could be effective. Several such approaches have been developed: (1) lining drainage ditches with gypsum, (2) inserting a highly absorptive material directly into the tile line, or (3) use of external "end-of-pipe" filters. All of these can help remove P from the tile discharge but additional work is needed to quantify effectiveness and economic feasibility of these approaches.

Practical Guidance

Some things to consider:

- *Installations of new tile*
  When installing new tile, make sure the system is properly designed pattern drainage (typically parallel lines through the whole field). This has many benefits over random tiling to drain specific areas within a field. Contact your local Soil and Water Conservation District (SWCD) for guidance and additional information (http://www.nys-soilandwater.org/contacts/county_offices.html).
- *Timing and amount of nutrient applications*
  Applying nutrients under good weather conditions and as close to crop uptake as possible improves nutrient uptake efficiency and reduces the risk of manure nutrient loss from fields during inclement weather.
- *Monitor the outflow during spreading events*
  Be aware of tile outlet locations and check these outlets periodically, particularly during or after manure spreading and in times when heavy flow is likely. If manure is applied when outlets are flowing, check outlets often for turbidity or manure breakthrough and discontinue spreading if concerns arise. An emergency action plan should include actions to be taken if a discharge occurs. For new systems, place outlets where some filtration will occur and implement water control structures where possible.
- *Incorporate manure*
  Tillage breaks up preferential flow pathways and mixes manure with the soil. It results in more filtering of water and sorption of nutrients as the water moves through the profile. Tillage does not have to mean intensive soil disturbance; there are several reduced tillage options that provide the desired benefits with low soil disturbance. An example is the use of an aerator for shallow mixing of manure and soil. Aerator incorporation also has the benefits of N conservation and odor reduction.

Additional Resources

- Agronomy Fact Sheet 57 (Subsurface (Tile) Drainage Benefits and Installation Guidance). http://nmsp.cals.cornell.edu/guidelines/factsheets.html.
- Emergency Action Plan Factsheet, NYS AEM. http://www.nys-soilandwater.org/aem/cnmp.html.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

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Nutrient Management Spear Program
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