



Agronomic Spotlight

Subsurface Drainage Management

- Tile drainage can help fields dry out quicker and decreases the amount of surface runoff, which reduces the loss of nutrients, sediment, and agricultural chemicals.
- There are concerns about the potential negative impacts on water quality from drainage reaching surface water, such as lakes and streams, and groundwater.
- The depth and spacing of subsurface drainage tiles can affect the quality of water exiting the system.

Benefits and Potential Concerns

Subsurface drainage is extensively used in the upper Midwest.¹ Drainage can help fields dry out more quickly and uniformly in the spring. Subsurface drainage systems have a positive impact because they generally decrease the amount of surface runoff, reducing the loss of nutrients, sediment, and agricultural chemicals. However, subsurface drainage systems can have potential negative impacts on the water quality of water bodies receiving drainage water, such as lakes and streams, and groundwater. Additionally, drainage may contribute to changes in the hydrology of watersheds. Research is ongoing to find cost-effective, local subsurface drainage improvements and crop management options that maintain profitability while mitigating water quality issues. Some benefits of subsurface drainage include:

- Improved yield potential of the field
- Timely planting
- Timely field operations
- Better soil tilth
- Deeper plant root zone
- Better plant stands
- Less plant stress
- Minimized compaction and soil salinity
- Improved harvesting conditions
- Less equipment wear

Tile drainage can promote better water infiltration. Studies indicate the potential for overall increases in water yield from 5 to 10%.² Research over many years has shown an average increase of 10 to 15% in crop yield when tile drainage is used in poorly drained soils.³ Typical yield responses to drainage can range from 10 to 30 bu/acre for corn and 4 to 8 bu/acre for soybean.

Subsurface drainage systems generally decrease the amount of surface runoff and transport of substances with overland flow. Midwest research has shown that subsurface drainage can help reduce surface runoff by 29 to 45%, which helps reduce sediment losses by 16 to 65% and phosphorous losses up to 45%.⁴



Figure 1. Subsurface drainage installation

Tile Spacing and Depth

Tile depth and spacing determines the rate of water removal from soil. A close relationship exists between soil permeability and the spacing and depth of tile drains (Table 1). Many tile systems were designed to quickly remove excess water from the plant root zone to help manage stress and improve yield potential. Different combinations of tile depth and spacing can have different effects on the quality of water exiting the system, while still effectively removing excess water from the field.

The goal of many current drainage programs is focused on optimizing yield potential while addressing water quality issues. Preliminary research results indicate that tiles at shallower depths and spaced closer together can reduce the nitrate concentration in tile water while maintaining yield potential.⁵ In this system, nitrates are converted to nitrogen gas by denitrifying bacteria, preventing nitrates from reaching tile and surface water. University of Illinois research has shown that a favorable rate of return and improved water quality were achieved with a 45 foot tile spacing and at a 2 foot depth.⁶

Fields with high water tables and irrigated fields can accumulate soluble salts in the plant root zone over time, which can reduce plant vigor and growth. Yield reductions for most crops can occur when salinity levels are above 1 millimhos per centimeter.³ Tile drainage systems can help reduce the salt concentration of the soil by improving water movement and

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leaching of soluble salts through the soil profile.³ During the process of reducing the soil salt concentration in a field, a sequence of more salt tolerant crops, such as small grains, should be considered before growing a salt sensitive crop, such as dry beans.⁷

Table 1. General parallel drain lateral spacing and depth suggestions

Soil type	Soil permeability	Drain spacing in feet for:			Drain depth in feet
		Fair drainage	Good drainage	Excellent drainage	
Clay loam	Very low	70	50	35	3.0 - 3.5
Silty clay loam	Low	95	65	45	3.3 - 3.8
Silt loam	Moderately low	130	90	60	3.5 - 4.0
Loam	Moderate	200	140	95	3.8 - 4.3
Sandy loam	Moderately high	300	210	150	4.0 - 4.5

Source: Wright, J. and Sands, G. 2001. Planning an agricultural subsurface drainage system. University of Minnesota.

Subsurface Drainage Management Options

A tile drainage management plan should include practices to reduce nutrient movement in tile water. Agricultural drainage research and education programs are working to identify viable management options to maintain crop productivity and improve drainage while helping to reduce water quality concerns. Strategies include:

- Nutrient best management practices
- Proper tile depth and spacing for soil types
- Shallow drainage to reduce nitrate loss
- Controlled drainage or drainage water management
- Reduced drainage intensity
- Improved surface outlets
- Wood chip bioreactors, rock inlets
- Winter cover crops
- Perennial crops in rotations
- Two-stage ditches
- Wetland restoration, constructed wetlands
- Nutrient retention basins

Cover crops can be used effectively to reduce soil erosion, reduce the need for herbicides and other pesticides, protect water quality by limiting nitrogen leaching, and increase soil organic matter.

Each of the 12 states in the Mississippi River Basin are working in concert with a broad base of stakeholder groups and federal agencies to implement local nutrient reduction strategies to support agricultural output and improve water quality.⁸ An important part of the program is the 4R philosophy (using the right fertilizer source at the right rate, at the right time, with the right placement) that relies on an innovative and science-based approach to offer environmental protections, increased production and profitability, and improved sustainability to promote improved nutrient utilization to reduce nutrient losses.

Sources

¹ Sugg, Z. 2007. Assessing U.S. farm drainage: can GIS lead to better estimates of subsurface drainage extent? World Resources Institute. ² Sands, G.R. Drainage fact sheet M1292. University of Minnesota. www.drainageoutlet.umn.edu. ³ Sands, G.R., Kandel, H., Scherer, T., and Hay, C. 2012. Frequently asked questions about subsurface (tile) drainage in the Red River Valley. University of Minnesota. ⁴ Zucker, L.A. and Brown, L.C. 1998. Agricultural drainage: water quality impacts and subsurface drainage studies in the Midwest. Extension Bulletin 871. Ohio State University. ⁵ Frankenberger, J., Klavivko, E., Sands, G., Jaynes, D., Fausey, N., Helmers, M., Cooke, R., Strock, J., Nelson, K., and Brown, L. 2006. Drainage water management for the Midwest. WQ-44. Purdue University. ⁶ Illinois drainage guide. www.wq.uiuc.edu. ⁷ Bauder, T.A., Davis, J.G., and Waskom, R.M. 2014. Managing saline soils FS 0.503. Colorado State University. ⁸ Mississippi River Gulf of Mexico Watershed Nutrient Task Force. <http://water.epa.gov>. Web sources verified 10/13/16. 150115133441

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