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4R MANAGEMENT TO REDUCE PHOSPHORUS LOSSES FROM AGRICULTURAL SUBSURFACE DRAINAGE

Installation of artificial subsurface drainage, often referred to as tile drainage, has been increasing across agricultural cropland in Midwestern states of the US since the mid-1970s. Tile drainage can improve soil aeration and reduce crop damage that results from seasonally high water tables or inundated fields. Yield increases often result from warmer soil temperatures, earlier planting dates and enhanced root development. These systems were designed to quickly remove excess water from the plant root zone to improve soil conditions and reduce plant stress.

As a result of field drainage, land that was previously hydrologically disconnected from rivers and streams now has a direct conduit to remove early spring snowmelt and precipitation from storm events more rapidly. Although P is a relatively immobile nutrient because its soluble ions bind to soil particles, a fraction is water soluble and can be lost through leaching. Although surface erosion may be decreased with tile drainage, an unintended consequence is the potential to lose more nutrients through subsurface flow through the tile drains. The dissolved P is the portion that is plant available; once it enters a waterbody it can accelerate plant and algal growth, leading to eutrophication.

In order to reduce the risk of losing dissolved P nutrients through subsurface drainage, consider incorporating 4R application practices into your P management. The 4Rs refer to the right source, right rate, right time and right place for each nutrient application.

Source: With any nutrient source, it is critical that an accurate nutrient analysis is available to prevent overapplication. Plant available P is water soluble; therefore, it is susceptible to loss when precipitation occurs before the opportunity to interact with the soil or for crop utilization. This opportunity for loss is reduced when the P source is applied at the appropriate rate and time, while placed where it is easily accessible to crops, minimizing loss pathways.

Rate: Applying fertilizer at rates greater than crop removal can cause an increase in soil test P (STP) concentrations, which can result in increased subsurface drainage P losses. To reduce subsurface drainage P loss, STP should be maintained near the critical soil P concentration. A soil test following the installation of new subsurface drainage into an area that was previously poorly drained may be beneficial to account for any changes in soil P mineralization since the drainage improvement can increase aeration and organic matter decomposition rates.



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“Fertilizer source, rate, timing and placement - the 4Rs - must be considered collectively in order to reduce subsurface dissolved P drainage losses.”

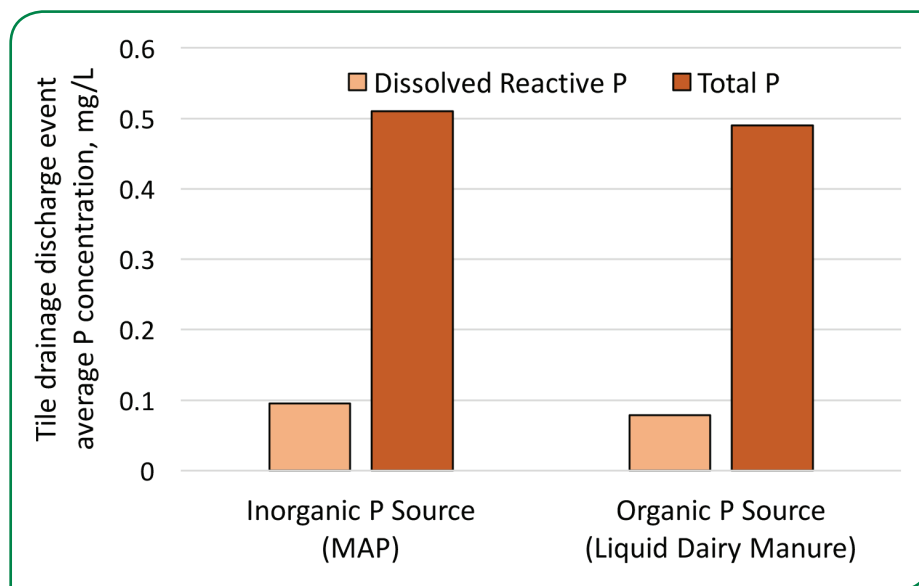
Timing: Losses of dissolved nutrients through tile lines tend to coincide with storm or large-snowmelt events, and are greatest during cool, wet conditions outside of the growing season. Therefore, the timing of nutrient application is important for managing both surface and subsurface dissolved P losses. Dissolved P losses in tile drainage decrease as the timing between application and the initial rainfall event lengthens. To reduce the potential for P loss through tile drains, consider spring fertilizer application when there is a lower soil-water content, and avoid rain and snowmelt events.

Placement: Preferential flow through macropores formed by roots, earthworms, and cracks can be a key factor driving nutrient loss to tile lines. In areas where the water quality priority is to minimize dissolved P loss, light tillage versus no-till may

reduce surface P stratification and break the preferential flow paths to reduce subsurface losses. Alternatively, surface disturbance could be minimized by subsurface placement of P fertilizer in no-till systems by banding or injection. This will reduce P stratification and increase soil-fertilizer contact. Subsurface placement of P fertilizers near the crop row or in furrow where the roots are most active reduces both surface P runoff losses and dissolved P subsurface loss in tile water. Broadcasting without incorporation should be avoided when and where there is a likely runoff risk.

References

King, K.W. et al. 2018. JSWC 73(1):35-47. doi:10.2489/jswc.73.1.35.



Edge-of-field monitoring data at a paired field site in northwest Ohio with similar soil test P. Application of MAP versus liquid dairy manure at the same rate indicated no significant difference in the susceptibility for total P or dissolved P losses (King et al., 2018).