N management influences on N losses through tile lines

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Abstract
Subsurface tile drainage from row-crop agricultural production systems has been identified as a major source of nitrate entering surface waters in the Mississippi River Basin. Tile drainage studies have been conducted on three drainage research facilities at two locations in Minnesota since 1973. Nutrient and crop management systems, including rate and time of nitrogen (N) application, N sources (fertilizer, dairy manure, and hog manure), nitrification inhibitors, cropping systems, and tillage systems have been evaluated to determine their agronomic and environmental characteristics. Results from these studies have been instrumental in the development of best management practices for nutrient management in Minnesota.

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Subsurface tile drainage from row-crop agricultural production systems has been identified as a major source of nitrate entering surface waters in the Mississippi River Basin. Tile drainage studies have been conducted on three drainage research facilities at two locations in Minnesota since 1973. Nutrient and crop management systems, including rate and time of nitrogen (N) application, N sources (fertilizer, dairy manure, and hog manure), nitrification inhibitors, cropping systems, and tillage systems have been evaluated to determine their agronomic and environmental characteristics. Results from these studies have been instrumental in the development of best management practices for nutrient management in Minnesota. This information is applicable to much of north central Iowa because the soils, cropping systems, and climate are similar.

The primary factors that influence the nitrate content of surface and subsurface waters draining agricultural landscapes can be divided into two categories: uncontrollable and controllable. Uncontrollable factors include precipitation, other climatic factors, and soil mineralization. Controllable factors include agricultural management practices that can be used by crop producers to best fit the needs of their enterprise and include 1) cropping system used, 2) rate of N applied, 3) time of N application, 4) placement method, 5) use of a nitrification inhibitor, and 6) tillage systems.

Loading of nitrate-N into surface water is a function of amount of drainage water and nitrate-N concentration in the transported water. The amount of drainage water leaving the landscape is largely a function of climate and soil properties, e.g., precipitation, texture, and infiltration rate. Drainage is further influenced by the temporal distribution of precipitation within a year and the amount of annual or growing season precipitation.

Numerous studies conducted on subsurface, tile drainage plots at Waseca and Lamberton, Minnesota, show the following:

- Distribution and amount of annual precipitation greatly affect drainage volume, nitrate concentrations, and nitrate losses. Approximately 65 percent of southern Minnesota's annual subsurface drainage volume and 70 percent of the annual nitrate-N losses in drainage occur in April, May, and June. Drainage volume is greatest in April, whereas nitrate-N losses are greatest in May. Nitrate-N concentrations and losses are greatly affected by dry and wet climatic cycles with greatest losses occurring in wet years after abnormally dry years.
- Nitrate losses from the landscape are highly related to the cropping system. Row crops, i.e., corn and soybean, yield much greater drainage volumes and nitrate-N concentrations in the drainage water than do perennial crops, i.e., alfalfa and conservation reserve program. Nitrate-N losses can be 30 to 50 times higher from
these row crops compared with perennial crops.

- Nitrate losses to subsurface drainage are greatly influenced by rate of N application and moderately influenced by time of N application. A 40-pound overapplication of N in excess of crop needs can be expected to increase nitrate-N concentrations in the drainage by 6 to 20 milligrams/liter (parts per million), depending on the severity and length of the preceding dry year(s). Nitrate-N losses increase as N rate increases with the magnitude of loss being much greater in wet years compared with dry years. Late fall applications of anhydrous ammonia with N-Serve or spring application of anhydrous ammonia can reduce nitrate-N concentrations by 3 to 4 milligrams/liter and losses by 8 to 16 pounds/acre/year compared with fall application of anhydrous ammonia without N-Serve. Early fall application increases the potential for greater nitrate-N concentrations and losses in drainage water, especially because the majority of leaching occurs early in the spring.

- Tillage has been shown to have minimal effects on nitrate losses in drainage from continuous corn grown in Minnesota. However, fall tillage after soybean would probably encourage soil mineralization and nitrate losses in the spring in portions of the Corn Belt where soils are not frozen for much of the late fall and early spring.

Use of best management practices by farmers reduces nitrate losses to subsurface drainage. But, will these practices be sufficient to reduce nitrate losses to meet the environmental goals of society? If not, will policies be developed to effect changes in land use, cropping systems, N application practices, subsurface drainage systems, or will other mitigating practices be required?

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