

Drainage Water Quality Impacts of Various In-field Nutrient Management Practices: Findings from 25 Years

Since 1989, a study of the effects of nitrogen (N) management and herbicide management practices on the quality of tile drainage has been performed on individually drained plots in north-central Iowa near Gilmore City, Iowa. In total, there are 72 plots which are each 50 ft. wide and 125 ft. long (Figures 1 and 2). The center tile line from each plot is monitored continuously for flow volume and a flow-proportional sample is collected for water quality analysis (Figure 3).

This document provides a brief summary of some major findings from this study. The research at this site has been important for understanding nutrient movement in the tile drained landscape and is one of the longest running, continuously active drainage research sites in the United States.



Figure 1. Aerial photo of Gilmore City research facility

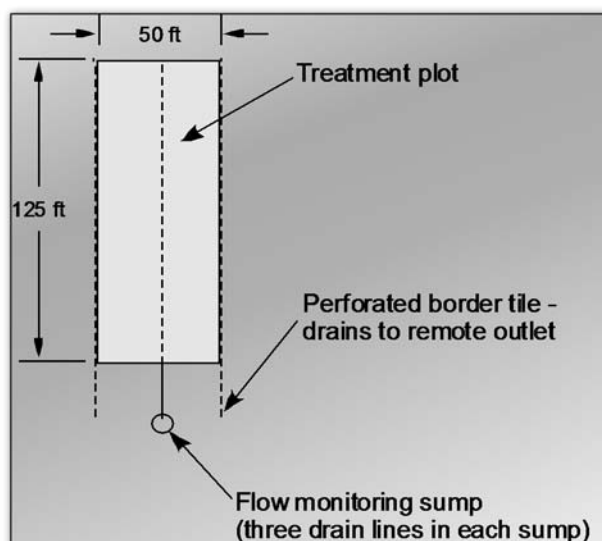


Figure 2. Subsurface drainage layout for individual plot



Figure 3. Drainage monitoring sump configuration

Bottom Line from 25 Years of Drainage and Water Quality Studies

- When N fertilizer is applied at economic N-rates, the average concentration of nitrate-nitrogen in tile drainage ranged from 12 to 16 mg/L (drinking water standard is 10 mg/L) (Figure 4).
- When similar nitrogen application rates to corn are used in a corn-soybean rotation or in a continuous corn rotation similar nitrate concentrations are observed in the tile drainage. When an additional 50 lbs-N/acre are applied to continuous corn, nitrate concentrations are about 25% greater than from the corn-soybean system.
- For our site, a 120–160 lb-N/acre fertilization rate for a corn-soybean rotation allowed the corn to reach its yield potential.
- Over the long-term, approximately 10 in. of the annual (30 in.) precipitation exited through the tile drains. This resulted in an average nitrate-nitrogen loss of approximately 31 lb-N/acre through the drainage system for a 150-160 lb-N/acre fertilization rate to corn in a corn-soybean rotation. Due to weather conditions, the annual loss at this application rate varied from 0.9 lb-N/acre to 94 lb-N/acre (Figure 5)

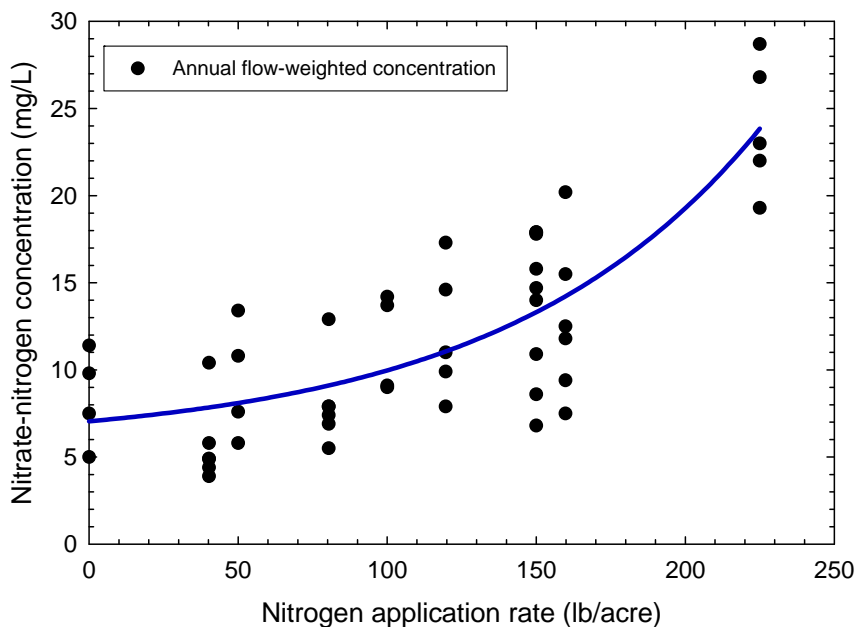


Figure 4. Overall nitrogen application rate effect on nitrate-nitrogen concentration for a corn-soybean rotation (1990-2004)

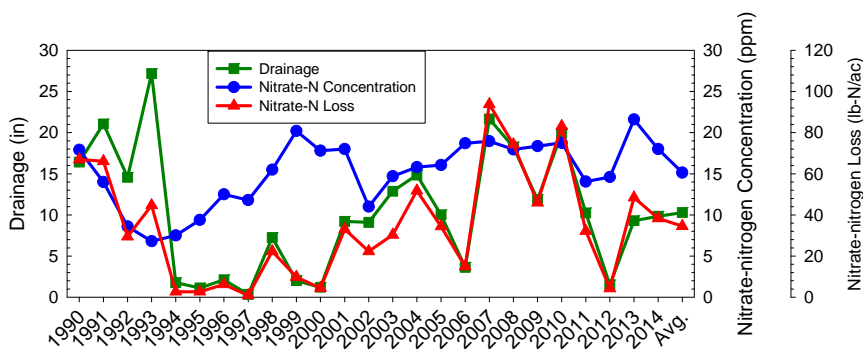


Figure 5. Comparison of drainage, nitrate-nitrogen concentration and nitrate-nitrogen loss for the 150-160 lb-N/acre fertilization rate to corn in a corn-soybean rotation

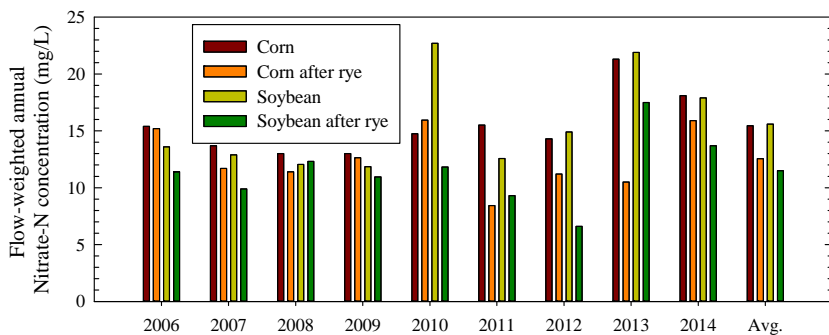


Figure 6. Impact of winter cereal rye cover crop on nitrate-N concentration

- For a corn–soybean rotation with no N fertilizer applied there was still 15–20 lb-N/acre lost through tile drains at nitrate-nitrogen concentrations of 6–8 mg/L.
- In general, the concentration of nitrate-nitrogen in the tile drains was similar for the corn and soybean phases of a corn–soybean rotation.
- The nitrate-nitrogen concentration in tile drainage from treatments fertilized with liquid swine manure was similar to areas treated with equal amounts of commercial fertilizer. Generally, the yields were improved through the use of the swine manure.
- Although spring application of N fertilizer would be the preferred timing for application, during the 15 yrs that timing of fertilizer application was studied there was little difference in the concentration or loss of nitrate-nitrogen between spring- and fall-applied N fertilizers.
- The loss of herbicides through tile drainage was studied for 10 yrs, and it was found that the concentrations of the herbicides exiting the drainage system were all below the Environmental Protection Agency’s (EPA’s) maximum contaminant level except for Bladex (cyanazine), which is now banned.
- Cover crops show potential for reducing nitrate-N loss (Figure 6)
- Overall, the research has shown that nitrate-nitrogen concentration generally exceeded 10 mg/L under a corn–soybean rotation when fertilized at common rates; even when no fertilizer is applied, there is loss of nitrate-nitrogen. Based on these studies, high nitrate levels are less about result of the land use and cropping practices.

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