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Managing Water for Tomorrow's Agriculture

USDA United States Department of Agriculture

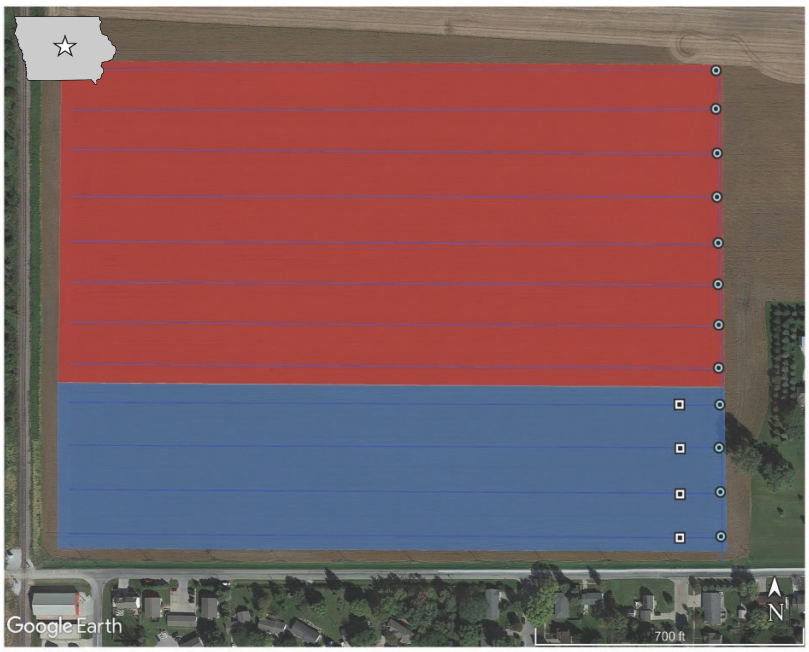
IA-STORY2

Controlled Drainage

Dan Jaynes

SITE SUMMARY

The research was conducted on a private 54 acre field located near Story City, Iowa (Figure 1). The field was in a corn – soybean rotation. The site consist of clay loam soils ranging from very poorly to somewhat poorly drained. There were four controlled drainage (CD) and eight conventional drainage (CNV) plots at this site. Areas of individual plots range from 3.4 for conventional drainage to 4.5 acres for controlled drainage. Each CD plot had a single tile installed down the middle of the plot at a depth of 4 feet, with a tile spacing between plots of 120 feet. CNV plots had tiles installed at the same depth, but with a tile spacing of 90 feet. All plots were designed to have a maximum drainage coefficient of 0.75-1.00 inches/day. Drainage water management (DWM) consisted of raising the outlet in the control structures to 4 inches below the soil surface after harvest, lowering the outlets to the elevation of the tile several weeks before planting, and raising the outlets to 2 feet below the soil surface in June after all crop management activities had been completed. In the fall, the outlet elevations were lowered to the elevation of the tiles two weeks before harvest, then raised again after harvest and fall tillage.



Controlled Drainage
Conventional Drainage
Observation Well
Drain Tile
Control Structure

Figure 1. Drainage map of Story County, Iowa drainage research site.

Box 1. Site info

CHARACTERISTICS

- Drainage system installed in 1992
- Soil: Kossuth-Ottosen, Harps, and Okoboji clay loams
- Rotation: Corn-Soybean

WATER MANAGEMENT PRACTICES

- Conventional Drainage (depth 4 feet, spacing 90 feet)
- Controlled Drainage (depth 4 feet, spacing 120 feet)

MEASUREMENTS IN DATABASE

DRAINAGE SYSTEM

- Tile Flow (2006-2009)
- Tile Water Quality: Nitrate-N (2006-2009)

SOIL

- Soil Texture (1996)
- Soil Bulk Density (1996)
- Soil Fertility: Soil Organic Carbon, Total N (1996)
- Soil Nitrate and Ammonium (2006-2009)

WEATHER

- On-Site Weather Station: Precipitation, Air Temperature, Relative Humidity, Solar Radiation, Wind Speed and Direction, Evapotranspiration (2005-2013)

CROP

- Crop Yield: Corn (2006, 2008), Soybean (2007, 2009)
- Total N: Grain (2006-2009)

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This material is based upon work that is supported by the National Institute of Food and Agriculture , U.S. Department of Agriculture , under award number 2015-68007-23193 , "Managing Water for Increased Resiliency of Drained Agricultural Landscapes", http://transformingdrainage.org. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

SUMMARY OF RESULTS

NITRATE CONCENTRATION

Flow weighted annual nitrate concentration ranged from 7 to 13 mg-N L^{-1} for the CNV treatment and from 6 to 11 mg-N L^{-1} for the CD treatment (Figure 2). Averaged over the four years, NO_3 concentrations for the CNV treatment were greater than for the DWM treatment by 1.4 mg N L^{-1} or about 13% but the difference was not significant. These results are similar to most other DWM studies, where little to no significant differences have been found in NO_3 concentrations from this practice (e.g., Evans et al. 1995).

NITRATE MASS LOSSES

Nitrate mass losses for CD were numerically lower than for CNV in every year and for the four years combined (Figure 3). Annual mass losses ranged from 19 to 46 kg N ha^{-1} (17 to 41 lb N ac^{-1}) for the CNV treatment and from 14 to 35 kg N ha^{-1} (13 to 31 lb N ac^{-1}) for the CD treatment. Averaged over the four years of the study this difference equaled 10 kg N ha^{-1} yr^{-1} (9 lb N ac^{-1} yr^{-1}) for a 29% reduction in nitrate mass loss. Mass loss appeared to be more influenced by the amount of rainfall and tile flow than by the crop. This behavior has been observed by many others (e.g. Gilliam et al. 1979) and illustrates the importance of hydrology on nitrate losses from these systems.

YIELD

Yields for the CD treatment were numerically higher than for the CNV treatment in 2006, 2007, and 2009. However, only in the soybean year (2007) and for the combined soybean years were the yield differences by drainage treatment significant, increasing by an average of 8% (4.6 bu/ac). In 2008, CD actually resulted in a 2.9 bu/ac lower corn yield than CNV. This may have been due to the relatively wet weather throughout the growing season. These results were consistent with modeling studies of CD that show only about a 3 – 4% yield increase with CD over CNV for corn and soybean across the Midwest (Thorp et al. 2008).

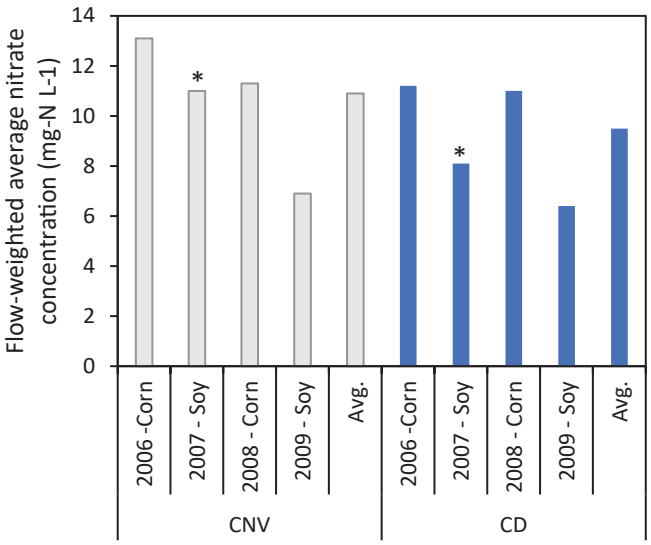

Figure 2 Flow-weighted average nitrate concentration for conventional (CNV) and controlled drainage (CD) for the years 2006 – 2009 and the average over all years.

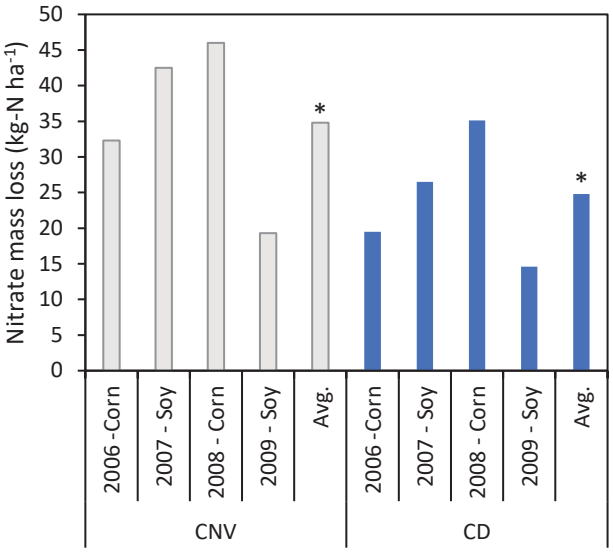

Figure 3 Nitrate mass loss for conventional (CNV) and controlled drainage(CD) for the years 2006 – 2009 and the average over all years.

PUBLISHED WORKS FROM THE SITE

Jaynes, D.B. 2012. Changes in yield and nitrate losses from using drainage water management in Central Iowa, USA. J. Soil and Water Conservation 67:485-494.

OTHER REFERENCED WORK

Evans, R.O., R.W. Skaggs, and J.W. Gilliam. 1995. Controlled versus conventional drainage effects on water quality. Journal of Irrigation and Drainage Engineering 121(4):271-276.

Gilliam, J.W., R.W. Skaggs, and S.B. Weed. 1979. Drainage control to diminish nitrate loss from agricultural fields. Journal of Environmental Quality 8(1):137-142.

Thorp, K.R., Jaynes, D.B., Malone, R.W. 2008. Simulating the long-term performance of drainage water management across the Midwestern United States. Transactions of the ASABE. 51(3):961-976.

Data Access

Data from this site are available through the USDA National Ag Library Ag Data Commons repository (https://doi.org/10.15482/USDA.ADC/1521092) or the interactive website at Iowa State University with visualization and querying capabilities (https://drainagedata.org).

ACKNOWLEDGEMENTS

TRANSFORMING DRAINAGE PROJECT

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