

Nitrogen Application and Its Impact on Water Quality

Glenn A. Raines, Agronomist
University of Illinois

Statement:

Subsurface **tile drainage** from row-crop production on **high organic matter** soils has been identified as a **major source** of **nitrate** entering surface waters.

G. Randall, MN (2000)

N Impact on Water Quality

- N is naturally occurring
- N is essential to plant growth
- Agriculture identified as major contributor
- N is mobile in the soil, (leaching)

Statement:

Total N concentrations were nearly **9 times greater** downstream from agricultural lands than downstream from forested areas.

Omernik, OR (1997)

Statement:

Very little nitrate - N is lost from the agricultural landscape via surface runoff.

Jackson in JEQ (1973)

Logan in S&Til Res. (1994)

Statement:

Agricultural disturbance (tillage) leading to high mineralization rates & N fertilization combined with subsurface tile drainage contributed greatly to nitrate export in the Embarras River in IL.

Characteristics of Rivers with High Nitrates

- Humid/high rainfall
- High organic matter soils
- Poorly drained, fine textured soils
- Tile drainage required
- Dominant corn-soybean intensive cropping

Factors That Effect Nitrate Content in Waters

- Rainfall, and other climatic factors
- Soil mineralization

[These are uncontrollable]

N In Mississippi River Basin

Sources:

- **Fertilizers**
- **Livestock
Manure**
- **Legumes and
Grasses**

Sources:

- **Domestic Waste**
- **Rainfall**
- **Municipal &
Industrial**

N In Mississippi River Basin

- Fertilizer usage has leveled, 1980-87
- Ag. N is partially filtered prior to entering a major water course.
- Municipal discharges are directly into the river.

Mississippi River Basin Contributions of Nitrate & Water

<u>River Basin</u>	Water <u>Discharged</u>	<u>Nitrate</u>
	----- % -----	
Upper Miss. River	22	51
Illinois River	4	12
Missouri River	10	9
Ohio River	41	21
Lower Miss. River	23	7

Antweiler,(1995)

Controllable Factors that Effect Nitrate in Waters

- Cropping System
- Rate of N and Time of Application
- Placement Method
- Use of an Inhibitor
- Tillage Systems

Nitrate - N Levels and Losses Are Affected by Dry & Wet Climatic Cycles

Dry cycle = increased residual soil N
= lower crop removal

Wet cycle = increased drain tile flow
= higher nitrate N loss

Effects of Precipitation

- Minnesota River Basin (10 million A.)
- Rainfall (W) = 22 in.
- Rainfall (E) = 32 in.
- High O.M. & tile drain on half of basin

Randall, MN. (2000)

Effects of Precipitation

- Monitored from 1977-1994
- N levels from 0.36 mg/L on west
- N levels to 4.6 mg/L on east
- Mean rainfall increases 10 in. across the area

Randall, MN. (2000)

Effects of Mineralization

- Conversion of organic forms to inorganic forms, i.e. NH_4^+ , NO_3^-
- High organic matter contributes high amounts
- Requires ideal moisture and temperatures

Effects of Mineralization Fallowed Land 1987-1999

- N in tile water - 57 mg/L in 1990
(Following 3 dry years)
- N in tile water - 38 mg/L in 1991
- 25 mg/L in 1992
- N in tile water - averaged 20 mg/L
through 1999

Effects of Cropping Systems

- Nitrate - N in subsurface drainage is related to cropping systems
- Nitrate - N under alfalfa and grass much lower than corn or soybeans

Effect of Cropping Systems Tile Lines 1990-93 in MN.

<u>Crop System</u>	<u>Total Drainage</u> inches	<u>Nitrate-N Conc.</u> ppm	<u>Loss</u> lb/A
CC	30.4	28	194
C/S	35.5	23	182
S/C	35.4	22	180
Alf.	16.4	1.6	6
CRP	25.2	0.7	4

Effect of N Rate & Time of Application, MN

Nitrogen Trt.		Annual Loss of	5-Yr Yield
Rate	Time	<u>NO₃-N in Water</u>	<u>Average</u>
lb/A		lb/A/Yr	bu/A
0	---	7	66
120	Fall	27	131
120	Spring	19	150
180	Fall	34	160
180	Spring	26	168

(Source: Amm. Sulfate applied 11/1 or 5/1)

Effect of Tillage for CC on Nitrate-N Losses in Tile (MN.)

<u>Parameter</u>	Tillage System	
	<u>MB Plow</u>	<u>No Till</u>
Drainage volume (in)	11.0	12.4
Nitrate-N conc. (mg/L)	15	13
Nitrate-N lost (lb./A)	38	37
N lost as % of applied N	21	20

(11 yr. Average 1982-92)

Effect of Mineralization

Elevated levels of nitrate-N will be lost to tile water from row crops grown on high O.M. soils **regardless** of fertilizer management practices.

Effects of Cropping Systems

Even though alternative cropping systems can reduce nitrate losses, obtaining a market for the crop and satisfactory economic return is a serious challenge.

Rate of Nitrogen Application

- Management in applying the proper rate for the crop
- Too little N will hamper yields
- Too much N is often called “insurance”.

Rate of Nitrogen Application

- Follow University guidelines
- Factor in credits
- Choose an appropriate N source
- N applied in excess of crop need, increases N loss

Rate of Nitrogen Application

(Survey in Champaign Co., IL.)

- Nearly 70 % of farmers applying 40 lb/A more N than need

Reason: “Risk aversion”

Hoefl, (1999)

Rate of Nitrogen Application

Over applying by 40 lb/A can elevate Nitrate-N by 6 to 20 mg/L depending on the severity of a dry spell.

Rate of Nitrogen Application

- Manure Management: Applied with disposal or utilization in mind?

Rate of Nitrogen Application

Manure Management

- Know nutrient content
- Use BMP for crop that's grown
- Apply in a responsible manner
- Know existing soil test values

Time of Nitrogen Application

Fall Application

- More time to apply
- Slightly lower yields
- Higher nitrate-N in tile water
(36 % higher)

Time of Nitrogen Application

Spring Application

- Less time to apply in spring
- Slightly higher yields
- Lower nitrate-N losses in tile water
- Higher risk of not being timely

Time of Nitrogen Application

Ammonia

- Greatest N loss was fall applied without a stabilizer
- N recovery in corn, lower with fall application w/o a stabilizer
- Use of stabilizer, a must for fall application

Effects of Tillage on N - Losses

- Iowa studies show tillage having less effect on nitrate-N loss than crop rotations

Bjorneberg, IA (1996)

Effects of Tillage on N - Losses

- MB Plow gave lowest tile line flow volumes
- Ridge till & No Till had lowest nitrate-N levels
- More water drained from the No-till areas

Summary: Tillage has little influence on N loss.

Relationships of Nitrate Loss & Nitrogen Application

- Nitrate loss in tile lines related to previous history of excessive rates of N.
- Nitrate loss was higher following corn than soybeans.
- Residual soil nitrate - N highest in fields with history of excessive N applications.

N Loss Summary

- Rainfall
- Nitrate losses related to cropping system
- Nitrate losses in tile lines influenced by Rate of N and Time applied
- Placement of N & Tillage have minimal effects
- Use of BMP's will reduce loss

Thanks For Your Attention!

Glenn A. Raines, Agronomist

ORR Research Center

University of Illinois

g-raines@uiuc.edu