2005

NO3-N Concentrations in Shallow and Deep Groundwater Wells from 1991 to 2003

Carl H. Pederson
Iowa State University, carl@iastate.edu

Rameshwar S. Kanwar
Iowa State University, rskanwar@iastate.edu

NO3-N Concentrations in Shallow and Deep Groundwater Wells from 1991 to 2003

Abstract
Nitrates from fertilizers and manure application have been detected in the surface and groundwater in many agricultural regions of the country including Iowa. The current practices of fertilizer application methods and rates are believed to be contributing significantly in the contamination of groundwater. Therefore, it is imperative that tillage and planting systems, regarded as best management practices for agricultural sustainability, minimize the potential for chemical runoff and leaching losses into groundwater with alternative chemical management systems. If the potential for contamination is not reduced by developing and successfully demonstrating the innovative nitrogen management practices, additional regulations could be the result.

Keywords
Agricultural and Biosystems Engineering

Disciplines
Agricultural Science | Agriculture | Bioresource and Agricultural Engineering

NO_3-N Concentrations in Shallow and Deep Groundwater Wells from 1991 to 2003

C. Pederson, research associate
R. S. Kanwar, professor and department chair
Department of Agricultural and Biosystems Engineering

Introduction

Nitrates from fertilizers and manure application have been detected in the surface and groundwater in many agricultural regions of the country including Iowa. The current practices of fertilizer application methods and rates are believed to be contributing significantly in the contamination of groundwater. Therefore, it is imperative that tillage and planting systems, regarded as best management practices for agricultural sustainability, minimize the potential for chemical runoff and leaching losses into groundwater with alternative chemical management systems. If the potential for contamination is not reduced by developing and successfully demonstrating the innovative nitrogen management practices, additional regulations could be the result.

Materials and Methods

The Nashua water quality site has 36 one-acre experimental plots with fully documented tillage and cropping records for the past twenty-five years. Tile drainage was installed in 1979 into all of the 36 approximately one-acre blocks (190 ft × 220 ft). The tile lines were installed about four feet deep at 95-ft spacings. Each one-acre plot has one tile line passing through the middle of the plot, with another tile line at each of the two borders.

Each plot has two piezometers (1.5-in.-diameter plastic pipe with an open bottom) installed 50 ft apart at depths of 6 and 8 ft. A set of nested deep wells was installed in 1990 to monitor the quality of groundwater at depths of 10, 15, 25, 35, and 65 ft. These wells will also be used to examine geochemical processes that effect recharge water to the bedrock aquifer. Piezometers are used to measure hydraulic head gradients and to obtain water samples for nitrate.

Monthly water samples were collected during the growing season from each piezometer and deep well. Since 1991, over 4,500 piezometer and 450 deep well samples have been collected and analyzed for nitrate concentration.

Results and Discussion

Results from the shallow piezometer samples (6- and 8-ft depths) indicate higher levels of NO_3-N concentrations (13.2–20.3 mg/L) in 1991 and 1992 when research cropping practices received 150 lb N/acre for corn in rotation to 180 lb N/acre for continuous corn. Nitrogen application rates were reduced to 100 lb N/acre for corn in rotation and to 120 lb N/acre for continuous corn 1993 to 1999. The NO_3-N concentrations in piezometer samples ranged from 8.7 mg/L to 12.1 mg/L for both 6- and 8-ft depths. Again in 2000, the application increased to an average of 150 lb N/acre for corn in rotation. The continuous corn rotation practice was terminated. From 2000 to 2003, the piezometer samples levels ranged from 10.8 mg/L to 17.8 mg/L for both 6- and 8-ft depths. This data clearly shows that a NO_3-N concentration in shallow groundwater is directly proportional to the N application rates in the plots. Higher N application rates resulted in high NO_3-N concentrations in piezometers at the 6- and 8-ft depths.

Results from this continuous monitoring indicate that the nitrate-nitrogen concentrations for the deep wells are far below the 10 mg/L health advisory level and indicate that very little nitrogen is leaching into the groundwater system.

Nashua monitoring well samples average nitrate concentration, mg/L

	Year	Rain, inches	N applied Rate lb/ac		Piezometer		Well Depth				
			CC	CS	6'	8'	10'	20'	30'	50'	65'
System I	1991	36.7	180	150	19.4	20.3					
	1992	24.2	180	150	13.2	15.8	7.3	1.7	1.7	2.2	2.9
System II	1993	39.1	120	100	10.1	13.1	5.0	0.6	0.7	1.1	1.8
	1994	27.2	120	100	8.7	10.5	7.4	0.3	0.4	0.0	1.5
	1995	29.5	120	100	10.2	10.4	5.8	0.0	0.0	0.2	0.6
	1996	21.7	120	100	12.1	11.1	7.9	1.0	0.3	0.0	0.5
	1997	27.4	120	100	10.2	11.4	6.0	1.7	0.1	0.0	0.6
	1998	38.6	120	100	11.7	11.3	5.1	1.4	0.5	0.2	0.9
	1999	42.8	120	100	10.1	10.9	5.9	0.6	0.0	0.0	1.1
System III	2000	24.5	-	150	11.7	10.8	*	0.0	0.3	1.1	0.9
	2001	22.3	-	150	14.2	13.6	6.9	1.6	0.3	0.5	1.3
	2002	27.5	-	150	14.0	14.3	6.4	3.9	0.7	0.5	1.5
	2003	19.9	-	150	17.8	15.6	6.9	2.8	0.8	0.4	1.2
	Overall Average				12.0	12.4	6.4	1.3	0.5	0.5	1.2

* Year 2000 values excluded due to analysis calibration errors.