Technical Note #56 from Watershed Protection Techniques. 1(5): 276-278

Nitrate Leaching Potential from Lawns and Turfgrass

It is well documented that high rates of nitrogen fertilization of row crops, such as corn, soybeans and tobacco, can cause nitrate to leach into groundwater at concentrations in excess of 10 mg/l. Nitrate levels of this magnitude can contaminate drinking wells, and lead to nutrient enrichment problems in sensitive coastal waters.

Given that many lawns receive high applications of nitrogen fertilizers (roughly 100 to 250 lbs/acre of inorganic-N) is there a similar risk of nitrate leaching from turfgrass? The conventional wisdom is that grass poses a much lower risk of nitrate leaching. It is thought that grass, by virtue of its extensive fibrous root network and dense thatch layer, effectively retains nitrogen fertilizer at the soil surface or within the root zone, thereby preventing soluble nitrates from percolating downward into groundwater (under normal conditions and in most environments).

A review of five nitrate-leaching studies by turfgrass researchers generally confirms this notion for most finely-textured soils (Table 1). For example, mean annual nitrate concentrations in soil water ranged from one to four mg/l in turfgrass studies conducted on fertilized sandy loams or silt loams. Although mean annual nitrate concentrations from turfgrass were relatively low in comparison to crops, they do exhibit a strong seasonal variation. The trend is toward lower nitrate levels in the early growing season (April to August) followed by sharply higher levels during the last stages of the growing season and the entire non-growing season (i.e., September to March when grass roots are no longer taking up nutrients and temperatures are lower). During this interval, nitrate levels in soil water can be briefly be as high as two to 10 mg/l (Gross *et al.,* 1990; Geron *et al.,* 1993; Morton *et al.,* 1991).

This is not to imply that turfgrass or home lawns cannot be a major source of nitrate leaching under unique conditions, most notably a combination of sandy soils, high fertilization rates and over-watering. For example, Exner *et al.* (1991) report maximum nitrate levels of 15 to 70 mg/l in leachate from a simulated lawn in Nebraska that met each of these extreme conditions. Indeed, as much as 95% of the applied fertilizer eventually leached during their 34 day experiment. Watts and his colleagues (1991) report mean nitrate levels ranging from 20 to 40 mg/l in over-fertilized, over-watered orchardgrass grown on sandy soils.

Over-watering appears to be the critical variable affecting nitrate leaching from fertilized lawns, even in finely textured soils. For example, Morton *et al.* (1988) recorded the highest rate of nitrate leaching in a simulated home lawn on sandy loam soil that was over-watered and over-fertilized. Since the over-watered lawn resulted in more percolation through the soil, the total mass of nitrogen that leached to groundwater was five to ten times greater than any other lawn management treatment in his study. In contrast, when turfgrass was not irrigated, or irrigation was precisely monitored to only meet the actual water demand of turfgrass, mean nitrate levels seldom exceed two mg/l in leachate, even at higher fertilization rates (Geron *et al.,* 1993; Gross *et al.,* 1990; Mancino and Troll, 1990).

Surprisingly, the form of fertilizer applied (e.g., inorganic vs. slow release) appeared to have little direct effect on the concentration of leached nitrate, in the absence of over-watering. For example, statistical analysis showed that nitrate leachate concentrations were not significantly different when slow release formulations were used in three turfgrass studies situated on finely textured soils (Mancino and Troll, 1990; Geron *et al.,* 1993; Gross *et al.,* 1990). Slightly higher nitrate levels were reported when turfgrass was established by sod rather than seed, which was thought to be due to the lower root mass of the sod (Geron *et al.,* 1993). Lastly, turfgrass researchers disagree about the role of seasonal timing of fertilization, with respect to nitrate leaching. Some have found late season fertilizer applications to increase nitrate levels, while others have found no effect.

In summary, current research generally supports the notion that turfgrass grown on finely textured soils with moderate inputs of nitrogen fertilizer and irrigation does not have the nitrate leaching potential of row crops, nor does it pose a significant risk to potable water supplies. A key exception are over-watered lawns on sandy soils. Even though the nitrate-leaching potential of most turfgrass is relatively low in comparison to many crops, turfgrass nitrate levels still exceed background concentrations of undisturbed land use (forest, meadow, etc.). As a result, lawn fertilization can represent a significant (and controllable) source of nitrogen to coastal waters and embayments that are sensitive to increased nitrogen inputs.

Table 1: Comparison of Nitrate-Nitrogen Leaching Studies, Examining Fertilization Rate, Grass and Soil Type, Irrigation Rate and Other Factors

Study	Soil/ grass type	N applied	Irrigation & management	Treatment	Nitrate Conc. (mg/l)
Geron *et al.*	Silt loam/	194 lbs/ac/yr	irrigated, but	Seeded turf	1.09
1993	Kentucky		not overwatered	Sodded	3.5
Ohio	Bluegrass		turf mowed to 2-3"	Slow release	1.84
Turfgrass			clippings left in place	Fast release	2.74
2 years				Early season fertilization	2.27
				Late season fertilization	2.30
Morton *et al.*	Sandy loam	none	Slight (a)	Grass moved to 2-3" tall,	0.51
1988	Bluegrass	none	Overwatered	clippings left in place,	0.36
Rhode Island		86 lbs/ac/yr	Slight	2 to3% slope	0.87
Simulated lawn		86 lbs/ac/yr	Overwatered		1.77
2 years		217 lbs/ac/yr	Slight		1.24
		217 lbs/ac/yr	Overwatered		4.02
Gross *et al.*	Sandy loam	196 lbs/ac/yr	not irrigated,	Liquid	1.02
1990	Tall fescue/		clippings removed	Granular	0.85
Maryland	bluegrass	None		None	0.33
Turfgrass					
2 years					
Exner *et al.*	sandy loam	214 lbs/ac/yr	overwatered	inorganic	34 to 70
1991	and sand		0.7 inch/day		in a pulse
Nebraska	bluegrass	single application	clippings		
Simulated lawn	red fescue		not removed		
Watts *et al.*	fine sand,	200 lbs/ac/yr	24"of irrigation/season		~ 22
1991	orchardgrass		37" of irrigation/season		~ 31
Nebraska		300 lbs/ac/yr	24" of irrigation/season		~ 17
3 years			37" of irrigation/season		~ 28

In addition, current research strongly suggests that efforts to educate homeowners about lawn care should stress the critical connection between fertilization and over-watering. The concept that careless watering can flush nitrogen through the soil and away from the grass that needs it should be strongly emphasized on both economic and environmental grounds. ***—TRS***

References

Geron, C. T., Danneberger, S. Train, T. Logan and J. Street. 1993. "Effect of Establishment Method and Fertilization Practices on Nitrate Leaching From Turfgrass." *J. Environ. Quality* 22: 119-125

Gold, A., W. DeRagon, W. Sullivan and J. Lemunyon. 1990. "Nitrate-Nitrogen Losses to Groundwater From Rural and Suburban Land Uses." *J. Soil Water Conserv.* 45: 305-310.

Gross, C, J. Angle and M. Welterlen. 1990. "Nutrient and Sediment Loss From Turfgrass." *J. Environ. Quality.* 19: 663-668.

Exner, M, M. Burbach, D. Watts, R. Shearman and R. Spalding. 1991. "Deep Nitrate Movement in the Unsaturated Zone of a Simulated Urban Lawn." *J. Environ. Quality* 20: 658-662.

Mancino, A and J. Troll. 1990. "Nitrate and Ammonium Leaching Losses From N Fertilizers of 'Pencross' Creeping Bentgrass." *Horticultural Sci.* 25: 977-982.

Morton, T, A. Gold and W. Sullivan. 1988. "Influence of Over-Watering and Fertilization of Nitrogen Losses From Home Lawns." *J. Environ. Quality* 17: 124-130

Watts, D, G. Hegert and J. Nichols. 1991. "Nitrogen Leaching Losses From Irrigated Orchardgrass on Sandy Soils." *J. Environ. Quality*. 20: 355-362