Washington State University

TITLE: Quantification and Fate of Nitrogen from Amended and Trafficked Sand Putting Green/Tee Profiles

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USGA REGION: Western

Quantification and Fate of Nitrogen from Amended
and Trafficked Sand Putting Green/Tee Profiles

Executive Summary

Nitrate-N leached from new sand lysimeters that were constructed similar to USGA specifications were monitored from October, 1991 to the present. Although the level of nitrate-N that was leached from the profiles was rate related, the level of nitrate-N leached was strongly modified by the rooting medium and frequency of nitrogen (N) application. Nitrate-N leached from pure sand profiles was much greater than the nitrate-N leached from sand profiles modified with peat moss. Sand amended with sphagnum peat greatly reduced the quantity of total N leached and the percentage of applied N that was leached as compared to pure sand for a 99-day period from October 24, 1991 to February 1, 1992.

The frequency of application of N significantly affected the level of nitrate-N leached. Although the impact of this factor was much lower than either N rate or rooting medium effects, it did consistently influence nitrate-N concentration in the leachate. The use of modified sand growing medium, moderate levels of N application and frequent, light application of N combined to reduce N leached to 3 to 4 kg ha^{-1} (2.67 to 3.56 lb A^{-1}) and the percentage of applied N to as low as 3 to 5% of applied N.

The data clearly show that an 'extra effort' approach as compared to an 'as usual' approach to sand green fertilization can significantly reduce the potential losses of nitrate-N from sand growing medium. This approach involved the best uses of four factors: 1) Moderate rather than excessive use of N; 2) application of N with higher frequency and with lower quantities per application; 3) use of modified sand rooting medium rather than pure sand and 4) selecting the appropriate combination of slow release N sources and soluble sources that provide functional putting green turf during the cool, wet season.

Quantification and Fate of Nitrogen from Amended and Trafficked Sand Putting Green/Tee Profiles

An Annual Report Submitted to the USGA Research Committee

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RESEARCH PROGRESS

Thirty-six research lysimeters were monitored since November of 1991 for nitrate-N moving in leachates from lysimeters simulating golf greens constructed similar to USGA construction specification guidelines. These lysimeters are 1.2 x 2.48 in size, each constructed with chlorosulfonated polyethylene reinforced liner, and fitted with 3.75 mm ABS perforated drain tubes. The drain tubes were overlaid by 8 cm of pea-sized gravel and 8 cm of course sand. Thirty-two cm of pure sand or peat amended sand was placed over the coarse sand and seeded on October 3, 1991 to 'Putter' creeping bentgrass. Fertilization treatments, consisting of two application timings and three annual nitrogen (N) fertilization rates, were begun on October 10, 1991. The research area was mist-irrigated from seeding time on October 3 to October 24 to provide uniform establishment of the bentgrass and not allow leachate to flow from the lysimeters. The first rainfall occurred on October 24 and leachates were collected beginning on October 25.

Leachate volumes were measured and leachate samples collected daily throughout the fall, winter, spring and summer months except on days when leachate volume was too small for sampling. Leachate sampling occurred on four occasions during the summer of 1992 when rainfall exceeded turfgrass water use. No leachates were generated by excessive irrigation during the summer period. Fall leachate collection began in mid-October and has occurred almost daily since then.

Leachate volumes were measured daily and leachate samples for nitrate-N and ammonium-N were preserved in 2 M KCl and held in 25 ml vials for analysis by segmented flow analysis (SFA). Approximately 6500 samples have been collected and analyzed by SFA for nitrate-N and ammonium-N at this time. Quantification of nitrate-N leached from the twelve fertilizer management schemes is estimated from leachate volumes and nitrate or ammonium-N content of the leachate collected.

In addition, two 50 ml leachate samples were preserved from each daily collection period for each treatment. One was preserved with boric acid to pH 2.0 for analysis with an Orion Model 290A pH/ISE meter equipped with a nitrate ion specific electrode (NISE). The remaining sample was preserved with concentrated sulfuric acid to pH 2.0 for analysis with an ammonium ion specific electrode

(AISE). Collection of the 50 ml samples for ammonium were discontinued after late December.

Plots were mowed five-times weekly with estimates of leaf growth collected once weekly. Leaf growth was weighed, processed and analyzed for total nitrogen to estimate plant growth rate and grow-out of nitrogen. Visual estimates of turf quality and diseases were conducted on a regular basis although little uniform disease development has been observed since early fall of 1991. The turf was treated with iprodione (Chipco 26019, 61 g are^{-1}) for control of cool season *Rhizoctonia* spp. during late October 1991. The research area was treated with a golf shoe traffic simulator on a regular basis since mid-summer. Quantification of nitrate-N leached has been estimated for the period from October 24, 1991 to February 1, 1992.

RESULTS

Nitrate-N Concentration in Leachates

Attached are graphs that show the trends in concentration of nitrate-N leached from the profiles of lysimeters from October 10, 1991 to July. Although the concentration of nitrate-N that was leached from the profiles was rate related, the concentration of nitrate-N was strongly modified by the rooting medium. Nitrate-N concentration from pure sand medium was much greater than the nitrate-N concentration from peat modified sand medium (Fig. 1).

The frequency of N application significantly affected the concentration of nitrate-N in the leachate. Although the effects of frequency of N application is much lower than the effects of either total N rate or rooting medium, application frequency consistently influenced nitrate-N concentration leached (Fig. 2).

The total significance of the impact of N rate, frequency of application and rooting medium can be seen visually by comparing Fig. 3 and 4. Fig. 3 shows the effects of the total annual N application when fertilization was timed to be applied eleven times annually to sand as compared to Fig. 4 which shows the effects of the total annual N application when fertilization was timed to be applied in twenty-two applications to modified sand. The first might be termed the 'as usual' approach (Fig 3) at least for the 585 kg ha^{-1} (12 lb. N 1000 sq ft^{-1}) annual rate while the other might be termed the 'extra effort' approach.

Clearly, total nitrogen rate had significant impact on nitrogen losses but so did the rooting medium. In Figure 3, nitrate-N concentration in leachates from pure sand elevated from 14 to 20 mg/l with the 390 kg ha^{-1} and 585 kg ha^{-1} (8 and 12 lb N 1000 sq ft^{-1}) annual rates in mid-November while the highest that occurred at any time in modified sand (Fig. 4) was about 7.5 mg/l, even at the highest rate of N application.

Quantity of Nitrate-N Leached

Table 1 summarizes the quantity of nitrate-N leached and percentage of applied N leached from profiles during the first 99 days after leachate collections occurred in 1991. An average of 11.2 kg ha^{-1} (9.97 lb A^{-1}) of nitrate-N leached from sand profiles during the 99 day period while 6.0 kg ha^{-1} (5.34 lb A^{-1}) leached from modified sand profiles. However, the range of nitrate-N leached from sand profiles was from a low of 6.1 kg ha^{-1} (5.4 lb A^{-1}) where fertilizer was applied at 8.86 kg ha^{-1} (0.18 lb 1000 sq ft^{-1}) every two weeks to 18.8 kg ha^{-1} (16.7 lb A^{-1}) leached where fertilizer was applied at 53 kg ha^{-1} (1.09 lb 1000 sq ft^{-1}) every four weeks. Only 1.16 kg ha^{-1} (1.1 lb A^{-1}) of nitrogen was leached during the 99 days where fertilizer was applied at 8.8 kg ha^{-1} (0.18 lb 1000 sq ft^{-1}) at two week intervals. This level of nitrogen application was insufficient to support bentgrass or annual bluegrass growth in putting greens under play in the Northwest, but 17.6 kg ha^{-1} (0.36 lb 1000 sq ft^{-1}) at two week intervals may be adequate. At this level of fertilization each 14 days, 3.04 kg nitrate-N ha^{-1} (2.7 lb A^{-1}) was leached and this was only 2.09% of the nitrogen applied. These data represent very young and immature turf which would be strongly subject to nitrate-N movement because of the lack of a mature root system to utilize available nitrate. Data from 1992-93 winter season should provide a better perspective of this concept in more mature sand profiles.

Figure 1

Effect Of Sand Or Amended Sand Medium

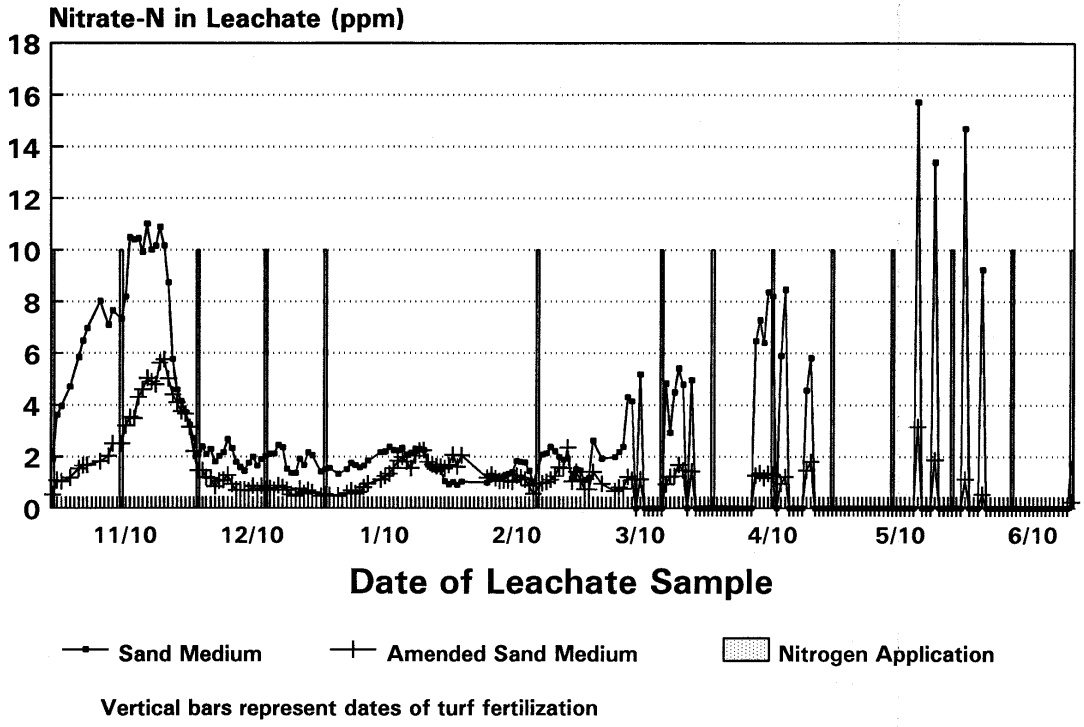


Figure 2
Effect Of Frequency Of Fertilization

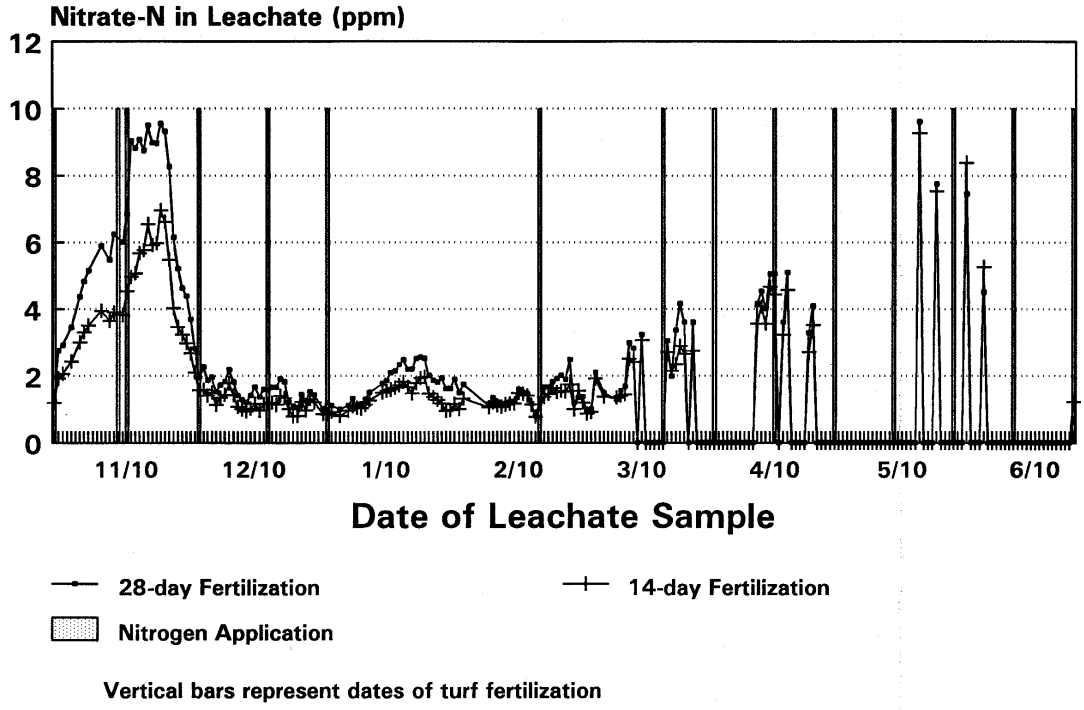
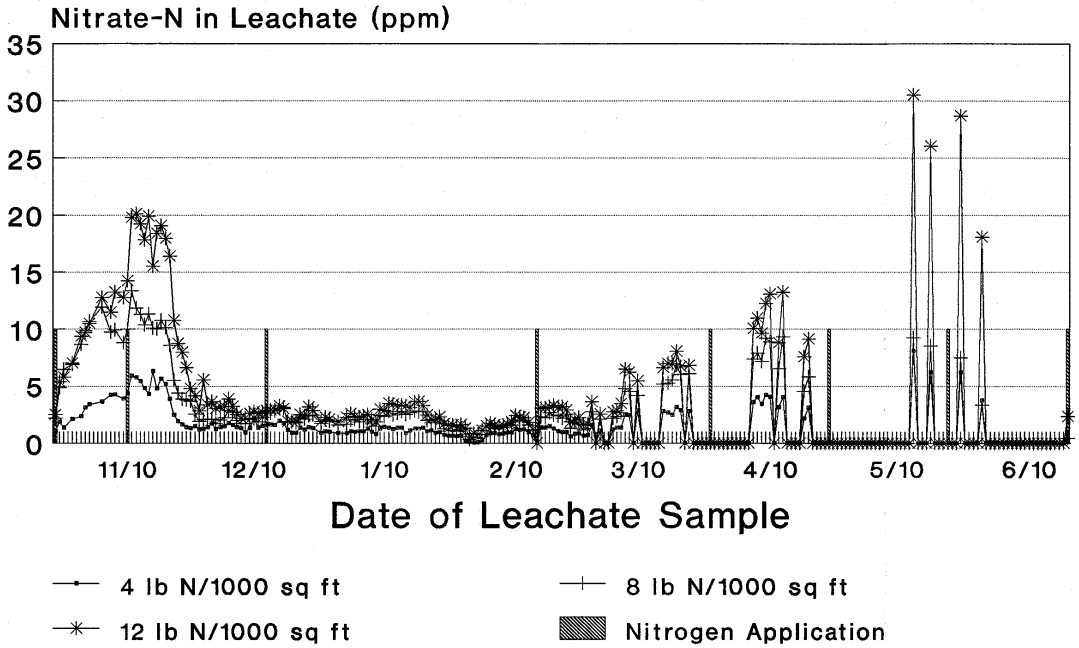


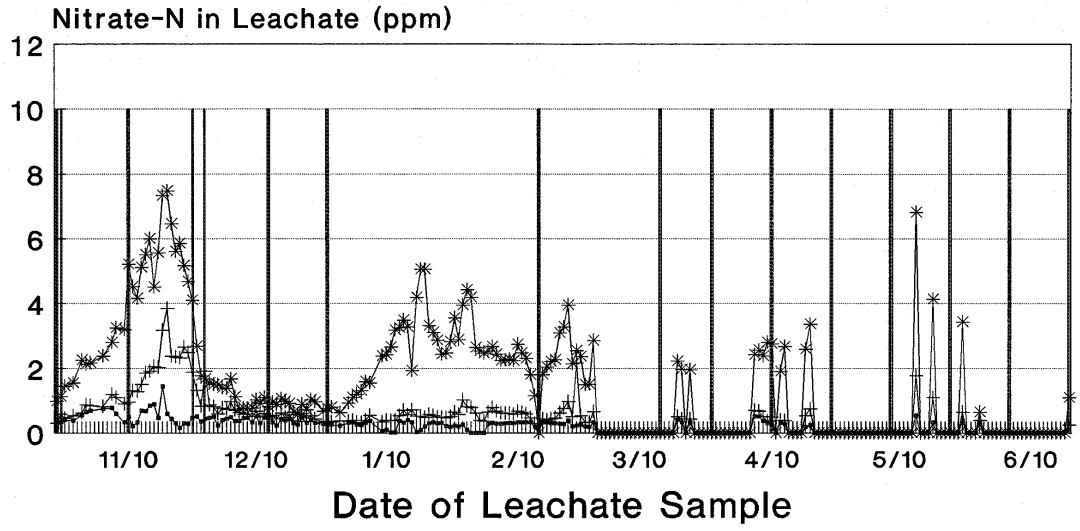
Figure 3
Eleven Applications Annually to Sand



Vertical bars represent dates of turf fertilization

Figure 4

Twenty-Two Applications Annually-ModSan



Vertical bars represent dates of turf fertilization

Table 1. Nitrate-N loss of fertilizer nitrogen applied to 'Putter' creeping bentgrass putting turf.

Species[1]	Experimental conditions	Duration[2] of sampling	Nitrogen source Name[3]	Nitrogen source %[4]	Total N[7] application	Application frequency	Rooting[5] medium	Temp[6] °C	Nitrate-N leached Total	Nitrate-N leached Percent of applied
					(kg ha^{-1})				(kg ha^{-1})	
Creeping bentgrass	Field	99 days	AP	21.2	195	28	Sand	3.5-15.3	6.02	11.3
			NH_4SO_4	56.9						
			IBDU	8.0						
			SCU	7.7						
			MU	6.1						
			AP	13.0	390	28	Sand	3.5-15.3	12.82	12.0
			NH_4SO_4	34.8						
			IBDU	19.2						
			SCU	18.6						
			MU	14.5						
			AP	9.4	585	28	Sand	3.5-15.3	18.80	11.8
			NH_4SO_4	35.0						
			IBDU	34.1						
			SCU	23.3						
			MU	18.2						
			AP	21.2	195	14	Sand	3.5-15.3	6.10	11.5
			NH_4SO_4	56.9						
			IBDU	8.0						
			SCU	7.7						
			MU	6.1						
			AP	13.0	390	14	Sand	3.5-15.3	10.33	9.7
			NH_4SO_4	34.8						
			IBDU	19.2						
			SCU	18.6						
			MU	14.5						

Table 1. (Continued).

Species[1]	Experimental conditions	Duration[2] of sampling	Nitrogen source Name[3]	Nitrogen source %[4]	Total N[7] application	Application frequency	Rooting[5] medium	Temp[6] °C	Nitrate-N leached Total	Nitrate-N leached Percent of applied
					(kg ha^{-1})				(kg ha^{-1})	
Creeping bentgrass	Field	99 days	AP	9.4	585	14	Sand	3.5-15.3	12.85	8.0
			NH_4SO_4	35.0						
			IBDU	34.1						
			SCU	23.3						
			MU	18.2						
			AP	21.2	195	28	Peat/sand	3.5-15.3	1.24	2.3
			NH_4SO_4	56.9						
			IBDU	8.0						
			SCU	7.7						
			MU	6.1						
			AP	13.0	390	28	Peat/sand	3.5-15.3	5.24	4.9
			NH_4SO_4	34.8						
			IBDU	19.2						
			SCU	18.6						
			MU	14.5						
			AP	9.4	585	28	Peat/sand	3.5-15.3	17.16	10.7
			NH_4SO_4	35.0						
			IBDU	34.1						
			SCU	23.3						
			MU	18.2						
			AP	21.2	195	14	Peat/sand	3.5-15.3	1.16	10.7
			NH_4SO_4	56.9						
			IBDU	8.0						
			SCU	7.7						
			MU	6.1						

Table 1. (Continued).

Species[1]	Experimental conditions	Duration[2] of sampling	Nitrogen source Name[3]	% [4]	Total N[7] application	Application frequency	Rooting[5] medium	Temp[6] °C	Nitrate-N leached Total	Percent of applied
					(kg ha^{-1})				(kg ha^{-1})	
Creeping bentgrass	Field	99 days	AP	13.0	390	14	Peat/sand	3.5-15.3	3.04	2.09
			NH_4SO_4	34.8						
			IBDU	19.2						
			SCU	18.6						
			MU	14.5						
			AP	9.4	585	14	Peat/sand	3.5-15.3	8.63	5.4
			NH_4SO_4	35.0						
			IBDU	34.1						
			SCU	23.3						
			MU	18.2						

[1] 'Putter' creeping bentgrass (*Agrostis stolonifera* var. *palustris*).

[2] October 24, 1991 to February 1, 1992.

[3] AP = ammonium phosphate.

[4] Percent of N-source product in fertilizer mix.

[5] 88% sand, 10% peat, 2% screened sandy loam (v/v/v).

[6] Temperature range from Oct. 24 to Feb. 1 at 5 cm depth in soil profile.

[7] The total N applications of 195, 390, and 585 kg ha^{-1} is equivalent to 4, 8, and 12 lb N 1000 sq ft^{-1}.