University of Nevada

TITLE: The Effect of Salinity on Nitrate Leaching From Turfgrass

INVESTIGATORS:

Daniel Bowman, Dept. of Plant Science, Univ. of Nevada, Reno
Wally Miller, Dept. of Plant Science, Univ. of Nevada, Reno
Dale Devitt, Dept. of Plant Science, Univ. of Nevada, Reno

1992 FUNDING: $20,000

CLIMATIC REGION: Warm Arid
USGA REGION: Western

Final 1992 Progress Report for USGA Sponsored Research Project:

The Effect of Salinity on Nitrate Leaching from Turfgrass

Executive Summary

D.C. Bowman, D.A. Devitt and W.W. Miller

This project was initiated in March of 1991, and consists of both a field component (Las Vegas) and a greenhouse component (Reno) to examine the effects of saline irrigation water on nitrate leaching from, and nitrogen uptake by bermudagrass and tall fescue turf.

Las Vegas: Nitrate leaching data were collected from April through September, 1992. Relatively large amounts of N were leached from all treatments during April, ranging from 3.4 to 11.4% of applied N. These high values were likely due to the large volumes of collected leachate, and possibly also to mineralization of N from organic matter. Data were collected during the same period on plant physiological response to salinity and water stress. The bermudagrass was overseeded in September, at which time the saline irrigation line was switched to fresh water. Salinity treatments will be imposed for a second year beginning next spring, and sampling will follow this year's procedure.

Reno: Nitrate leaching, growth, and N use efficiency of bermudagrass and tall fescue turf have been followed for the past 9 months. The nitrate concentration of the leachate has remained generally very low, usually below 1 ppm N. Cumulative nitrate-N leached over the nine month period amounted to approximately 7 mg N/column for the tall fescue and 5.0 mg N/column for the bermudagrass, representing 0.6-1.5% and 0.4-1.3% of the applied N, respectively. There was still no clear and consistent effect of salinity on nitrate leaching. There was also no apparent effect of N rate on total amount of nitrate leached.

The amount of N partitioned to leaf tissue and removed in clippings increased with increasing N application rate, but again, there was no effect of salinity. Average N allocation to leaf tissue (N use efficiency) ranged from 71-78% in the tall fescue and 84-88% in the bermudagrass. These data continue to support our previous reports that moderate salinity has very little effect on nitrogen dynamics in either turf system, and that the very efficient absorption of applied N minimizes the potential for nitrate leaching. Ammonium nitrate labeled with ^{15}N was applied in September to determine the pattern of allocation of concurrently absorbed N. Tissue samples are being analyzed commercially at this time.

A second greenhouse experiment is being initiated to examine the effects of leaching fraction and salinity on nitrate leaching from the two turf species. Tall fescue will be irrigated with water having added salt levels of 0, 20 and 40 meq/liter, while bermudagrass will be irrigated with 0, 40 and 80 meq/liter. Leaching fractions of 10, 30 and 50% will be imposed as a second factor. Nitrogen will be applied at 1# N/1000 ft^2 (5 g N/m^2). Data will be collected starting in April, 1993.

Final 1992 Progress Report for USGA Sponsored Research Project:

The Effect of Salinity on Nitrate Leaching from Turfgrass

D.C. Bowman, D.A. Devitt and W.W. Miller

This project was initiated in March of 1991, and consists of both a field component (Las Vegas) and a greenhouse component (Reno) to examine the effects of saline irrigation water on nitrate leaching from, and nitrogen uptake by turfgrasses.

Las Vegas: Nitrate leaching data were collected from April through September, 1992. Relatively large amounts of N were leached from all treatments during April, ranging from 3.4 to 11.4% of applied N (Table 4). These high values were likely due to the large volumes of collected leachate, and possibly also to mineralization of N from organic matter. Many of the lysimeters, particularly those positioned toward the outside of the irrigation gradient, ceased draining during the summer, and leachate volumes from those that did drain were reduced considerably. This may explain why little to no nitrate leached during July and August. Data were collected during the same period on plant physiological response to salinity and water stress, and are being analyzed. The bermudagrass was overseeded and the tall fescue was reseeded to repair damaged areas in September, at which time the saline irrigation line was switched to fresh water. Salinity treatments will be imposed for a second year beginning next spring, and sampling will follow this year's procedure.

Reno: Nitrate leaching, growth, and N use efficiency of bermudagrass and tall fescue turf have been followed for the past 9 months. Growth, expressed as clipping yield, oscillated in response to monthly fertilization, and increased with N application rate (Figs. 1 and 2). The growth oscillations were not an artifact of variable sampling periods, since data normalized for time interval exhibited the same periodicity (Fig. 3). There was a sharp increase in growth of the bermudagrass around day 150 (Fig. 2), which was probably due to greater sunlight and higher temperatures in the greenhouse during the summer months.

The amount of N partitioned to leaf tissue and removed in clippings increased with increasing N application rate, but again, there was no effect of salinity in either species. Average N allocation to leaf tissue (N use efficiency) was very constant over the 9 month period, and ranged from 71-78% in the tall fescue (Fig. 4) and from 84-88% in the bermudagrass (Fig. 5). These data continue to support our previous reports that moderate salinity has very little effect on nitrogen dynamics in either turf species, and that the very efficient absorption of applied N minimizes the potential for nitrate leaching. Ammonium nitrate labeled with ^{15}N was applied in September to determine the pattern of allocation of concurrently absorbed N. Tissue samples are being analyzed commercially at this time.

The nitrate concentration of the leachate has remained generally very low, usually below 1 ppm N (Figs. 6 and 7). There was a peak in concentrations during May (~ day 90), with values approaching 10 ppm. This peak was associated with an unintentionally high leaching fraction during the month, and resulted in considerably greater amounts of NO_3 leached than during any other month. The NO_3 concentrations in the leachate from bermudagrass were consistently lower than from the tall fescue.

Cumulative nitrate-N leached over the nine month period ranged from 5 to 8 mg N/column for the tall fescue (Fig. 8) and 4-9 mg N/column for the bermudagrass (Fig. 9), representing 0.6-1.5% and 0.4-1.3% of the applied N, respectively. If the large amount of N leached during May is subtracted from the total, less than 0.5% of the applied N, on average, leached. There was still no clear and consistent effect of salinity on nitrate leaching. There was also no apparent effect of N rate on total amount of nitrate leached. A summary of the nitrate leaching data is presented in Table 3.

Salinity significantly increased the level of Na and Cl while reducing the level of Mg in leaf tissue of both species (Tables 1 and 2). Leaf K was reduced by salinity only in the bermudagrass. Both species accumulated Na to similar levels at 30 meq/liter salt, but the tall fescue accumulated considerably higher levels of Cl than the bermudagrass.

Based on the observed peak in nitrate leaching during May, described above, a second greenhouse experiment is being initiated to examine the effects of leaching fraction and salinity on nitrate leaching from the two turf species. Tall fescue will be irrigated with water having added salt levels of 0, 20 and 40 meq/liter, while bermudagrass will be irrigated with 0, 40 and 80 meq/liter. Leaching fractions of 10, 30 and 50% will be imposed as a second factor. Nitrogen will be applied at 1# N/1000 ft^2 (5 g N/m^2). Data will be collected starting in April and ending in November, 1993.

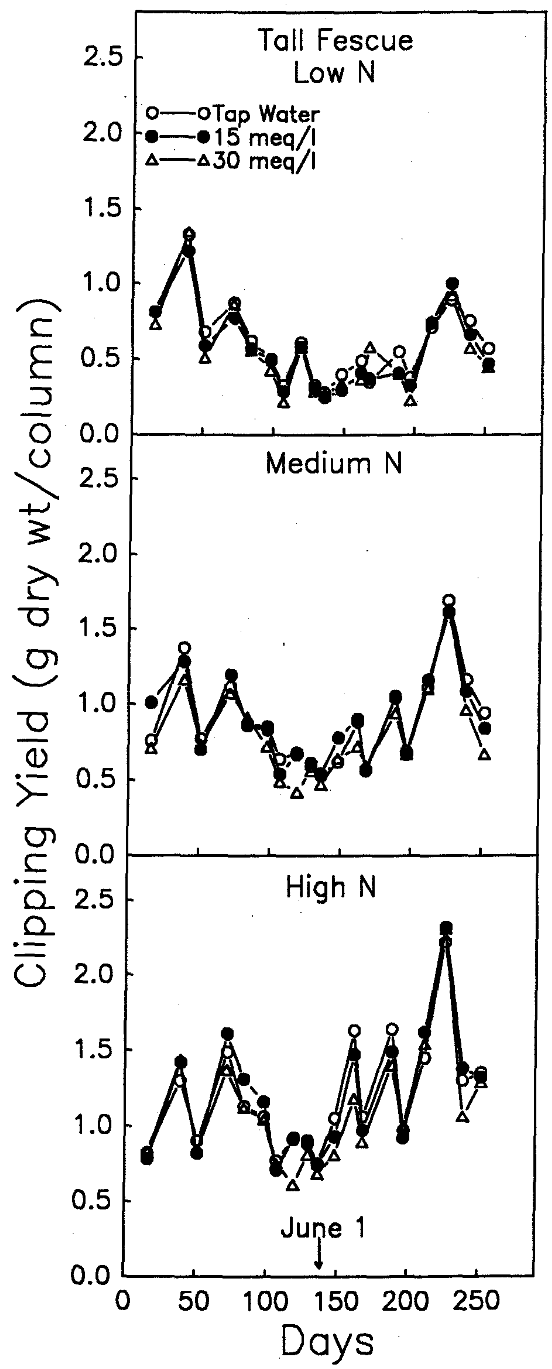

Tall Fescue
Low N
Tap Water
15 meq/l
30 meq/l
Medium N
High N
June 1
Clipping Yield (g dry wt/column)
Days
0.0
0.5
1.0
1.5
2.0
2.5
0
50
100
150
200
250

Fig 1

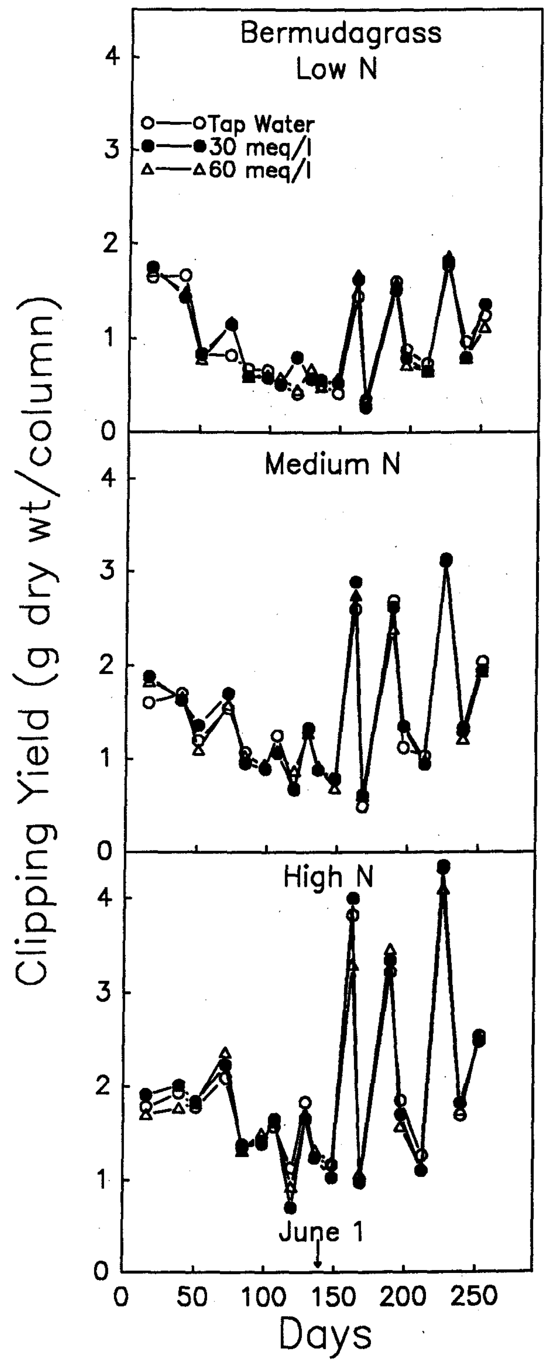

Bermudagrass
Low N
Tap Water
30 meq/l
60 meq/l
Medium N
High N
June 1
Clipping Yield (g dry wt/column)
Days
0
1
2
3
4
0
50
100
150
200
250

Fig.2

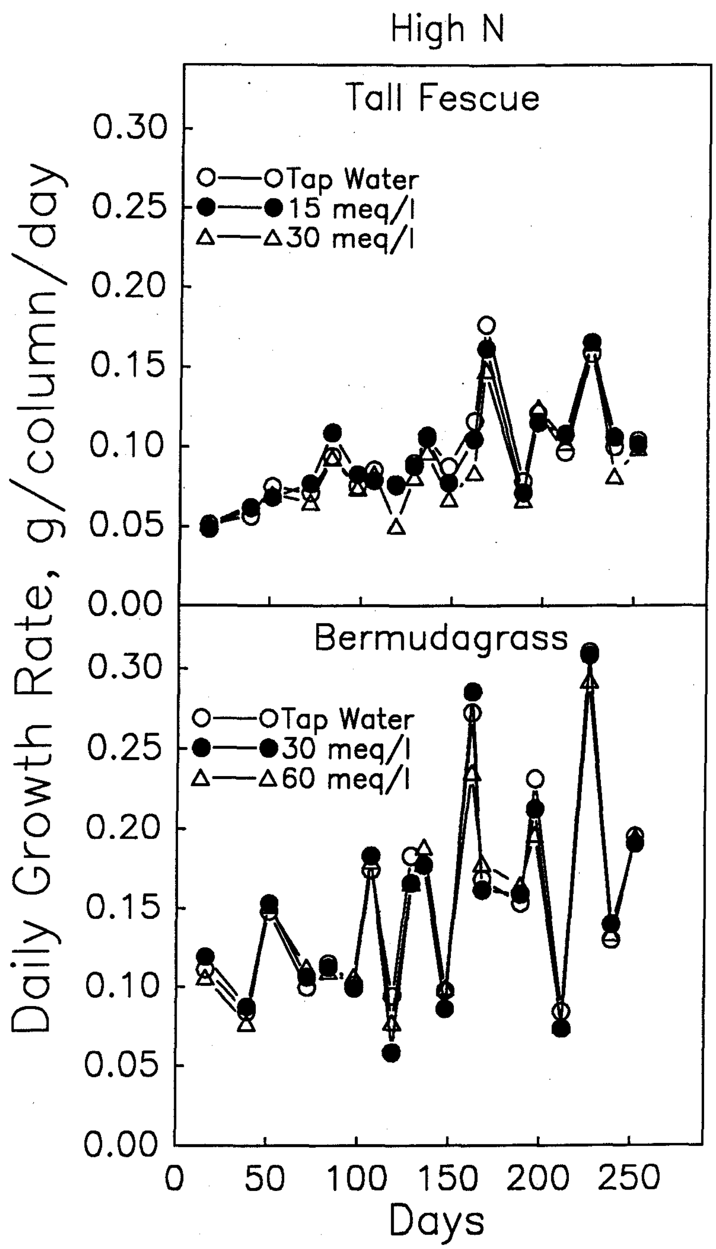
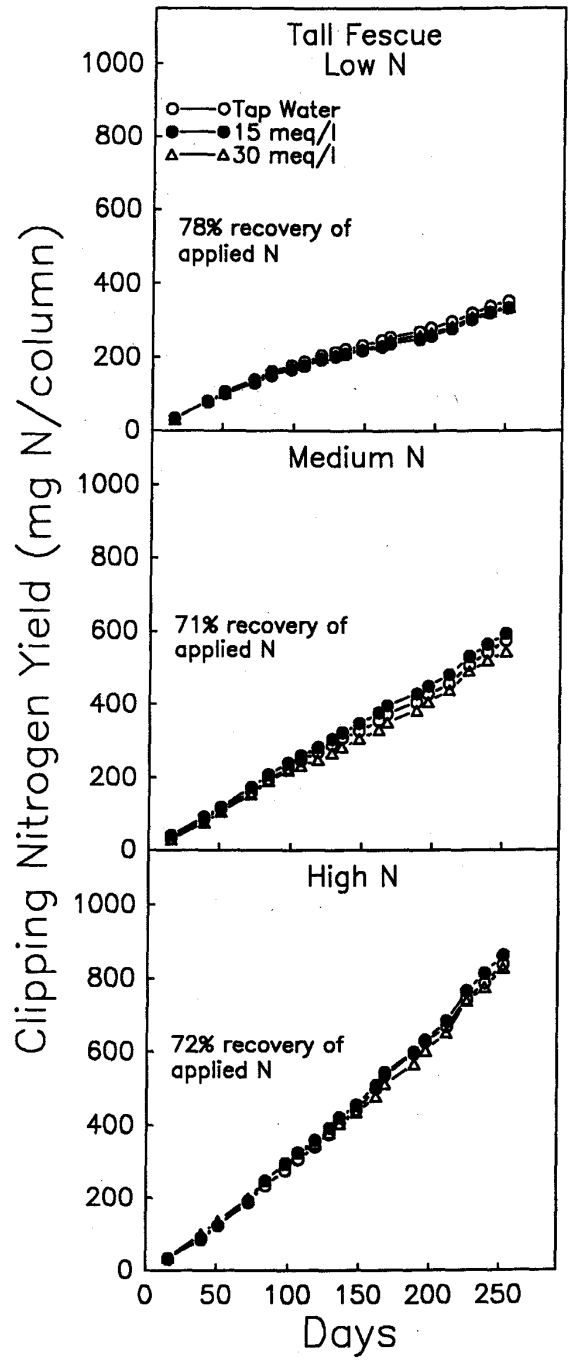
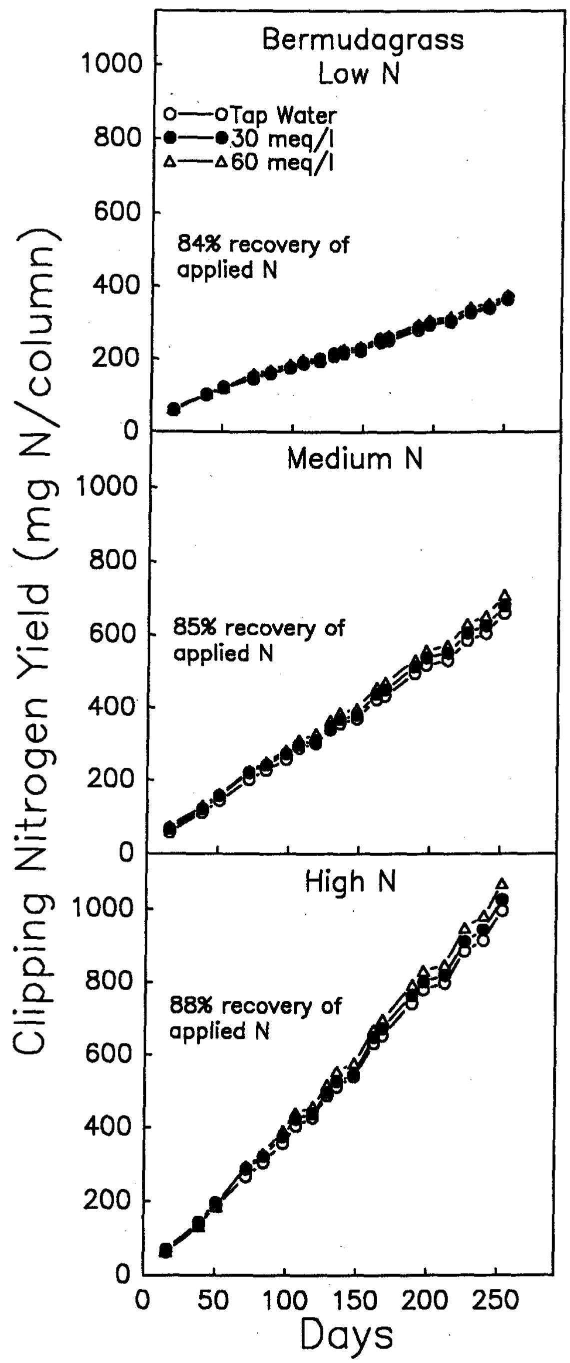

High N
Tall Fescue
Tap Water
15 meq/l
30 meq/l
Bermudagrass
Tap Water
30 meq/l
60 meq/l
Daily Growth Rate, g/column/day
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0
50
100
150
200
250
Days

Fig.3



Tall Fescue
Low N
Tap Water
15 meq/l
30 meq/l
78% recovery of applied N
Medium N
71% recovery of applied N
High N
72% recovery of applied N
Clipping Nitrogen Yield (mg N/column)
Days
0
200
400
600
800
1000
0
50
100
150
200
250

Fig. 4



Bermudagrass
Low N
Tap Water
30 meq/l
60 meq/l
84% recovery of applied N
Medium N
85% recovery of applied N
High N
88% recovery of applied N
Clipping Nitrogen Yield (mg N/column)
0
200
400
600
800
1000
0
50
100
150
200
250
Days

Fig. 5

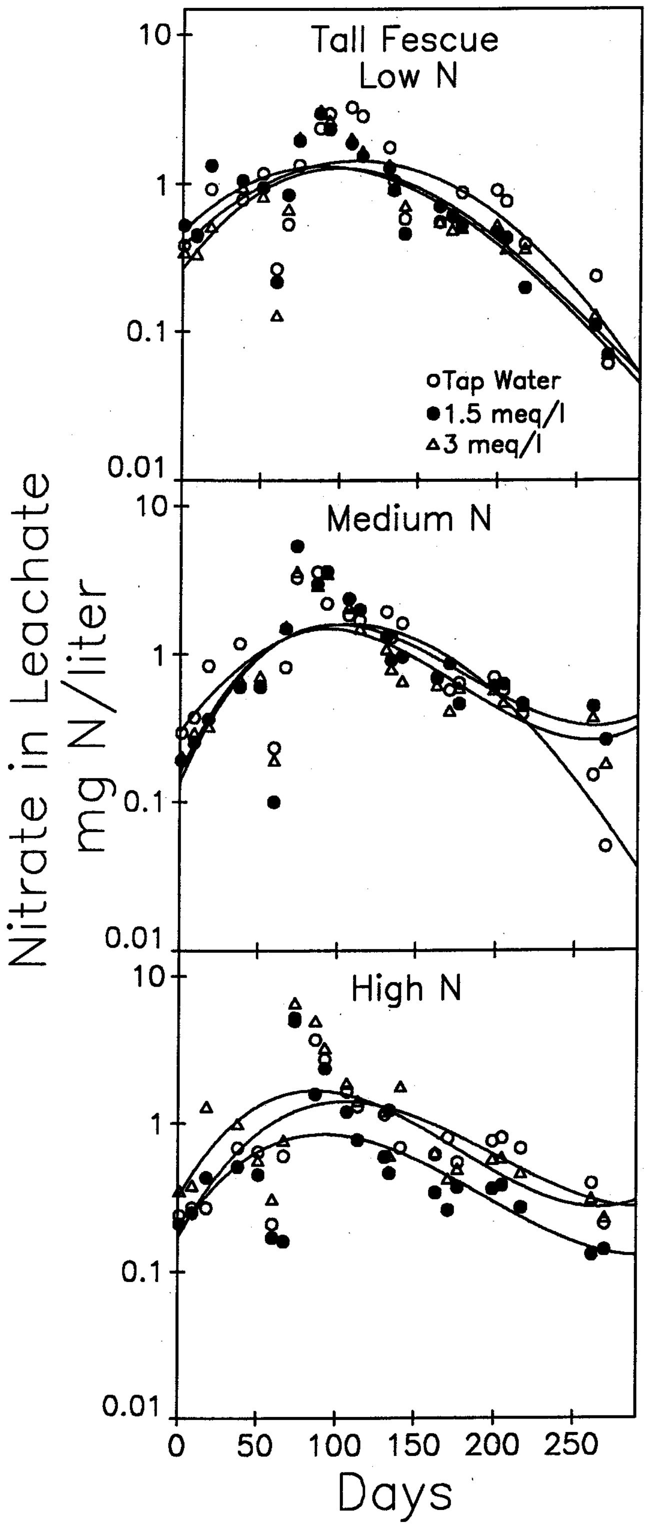

Tall Fescue
Low N
Medium N
High N
oTap Water
●1.5 meq/l
△3 meq/l
Nitrate in Leachate
mg N/liter
Days
10
1
0.1
0.01
0
50
100
150
200
250

Fig. 6

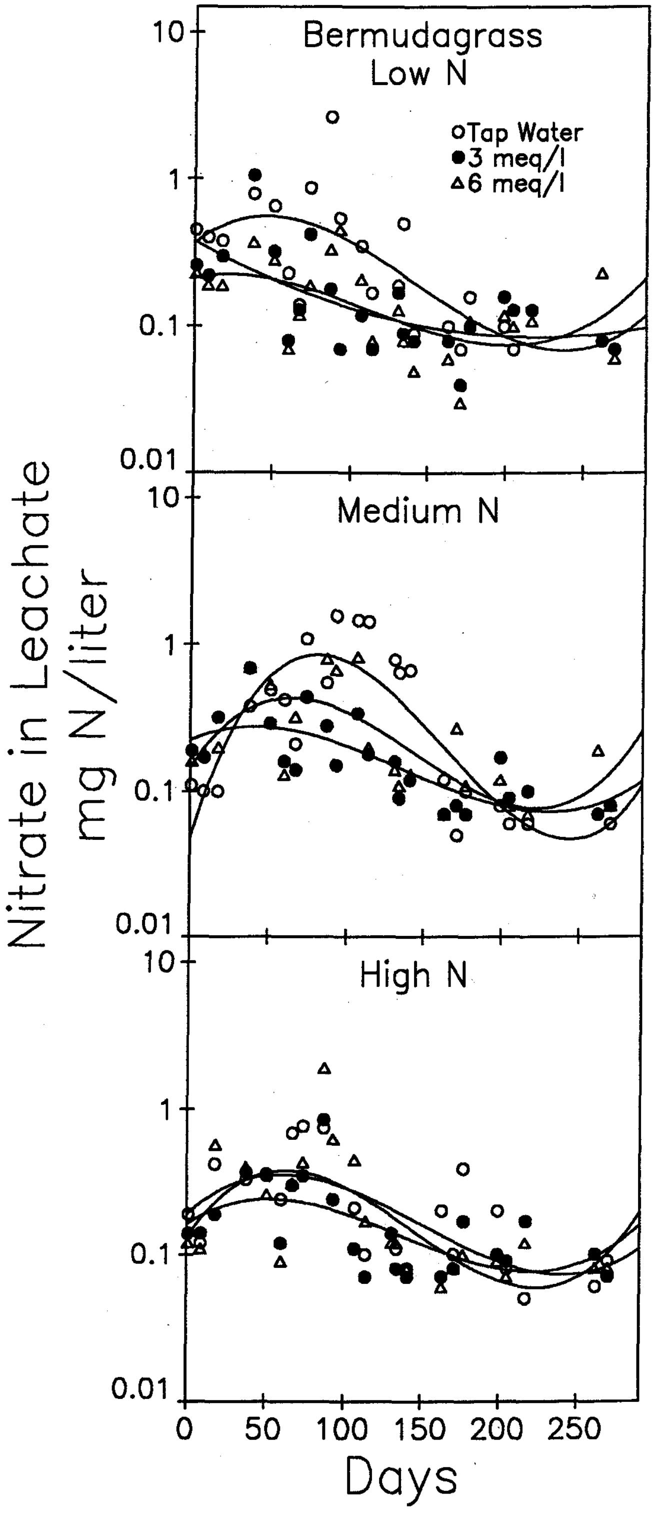

Bermudagrass
Low N
Tap Water
3 meq/l
6 meq/l
Medium N
High N
Nitrate in Leachate
mg N/liter
10
1
0.1
0.01
0
50
100
150
200
250
Days

Fig. 7

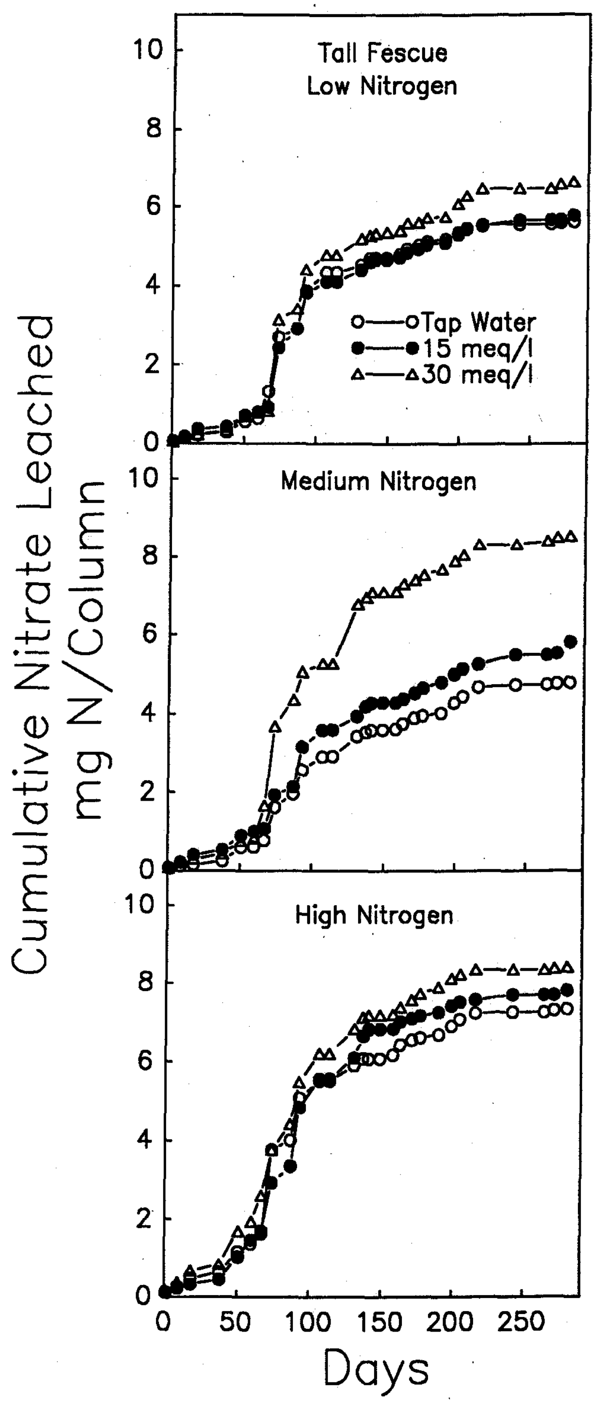

Tall Fescue
Low Nitrogen
Medium Nitrogen
High Nitrogen
Tap Water
15 meq/l
30 meq/l
Cumulative Nitrate Leached
mg N/Column
Days
0
2
4
6
8
10
50
100
150
200
250

Fig. 8

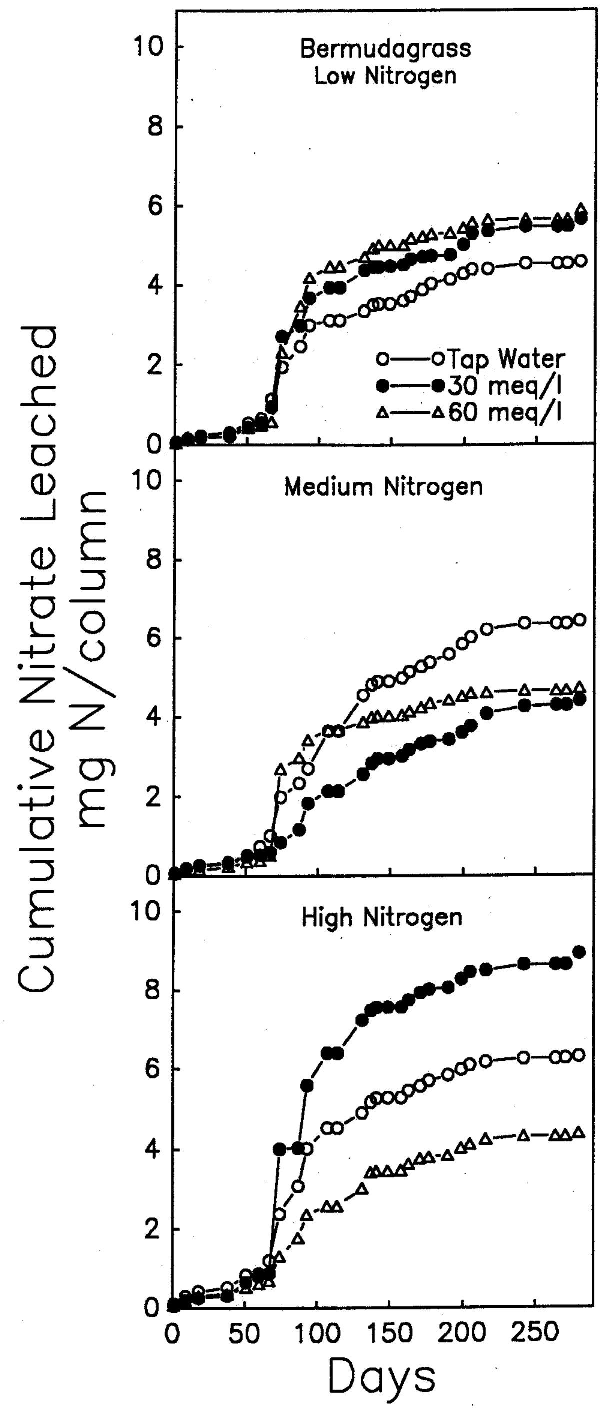

Bermudagrass
Low Nitrogen
Tap Water
30 meq/l
60 meq/l
Medium Nitrogen
High Nitrogen
Cumulative Nitrate Leached
mg N/column
Days
0
2
4
6
8
10
0
50
100
150
200
250

Fig.9

Table 1. Tissue analysis of tall fescue leaf clippings as a function of N and salt level. Values are means of 4 replicates.

	Na	Ca	Mg	K	Cl
			%, dry weight basis		
Low N					
Tap Water	0.17	0.44	0.21	1.63	0.82
1.5 EC	0.26	0.56	0.18	1.56	1.05
3.0 EC	0.35	0.53	0.12	1.34	1.02
Medium N					
Tap Water	0.20	0.61	0.44	2.74	1.34
1.5 EC	0.32	0.68	0.33	2.66	1.77
3.0 EC	0.40	0.77	0.23	2.34	1.73
High N					
Tap Water	0.20	0.76	0.46	2.84	1.30
1.5 EC	0.32	0.72	0.36	2.81	1.97
3.0 EC	0.44	0.78	0.30	2.60	2.00
$LSD_{0.05}$	0.08	0.27	0.10	0.55	0.43

Table 2. Tissue analysis of bermudagrass leaf clippings as a function of N and salt level. Values are means of 4 replicates.

	Na	Ca	Mg	K	Cl
			%, dry weight basis		
Low N					
Tap Water	0.21	0.54	0.15	1.84	0.52
3.0 EC	0.44	0.78	0.14	1.47	1.03
6.0 EC	0.70	0.88	0.12	1.35	1.44
Medium N					
Tap Water	0.20	0.53	0.17	1.92	0.58
3.0 EC	0.40	0.67	0.14	1.70	1.06
6.0 EC	0.59	0.71	0.12	1.65	1.29
High N					
Tap Water	0.23	0.56	0.18	2.16	0.64
3.0 EC	0.38	0.62	0.14	2.02	1.09
6.0 EC	0.55	0.64	0.12	2.03	1.31
$LSD_{0.05}$	0.10	0.13	0.03	0.17	0.24

Species	Source	Single N rate	Total N per year	Season applied	Irrig. EC (33% LF)	Soil Texture	% of applied N leached	$[NO_3]$ in water ppm N (average)*	$[NO_3]$ in water ppm N (volume weighted)
		kg N/ha							
Festuca arundinacea	NH_4NO_3	25	300	monthly	0.3	Loamy sand	1.3	1.10	0.60
				"	1.5	"	1.3	0.96	0.61
				"	3.0	"	1.5	0.93	0.75
		50	600	"	0.3	"	0.6	1.12	0.48
				"	1.5	"	0.7	1.21	0.65
				"	3.0	"	1.1	1.04	0.91
		75	900	"	0.3	"	0.6	1.09	0.79
				"	1.5	"	0.7	0.72	0.82
				"	3.0	"	0.7	1.30	0.93
Cynadon dactylon	NH_4NO_3	25	300	monthly	0.3	Loamy sand	1.0	0.40	0.51
				"	3.0	"	1.3	0.19	0.58
				"	6.0	"	1.3	0.16	0.59
		50	600	"	0.3	"	0.8	0.46	0.69
				"	3.0	"	0.5	0.19	0.46
				"	6.0	"	0.6	0.28	0.56
		75	900	"	0.3	"	0.5	0.26	0.64
				"	3.0	"	0.8	0.19	0.95
				"	6.0	"	0.4	0.28	0.47

* The average concentration of NO_3 in the leachate, expressed as ppm N, is a simple average of values obtained over the course of the experiment. Volume weighted averages were calculated as total N leached divided by total leachate volume from March through September.

Table 3

Average monthly leaching losses of NO_3-N as a percent of N applied as ammonium nitrate.

	april	may	june	july	aug
bermudagrass, saline	3.4	11.9	10.1	1.0	.0
bermudagrass, fresh water	5.0	1.9	.2	.0	.0
tall fescue, saline	11.4	.7	1.2	.1	.0
tall fescue, fresh water	5.5	.3	.0	.0	.0

Table 4