1993 Executive Summary

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: The line source treatments were reestablished during the summer, 1993, to obtain second year data on nitrate leaching. Drainage samples have been collected and analyzed for salt and nitrate concentrations. Unlike the results of the Reno experiment, these data indicate relatively high concentrations of nitrate leaching from the lysimeters (over 1 mM), especially the salt-treated and those suffering from or killed by extreme drought stress. This is possibly due to the high-salt irrigation water containing approximately 1 mM nitrate-N. Clippings were collected from the lysimeters at each mowing and are currently being analyzed for Kjeldahl N. Leaf N generally is quite high, typically ranging between 4.7% and 5.2%. This indicates that the combination of monthly N application at 50 kg N/ha, plus N applied with the irrigation water, plus clipping return, provides more than optimal N for the turf, the excess of which might be subject to leaching. The large amount of data already obtained, or yet to be obtained, is presently being analyzed.

Reno: The greenhouse aspect of this experiment was terminated in December, 1992. We have been analyzing tissue and soil for nitrate and total N, and ion content. Essentially all the data has been analyzed on a preliminary basis, and manuscripts are in preparation. Pertinent data are summarized:

1. The nitrate concentration of the leachate was generally very low, usually below 1 ppm N. Monthly averages revealed a peak during March, April and May, which may have been related to the unintentionally high leaching volumes. However, all averages during the year were well below the critical 10 ppm N level. Cumulative nitrate-N leached over the eleven month period amounted to 1.0% and 0.3% of the applied N, for the tall fescue and bermudagrass, respectively.

2. Nitrogen removed in the clippings increased with increasing N application rate, but there was little effect of salinity. Essentially all the applied N was removed in clippings at the low N rate for both species, while recovery at the higher rates ranged from 74 to 87%.

From this data, we conclude that moderate salinity has little or no impact on the amounts of nitrate leaching, at least when adequate leaching maintains a favorable salt balance in the soil profile.

1993 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: The line source treatments were reestablished during the summer, 1993, to obtain second year data on nitrate leaching. Additionally, data on plant physiological response has been collected. Drainage samples have been collected and analyzed for salt and nitrate concentrations. Unlike the results of the Reno experiment, these data indicate relatively high concentrations of nitrate leaching from the lysimeters (over 1 mM), especially the salt-treated and those suffering from or killed by extreme drought stress. This is possibly due to the high-salt irrigation water containing approximately 1 mM nitrate-N. During the second season, adjustments were made to the amounts of fertilizer applied monthly to account for the additional N added via the saline irrigation. Clippings were collected from the lysimeters and are currently being analyzed for Kjeldahl N. From the tissues already analyzed, leaf N appears quite high, typically ranging between 4.7% and 5.2%. This indicates that the combination of monthly N application at 50 kg N/ha, plus N applied with the irrigation water, plus clipping return, provides more than optimal N for the turf, the excess of which might be subject to leaching. The large amount of data already obtained, or yet to be obtained, is presently being analyzed.

Reno: The greenhouse aspect of this experiment was terminated in December, 1992. We have been analyzing tissue and soil for nitrate and total N, and ion content. Essentially all the data has been analyzed on a preliminary basis, and manuscripts are in preparation. Pertinent data, which have been presented in incomplete form previously, are summarized:

The nitrate concentration of the leachate was generally very low, usually below 1 ppm N. Monthly averages (Fig. 1b) revealed a peak during March, April and May, which may have been related to the high leaching fractions due to unintentionally excessive irrigation (Fig. 1a). This concentration peak was more prominent in the tall fescue than the bermudagrass. However, all averages during the year were well below the critical 10 ppm N level. Cumulative nitrate-N leached over the eleven month period amounted to approximately 10 mg N/column for the tall fescue and 3.0 mg N/column for the bermudagrass, representing 1.0% and 0.3% of the applied N, respectively (Figs. 2 and 3). There was no clear effect of salinity on nitrate leaching in either species.

Clipping dry weight and percent N in the tissue (data not shown) were used to calculate the amount of N partitioned to leaf tissue and removed in clippings (Figs. 4 and 5). Nitrogen removal increased with increasing N application rate, but there was little effect of salinity. The slope of the linear regression of the data in Figs. 4 and 6 ($r>0.99$ in all cases) was used to estimate average daily N allocation to leaf tissue. This can be compared to the average daily N addition rate (monthly rate/30 days) to determine N uptake efficiency. The data in Table 1 indicate that uptake efficiency decreases in both turf species with higher N rates. The bermudagrass clippings contained approximately 10 more of the applied N than the tall fescue clippings at the medium and high N rates. Essentially all the applied N was removed in clippings at the low N rate for both species. These data indicate that although very little N is lost through leaching, a considerable portion of the applied N remains unaccounted for. It is possible that much of this N is partitioned to shoot and root (non-leaf) tissue. Root and shoot tissues from the final harvest were analyzed for N to determine how much N was present in the standing biomass. Roughly twice as much N was present in the shoots of tall fescue as compared to bermudagrass (Table 2). Root systems contained much lower amounts of N than the shoots, and the two species were very similar. The total amount of N in the standing biomass was converted to "monthly N equivalents" by dividing the biomass N by the monthly N application rate. Tall fescue tissue contained from 3.0 to 6.3 months worth of N in the biomass, depending on the N treatment, whereas the bermudagrass tissue contained from 1.6 to 3.4 months worth of N. This clearly demonstrates the sink strength of both shoots and roots for applied N, with the tall fescue tissue presumably representing a stronger sink than bermudagrass.

Finally, to determine how the two species allocate recently-absorbed N between new leaf growth and older tissues (shoots and roots), ^{15}N-labeled fertilizer was applied to the columns in September. Clippings were collected during the next month, pooled on a weight-averaged basis, and analyzed for ^{15}N content. The percent of applied N allocated to new leaf growth was roughly twice as high in bermudagrass as in tall fescue. From 45% to 65% of the previous N application was allocated to new leaf growth in bermudagrass, whereas tall fescue allocated from 22% to 37%. Both species allocated more N to new leaves at higher N application rates. The difference between species could be due to the relative sink strengths for N represented in the shoots and roots, as discussed above. With tall fescue shoots apparently requiring more N than bermudagrass shoots, it is probable that a greater amount of recently absorbed N was allocated to tall fescue shoot tissue, at the expense of new leaf tissue.

Table 1. Nitrogen uptake efficiency for tall fescue and bermudagrass at three N application rates. Efficiency is calculated as average daily N removed in clippings (based on regression analysis) divided by the average daily N addition (monthly divided by 30, amounting to 1.52, 3.03 and 4.55 mg N/column/day for the low, medium and high N rates, respectively).

Species	N rate	N removed in clippings (mg N/column/day)	N uptake Efficiency %	^{15}N Allocation to leaf tissue
Tall Fescue				
	Low	1.38	93	22%
	Medium	2.30	77	37%
	High	3.31	74	34%
Bermudagrass				
	Low	1.42	95	45%
	Medium	2.60	87	57%
	High	3.68	82	65%

Table 2. Nitrogen content of roots, shoots, and total standing biomass of tall fescue and bermudagrass at three N application rates, averaged over three salt treatments. Monthly equivalents of standing biomass N were calculated by dividing total N by 45.5, 91, or 136.5 mg N/month for the low, medium and high N addition rates, respectively.

Species	N rate	Shoot N	Root N	Total N	Month Equivalents
		---------------(mg/column)-------------			
Tall Fescue					
	Low	229	59	288	6.3 months
	Medium	317	67	384	4.2 months
	High	352	54	406	3.0 months
Bermudagrass					
	Low	117	39	156	3.4 months
	Medium	164	40	204	2.2 months
	High	184	38	222	1.6 months

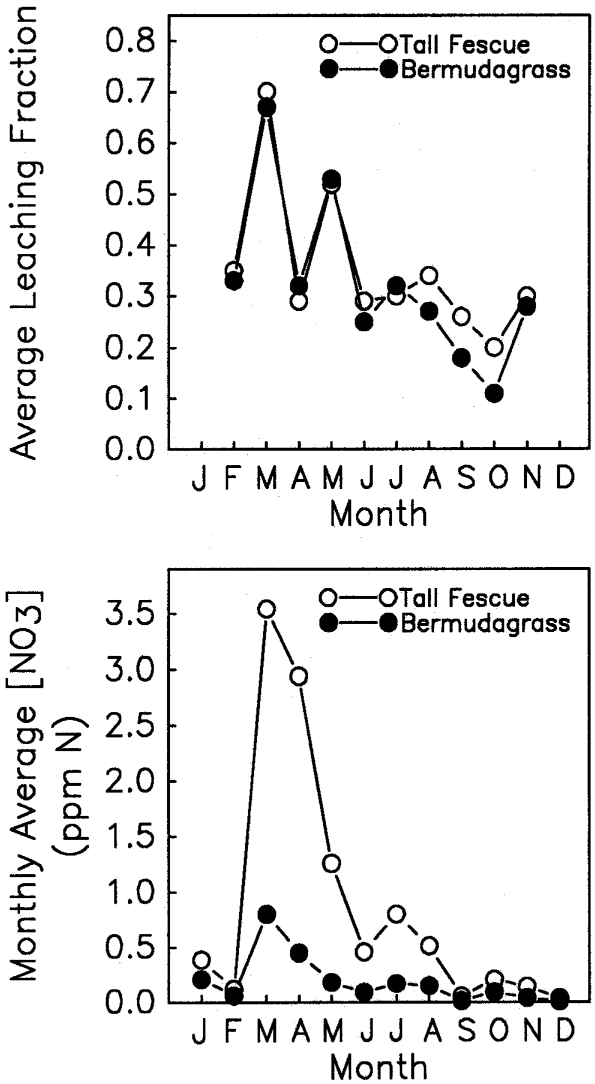
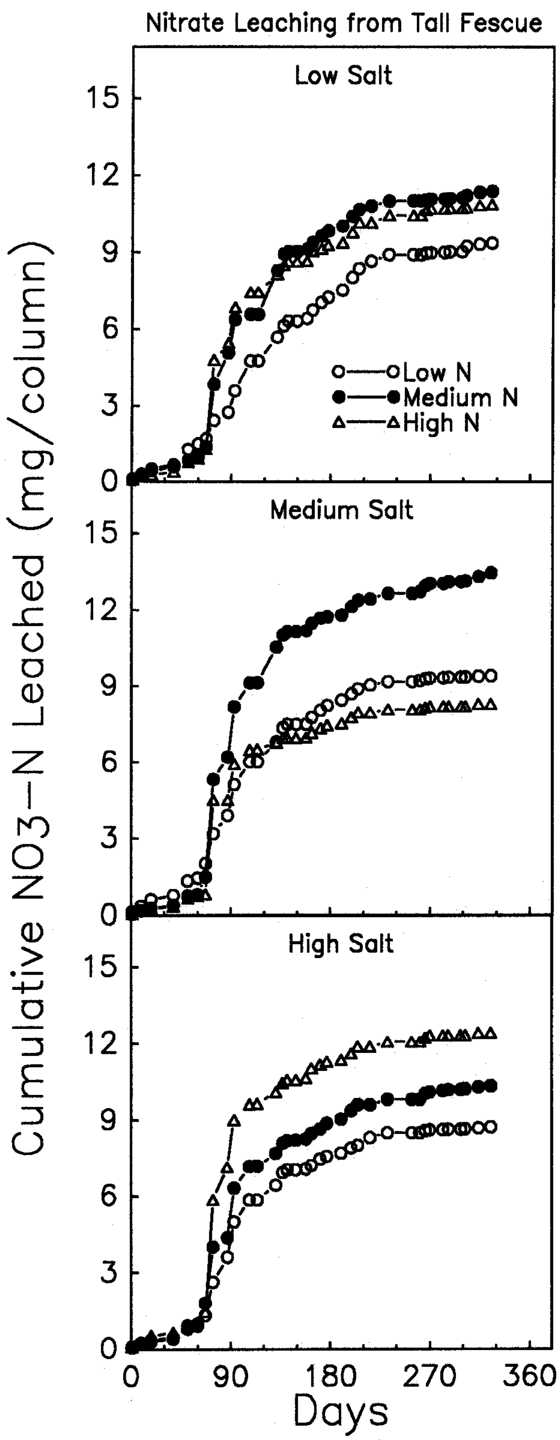
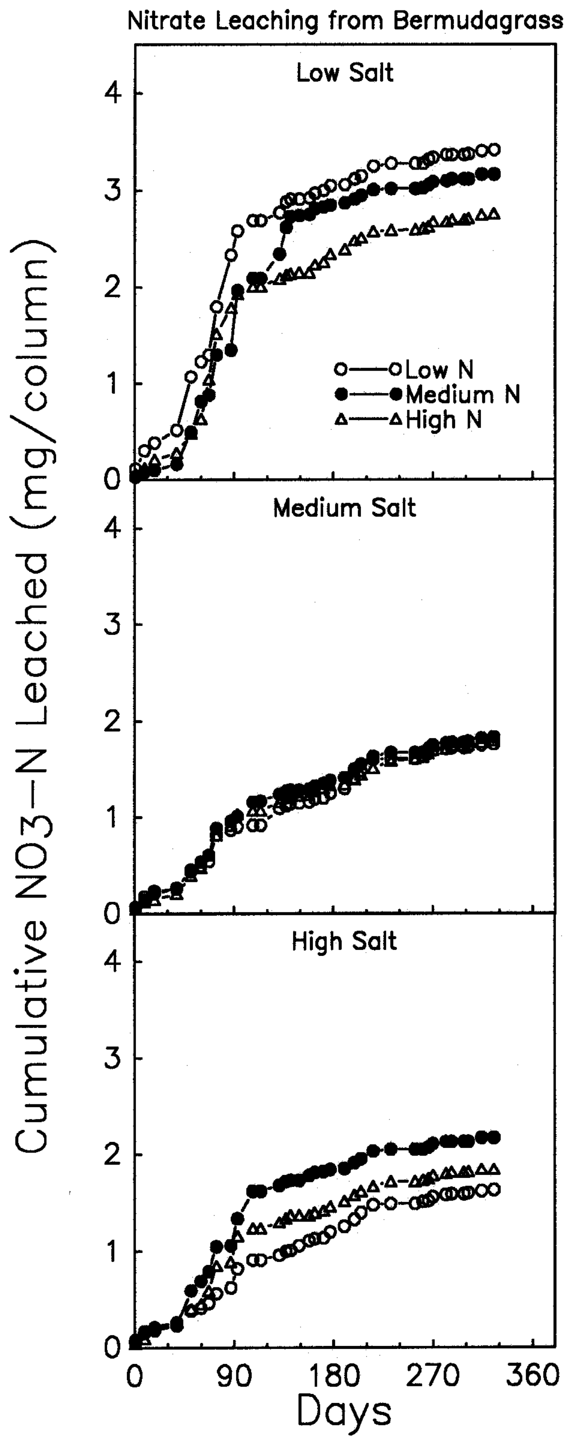


Figure 1a (above) and 1b.



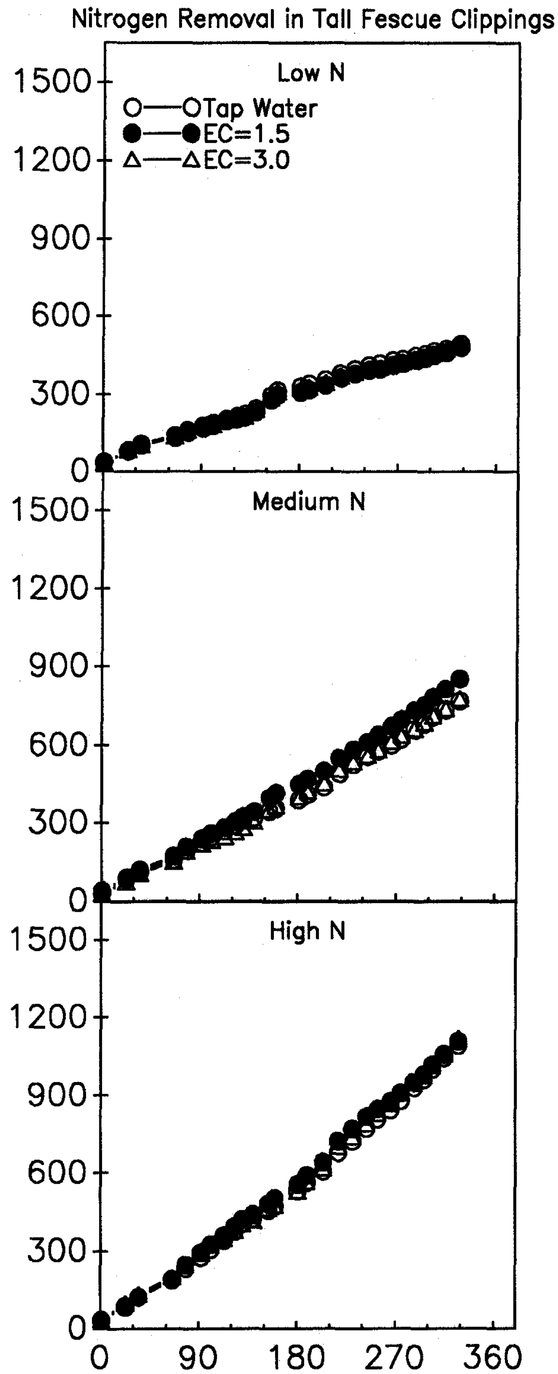
Nitrate Leaching from Tall Fescue
Low Salt
Medium Salt
High Salt
Cumulative NO3—N Leached (mg/column)
Low N
Medium N
High N
0
3
6
9
12
15
0
90
180
270
360
Days

Figure 2.



Nitrate Leaching from Bermudagrass
Low Salt
Medium Salt
High Salt
Low N
Medium N
High N
Cumulative NO3—N Leached (mg/column)
Days
0
90
180
270
360
0
1
2
3
4

Figure 3.



Nitrogen Removal in Tall Fescue Clippings
Low N
Tap Water
EC=1.5
EC=3.0
Medium N
High N
1500
1200
900
600
300
0
0
90
180
270
360

Figure 4.

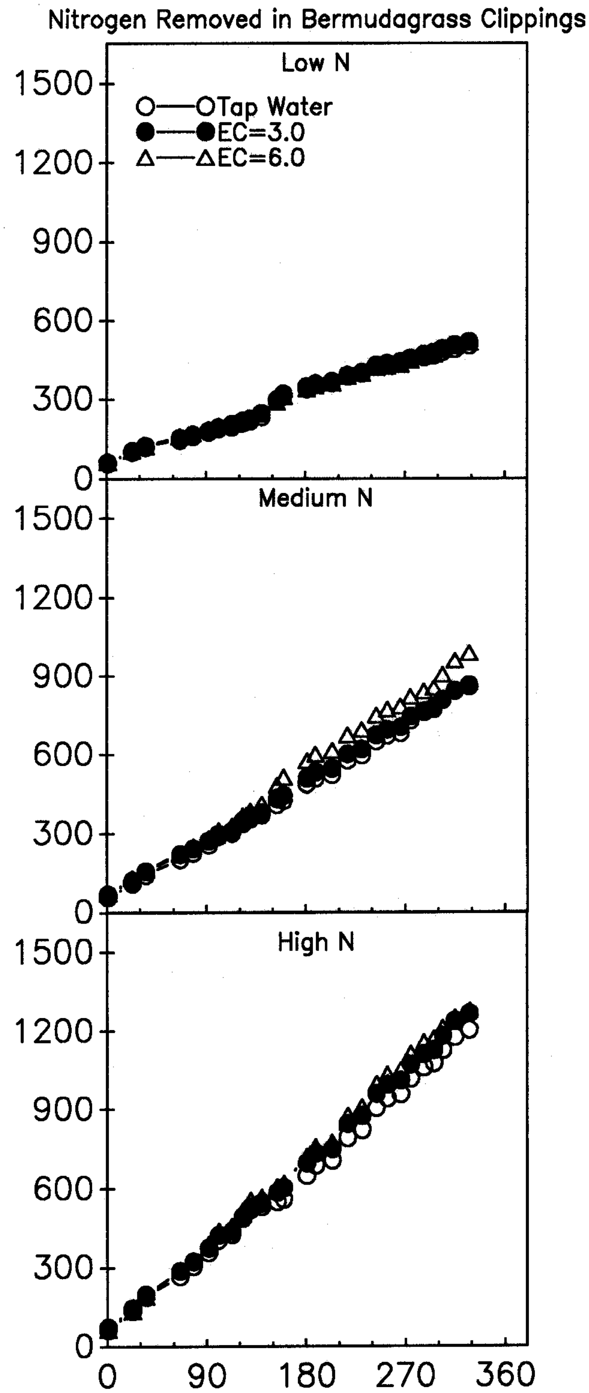

Nitrogen Removed in Bermudagrass Clippings
Low N
Tap Water
EC=3.0
EC=6.0
Medium N
High N
0
300
600
900
1200
1500
0
90
180
270
360

Figure 5.