5. The effect of zeolite amendments on nutrient retention of sand based rootzone by Lucy Giles Townsend

Sand dominated rootzones have the beneficial property of being fast draining, however, they also have low cation exchange capacities (CEC) which results in poor nutrient retention capabilities. Zeolite is an amendment that can be added to sand dominant rootzones in order to increase nutrient retention. This is due to the CEC of the zeolite minerals. The surfaces of the minerals have numerous negatively charged areas (cation exchange sites). Positively charged plant nutrients, such as ammonium-nitrogen and potassium, can be "held" in the rootzone due to the attraction to the exchange sites. By increasing the CEC of a rootzone the potential for greater nutrient retention also increases.

Nutrient retention levels, due to the addition of zeolites in sand rootzones, can be investigated by setting up a simple experiment (Figure 14). By treating columns containing either 100% sand, or a mix of sand and zeolite at a ratio of 90:10 (sand:zeolite v/v), with nutrient solutions a comparison can be made as to which rootzone sample has retained the most nutrients. This can be achieved by eluting each profile 10 times with water and collecting the leachate for analysis.

Figure 14: 12 eluting soil columns, 4 containing a zeolite amendment rootzone (a), 4 containing another zeolite amendment rootzone (b), both incorporated at a ratio of 90:10 (sand:zeolite v/v), and 4 control columns contain 100% sand (c).

The aim of this study was to evaluate and compare the performance of two zeolite amendments in sand rootzones in terms of their effect on nitrogen and potassium loss when treated with 4–3–12 fertiliser and an additional application of ammonium sulphate in relation to 100% sand sample.

K^+ loss

Both zeolites were mainly composed of a natural clinoptilite zeolite. One zeolite amendment was pre-loaded with K^+ and NH_4^+. (Zeopro™), while the other was unmodified (Sportslite, Ecosol), but also contained potassium feldspar. As a consequence, K^+ was displaced from both zeolite amended columns when treated with water compared to 100% sand rootzone (($P < 0.05$) two-way ANOVA, *post hoc* Tukey) (Figure 15). With the addition of ammonium sulphate the 100% sand based column retained a significantly higher amount of K^+ ($P < 0.05$) compared to the two amended rootzones (Figure 15). The fact that there was an initially higher concentration of K^+ present on exchange sites of Zeopro and Sportslite would suggest the potential for a greater level of displacement to occur, once ammonium sulphate was added to the columns. When the fertiliser (4-3-12) was applied to the soil profiles (Figure 15) it was clear that both the zeolite amended soils had a greater propensity to retain K^+ compared to the 100% sand profile ($P < 0.05$) due to the greater number of cation exchange sites present. Once ammonium sulphate was applied after the application of the mixed fertiliser treatment (Figure 15), both the 100% sand based and the Sportslite amended soils leached significantly higher ($P < 0.05$) concentrations of K^+ compared to the Zeopro amended soil, suggesting that the Zeopro amendment was better able to retain K^+ after the addition of the 4-3-12 fertiliser and an additional application of ammonium sulphate, even though it had been pre-loaded with K^+ and NH_4^+. Table 2 indicates that a large percentage of the applied K^+ was leached after the application of ammonium sulphate from both the 100% sand and the sand/Sportslite test mix compared to the sand/Zeopro test mix.

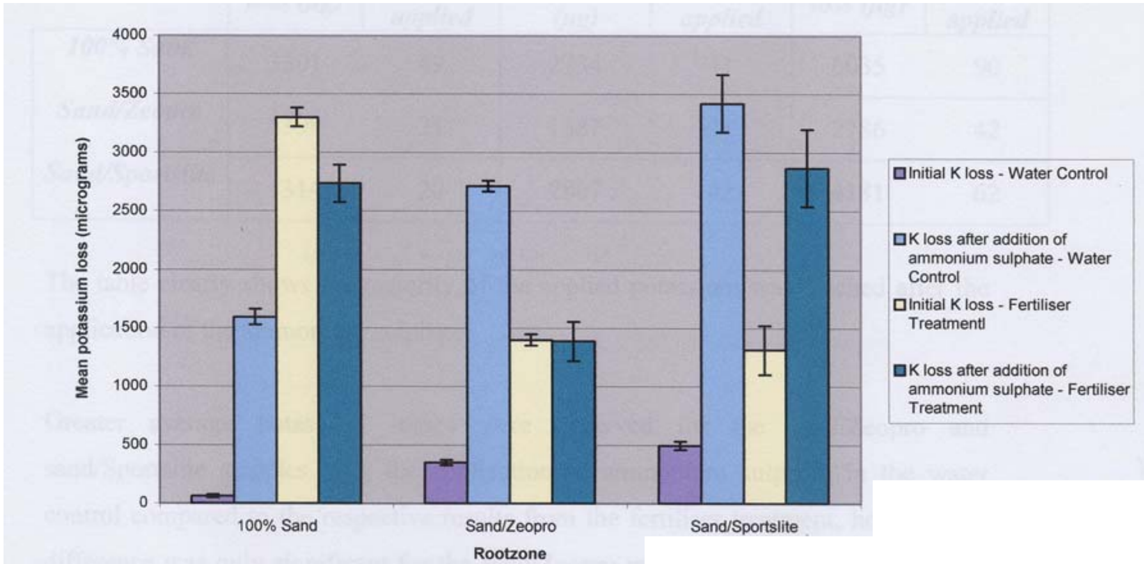


Figure 15: Initial losses of K^+ after the application of a water control, ammonium sulphate and 3-4-12 fertiliser to 3 different rootzone mixes (100% sand, sand/Zeopro, sand/ Sportslite), and K^+ losses after the additional application of ammonium sulphate to mixed fertiliser treated profiles. Error bars = +/- standard error, n = 4.

Table 2: Percentage K^+ loss from rootzone test mixes after applications of 4-3-12 fertiliser and ammonium sulphate.

	4-3-12 fertiliser applied		*Ammonium sulphate applied*			
	Initial loss (μg)	***% of amount applied***	***Loss after $(NH_4)_2SO4$ (μg)***	***% of amount applied***	***Total loss (μg)***	***% of amount applied***
100% Sand	3301	49	2734	41	6035	90
Sand/Zeopro	1399	21	1387	21	2786	42
Sand/Sportslite	1314	20	2867	42	4181	62

Nitrogen loss

Loss of nitrogen from these soil profiles was also investigated before and after treatments with fertiliser (Figure 16). Significantly higher levels of nitrogen were lost from the Zeopro amended profile compared to the other two test mixes when treated with water, suggesting some loss of the pre-loaded ammonium source of nitrogen (($P < 0.05$) two-way ANOVA, *post hoc* Tukey). Once ammonium sulphate was added to the profiles the 100% sand mix lost very high quantities of nitrogen compared to the zeolite amended soils ($P < 0.05$) and the sand/Sportslite profile retained significantly higher quantities of this element than the sand/Zeopro mix ($P < 0.05$). Both the Zeopro and the Sportslite test mix retained more nitrogen than the 100% sand profile after applications of 4-3-12 fertiliser ($P < 0.05$) and after the additional applications of ammonium sulphate ($P < 0.05$). Again the sand/Sportslite profile retained higher levels of nitrogen than the sand/Zeopro mix once the additional ammonium sulphate was applied ($P < 0.05$). Table 3 records the total percentage of nitrogen lost from each test mix and highlights the efficiency of Sportslite at retain nitrogen on its exchange sites.

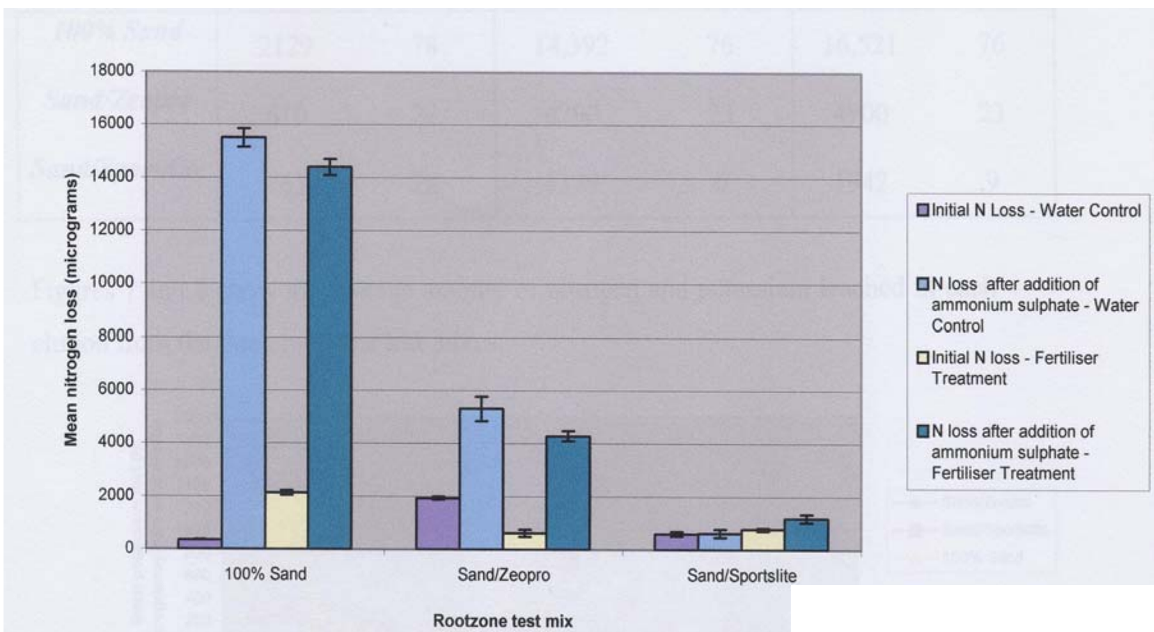


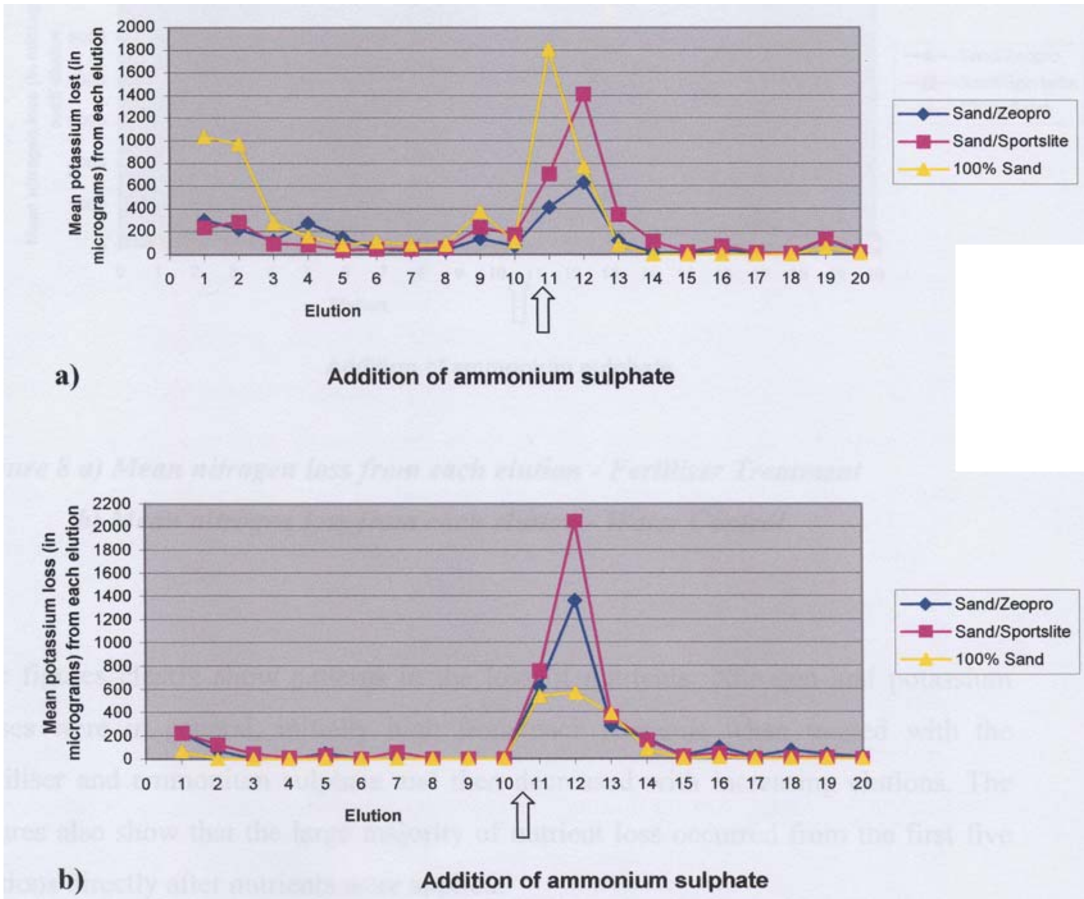
Figure 16: Initial losses of nitrogen after the application of a water control, ammonium sulphate and 3-4-12 fertiliser to 3 different rootzone mixes (100% sand, sand/Zeopro, sand/ Sportslite), and nitrogen losses after the additional application of ammonium sulphate to mixed fertiliser treated profiles. Error bars = +/- standard error, n = 4.

Table 3: Percentage nitrogen loss from rootzone test mixes after applications of 4-3-12 fertilier and ammonium sulphate.

	4-3-12 fertiliser applied		Ammonium sulphate			
	Initial loss (µg)	**% of amount applied**	**Loss after $(NH_4)_2SO4$ (µg)**	**% of amount applied**	**Total loss (µg)**	**% of total amount applied**
100% Sand	2129	78	14,392	76	16,521	76
Sand/Zeopro	610	22	4290	23	4900	23
Sand/Sportslite	763	28	1179	6	1942	9

Figure 17 and 18 record the average amount of nitrogen and K^+ leached from each elution taken from the 3 rootzone test mixes. Most nutrients were loss during the first 2 to 4 elutions suggesting that 1 or 2 heavy rain storms, or irrigation periods that saturate the soil profile could result in high nutrient losses, particularly in sand based construction with low CECs.

The overall findings suggest that high levels of K^+ can be displaced from sand based profiles, even with zeolite amendments present, after additional applications of ammonium sulphate. This has impliactions for the sequence and timing of fertiliser applications to turfgrass surfaces. The sand/Zeopro test mix was most effective at retaining high levels of K^+ in the soil columns, while the sand/Sportslite mix was most efficient at retaining nitrogen levels. A combination of both forms of zeolite within a sand-based rootzone may provide the optimum cation exchange sites for retaining levels of K^+ and nitrogen. These findings provide a sound bases for further investigations into nutrient retention levels within turfgrass profiles amended when treated with specific rootzone products.



<u>Figure 17:</u> K^+ losses from each solution and each rootzone test mix when 4-3-12 fertiliser and additional ammomuim sulphate was applied (a) and when water, as a control, and ammonium sulphate was applied (b).

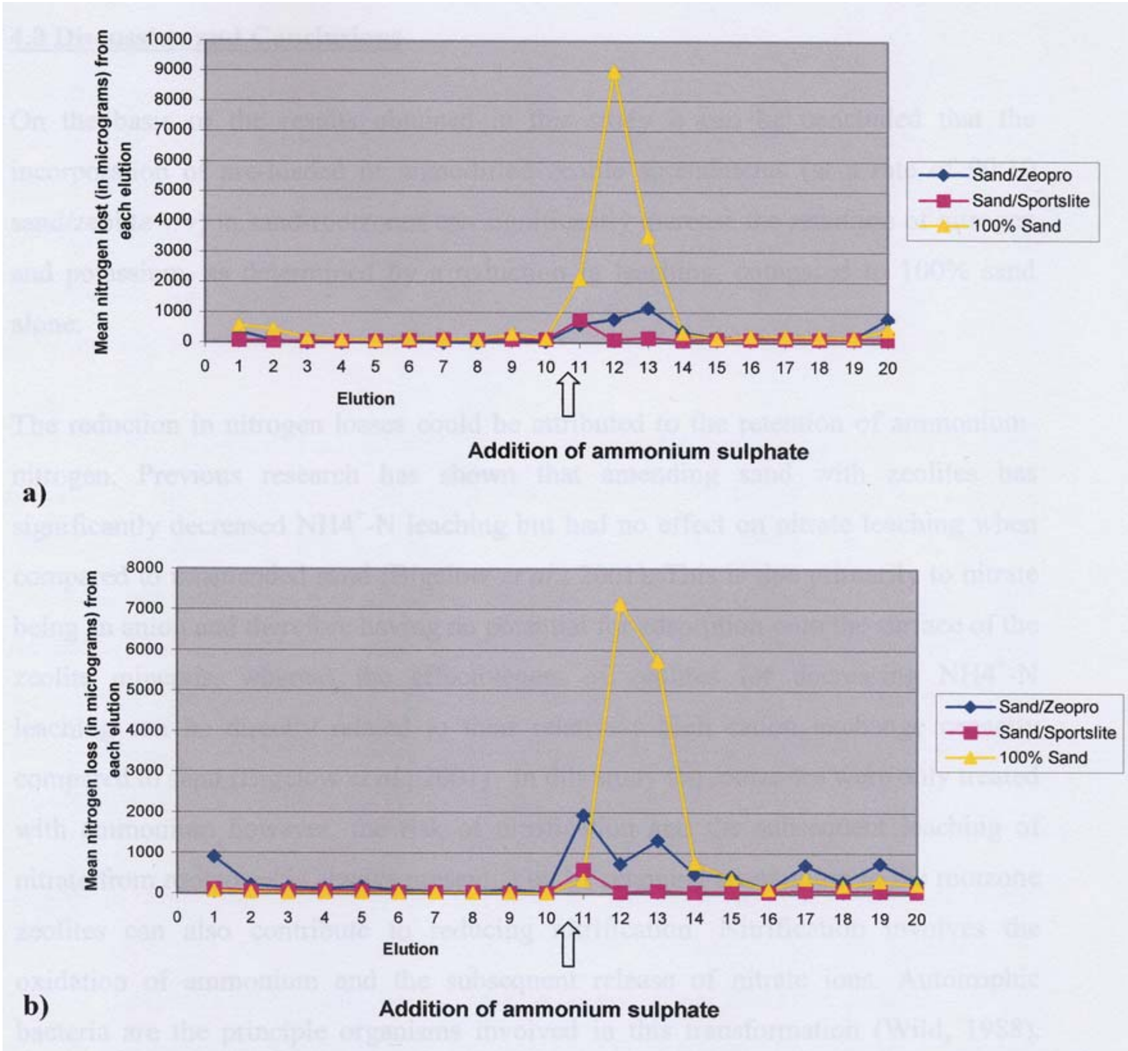


Figure 18: Nitrogen losses from each solution and each rootzone test mix when 4-3-12 fertiliser and additional ammomuim sulphate was applied (a) and when water, as a control, and ammonium sulphate was applied (b).