EFFECTS OF SODIUM AND CADMIUM APPLICATION TO PASTURE ON MINERAL LEACHING

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ABSTRACT
Leaching of essential elements from pasture constitutes a significant loss of valuable nutrients, and the release of nitrates and toxic elements such as cadmium to ground water poses a risk to wildlife and consumers. Results are presented from two experiements on the effects of applying Na and Cd to perennial ryegrass (*Lolium perenne*) swards on the leaching of essential and toxic elements. Socium application increased Na and decreased K concentration in leached waters, and cadmium contamination increased the leaching of Na, K, Mg, Ca and P. The application of cadmium did not increase the cadmium concentration in leached water at a depth of 1m.

KEYWORDS
Leaching, cadmium, sodium, ryegrass, pollution

INTRODUCTION
The efficiency of nutrient utilization is a function of effective recovery from the rootosphere and minimisation of losses, for example by leaching to underground water. Improvements in the recovery of N, S, P, Na, Ca and Mg from dairy cow pastures have been recorded following application of 18 kg Na/ha/yr (Chiy and Phillips, 1993). The improvement in nutrient recovery rate in the study occurred concomitantly with increased herbage yield and concentration of Na, Ca and Mg in herbage DM. In addition, despite a reduction in herbage K content by Na, the K recovery by herbage is not decreased. It was beyond the scope of that study to distinguish the role of increased herbage accumulation and changes in mineral composition that occurred following application of low levels of Na fertilizer from the direct chemical effects of Na on the leaching of these nutrients. The objective of experiment 1 was therefore to examine the effects of applying 32 kg Na/ha/yr on the leaching of cations and nitrate from dairy cow pasture.

Incremental emissions of toxic elements into the environment has increased concerns on the introduction of these toxins to the human food chanin and the ecological risks associated with them. Cadmium is relatively more mobile than the other heavy metals, a property that enables its uptake by plants but also enhances the rapid leaching of unabsorbed Cd and its interference with the utilization of other nutrients in pasture. In experiment 2, the effects of contaminating perennial ryegrass with Cd on leaching of metals from lysimeters was investigated.

MATERIALS AND METHODS
Experiments 1. An area of 14.2 ha perennial ryegrass (*Lolium perenne* L. cv. S23) pasture was divided into eight equal plots. Each plot was randomly allocated to one of two treatments: receiving 0 or 32 kg Na/ha/yr and was grazed by 16 dairy cows from turnout (25 April) to housing (31 October). One porous pot installed within each quarter of the grazing plot was used to collect leachate water samples for subsequent chemical analyses by Atomic Absorption Spectrophotometer (AAS).

Experiment 2. Perennial ryegrass (*Lolium perenne* L. cv S23) was grown on 22 lysimeters (each 1.375 m^2). Each lysimeter was allocated to one of two treatments: receiving no cadmium or a provocative foliar application 100 mg Cd as $Cd(NO_3)_2$/lysimeter. Leachate water samples were continuously collected from a drainage pipe from the sloping floor of each lysimeter and used for metal analyses by AAS.

RESULTS
In the first experiment sodium fertilizer increased the sodium concentration in leached water by 15%. It decreased the K concentration in the leached water and had no effect on Mg, Ca and nitrate concentrations (Table 1).

In the second experiments applying Cd increased the concentration of Na (92%), K (70%), Mg (86%), Ca (66%) and P (183%) in soil water.

DISCUSSION
Experiment 1. Recovery of Mg, Ca and NO_3 has previously been increased by Na fertilizer (Chiy and Phillips, 1993). The absence of effect of sodium fertilizer on Mg, Ca and NO_3 suggests that the increase in recovery originates from the increase in grass growth and changes in composition with Na fertilizer. Ionic interaction is, however, evident when considering monovalent cations. The excess of Na ions increased Na leaching and decreased K leaching, two ions that often behave antagonistically. Thus with an increase in the sodium concentration of soil water, less potassium is attracted out of the soil lattice structure.

Experiment 2. Cadmium is known to be phytotoxic and it is liekly that damage occurred to the grass roots. It remains within the top. The DM yield of herbage was reduced by cadmium and the concentration of Na, Mg and P was also reduced. Thus uptake was reduced and this may have caused greater leaching. In addition there may have been competitive inhibition between Cd and similar cations, in particular sodium which has an almost identical ionic radius to Cd.

REFERENCES
Chiy P.C. and Phillips C.J.C. (1993). Sodium fertilizer application to pasture. 1. Direct and residual effects on pasture production and composition. *Grass and Forage Science*, **48**, 189-202.

Table 1
Effect of sodium supply on metal concentration in leachate from pasture leachate.

	kg Na/ha/yr			
	0	32	SED	Prob
Cd (u/l)	–	–	–	-
Na (mg/l)	12.3	14.1	0.53	0.001
K (mg/l)	1.59	1.76	0.08	0.043
Mg (mg/l)	17.7	17.5	0.98	0.842
Ca (mg/l)	29.1	27.6	1.64	0.397
NO_3 (mg/l)	45.8	43.6	4.82	0.662
P	–	–	–	–

Table 2
Effect of cadmium contamination on metal contamination in lysimeter.

	Mg Cd/lysimeter		
0	100	SED	Prob
0.74	0.61	0.272	0.627
21.3	40.9	8.18	0.023
16.2	27.5	4.17	0.011
4.35	8.11	0.142	0.002
97.7	162	26.97	0.024
–	–	–	–
0.48	1.36	2.38	0.041