The effect of saline irrigation water on perennial pasture quality in the Goulburn Valley

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Abstract

A survey of five farms in the Goulburn Valley of northern Victoria that used saline groundwater for irrigation was conducted in March 2001. On each farm, samples were taken from paddocks that both used saline groundwater and nonsaline irrigation water. Measurements made at each site included soil and water chemistry, plant biomass, pasture species composition, plant tissue ion concentrations (including dietary cation/anion balance) and plant dry matter digestibility levels. The EC and SAR levels of the saline irrigation water used by the farmers ranged from 1.5 to 3.7 dS/m and from 4.5 to 10.2 respectively. Soil $EC_{1:5}$ levels averaged 0.4 dS/m in the paddocks using saline water and 0.15 dS/m in the paddocks using nonsaline water. Plant tissue Na and Cl concentrations were particularly high in the clover component of the saline pastures (viz. 1.0% and 1.7% on a dry matter basis respectively) and these concentrations were significantly greater in the saline compared with the nonsaline pastures. High concentrations of these ions in pasture can detrimentally affect pasture palatability and animal appetite in dairy cows.

Key words

forage production, groundwater, NaCl, salt tolerance

Introduction

The recommended maximum salinity limit of irrigation water applied to perennial pasture in the Shepparton Irrigation Region is 0.8 dS/m in order to avoid adverse effects on soil chemistry and pasture growth. However, this limit is not always adhered to with some farmers using water of salinity levels up to 4.5 dS/m. Irrigating with water with these levels of salinity leads not only to a reduction in pasture dry matter production but to high concentrations of Na and Cl in the plant tissue (1). In general, a lactating dairy cow only requires around 0.18% Na and less than 0.28% Cl on a dry weight basis (2). Combined concentrations of Na and Cl in excess of 5% may, at the very least, reduce palatability, increase the rate of digestion and depress animal appetite. In a recent field study, concentrations of Na and Cl reached 4% of total dry matter when saline groundwater of 2.4 dS/m was used continuously throughout the irrigation season (1). Following on from this research, a small survey was conducted of farms in the Goulburn Valley region that used saline groundwater for irrigation. The aim was to provide a snapshot on a regional basis on the effects of saline groundwater on pasture quality.

Methods

Five farms were identified in the Goulburn Valley region that used groundwater to irrigate perennial pasture. On each of these farms, the pastures, soils and saline groundwater-irrigation water were sampled. On four of these farms, samples were also taken from a paddock on the farm that was irrigated with nonsaline channel water. At each site, three soil samples were taken at depth intervals of 0-15 cm, 15-30 cm and 30-60 cm and analysed for $pH_{1:5}$, $EC_{1:5}$, Na, K, Mg, Ca and Cl concentrations, and Sodium Adsorption Ratios ($SAR_{1:5}$) and Exchangeable Sodium Percentages (ESP) were derived. A sample of irrigation water was analysed for pH, EC, Cl, P, S Na, K, Mg and Ca.

Pasture samples were taken from the centre of bays by cutting 4 quadrats (20 cm x 20 cm) at random. The harvested plant material was separated into the ryegrass, paspalum and clover components, dried and ground. Their Cl, Na, K, Ca ,Mg , P and S contents were measured and dietary cation-anion

differences (DCAD ie. (Na + K) - (Cl + S)) were calculated (3). A rising plate meter was used to estimate dry matter production. Plant *in vitro* dry matter digestibility levels were determined using the two stage pepsin-cellulase technique (4).

Results and Discussion

The EC and SAR levels of the saline groundwater applied to pastures ranged from 1.5 to 3.7 dS/m and from 4.5 to 10.2 respectively. These EC levels are considerably higher than the recommended limit to apply to pastures of 0.8 dS/m. Cl and Na levels varied considerably peaking at 1320 mg/L for Cl and 744 mg/L for Na. The pH levels ranged from 8.0 to 8.6.

Soil $EC_{1:5}$ levels averaged 0.15 dS/m in the paddocks receiving nonsaline water and 0.4 dS/m in the paddocks receiving saline water ($P<0.10$). Based on the definitions of Rengasamy *et al*. (5) (ie. $EC_{1:5}$ >0.3 dS/m), these soils would be classified as saline. The SAR and ESP levels were significantly higher in the paddocks irrigated with groundwater compared with those irrigated with channel water (viz. 2.65 and 0.65 for SAR and 13.15 and 6.00 for ESP, P=0.10 and 0.05 respectively). Soil pH was in the neutral range (viz. 6.8 to 7.6) at all sites.

Table 1. Tissue Cl and Na concentrations in pasture components irrigated with groundwater and channel water.

	Clover		Ryegrass		Paspalum	
	Cl (%)	Na (%)	Cl (%)	Na (%)	Cl (%)	Na(%)
Groundwater	1.69	0.96	1.31	0.67	0.87	0.40
Channel water	0.85	0.22	1.30	0.35	0.79	0.12
LSD (P=0.05)	0.55	0.24	0.26	0.23	0.19	0.12

Plant tissue Na and Cl concentrations were higher in the pasture irrigated with groundwater, especially in the clover component, compared with the pasture irrigated with channel water (Table 1). Concentrations of these ions were much higher in all species than those reported by Stockdale in Jacob and Rigby (3) for pastures in this region. K and P concentrations were lower and Mg levels were higher in the groundwater pastures. Generally, there were no differences in the plant Ca or S levels between the two irrigation water treatments. Dietary cation-anion difference measurements (DCAD) were all positive but low. Pasture dry matter digestibility measurements were significantly lower (P=0.05) in the pastures irrigated with saline groundwater compared with values for pasture irrigated with nonsaline channel water.

Conclusion

Overall at this March sampling, the combined Na and Cl levels in pastures of the five farms did not exceed 2.5 - 3%. However concentrations of Na and Cl in plant tissue tend to peak during mid summer and therefore it is possible that in January, ion levels may rise above 5%. There is very little published information on the maximum levels of Na and Cl in pasture that can be tolerated by dairy cows, as well as on the implications of using saline groundwater to irrigate pastures on pasture quality and animal performance. Results from this preliminary survey suggest that further research in this area would be worthwhile.

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