Production of forage from saline water

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Abstract

The dry matter production of four salt-tolerant grass species irrigated with saline irrigation water was studied at Undera in northern Victoria. Irrigation water with average salt contents of 21.7 and 62.5 dS/m respectively were applied to the grasses. The initial electrical conductivity ($EC_{1:5}$) of the surface 15 cm of the soil profile was 1.49 dS/m. At the completion of the 2000/01 irrigation season, this value had increased significantly to 2.55 dS/m for the moderately-saline treatment, and up to 5.25 dS/m for the highly-saline treatment. The *Puccinellia* did not establish under these treatments while the *Leptochloa* did not persist into the second irrigation season. Plant dry matter yields, protein and ash contents, and dry matter digestibilities were measured during the experiment. The highly-saline irrigation water elevated the ash contents of the *Leptochloa* and *Paspalum* plant tissue.

Key Words

salinity, *Distichlis*, *Leptochloa*, *Paspalum*, *Puccinellia,* dry matter yield, irrigation water, protein and ash content, digestibility

Introduction

Within Australia it has been estimated that approximately 2.5 million hectares are salt affected, with the potential to increase to 15 million hectares. Much of this salt-affected land lies within Western Australia; however the recent National Land and Water Resources Audit indicated that the greatest increases in salinity are likely to occur in New South Wales and Victoria. This report also found that half of the salt-affected land within Australia is used for sheep production. One of the major limitations to production from saline land is the lack of commercial forage species that can be used successfully on these areas. The halophytic grass *Distichlis spicata* cv. yensen-4a has been grown successfully as a sheep forage at dryland sites in the Western Australia wheat belt (personal observation). The aim of this research was to investigate the potential of this grass for forage production in south-eastern Australia when irrigated with saline irrigation water.

Methods

A field experiment was conducted at Undera in the Goulburn Valley of northern Victoria; the annual average rainfall of this area is 460 mm, and irrigated dairying is it's main industry. Four salt-tolerant grasses *(Leptochloa fusca, Puccinellia cilliata, Paspalum vaginatum* and *Distichlis spicata* cv. yensen-4a*)* were established with 20 kg P/ha and 18 kg N/ha during the summer of 2000. Treatments consisted of moderately-saline and highly-saline irrigation water, replicated four times. The saline irrigation water came from the evaporation basins of the Serial Biological Concentration experiment located at the same site. Irrigation water was applied whenever the cumulative evaporation minus rainfall reached 60 mm; at each irrigation, the electrical conductivity (EC) of each source of irrigation water was recorded.

Plots (2 m x 1 m) were harvested when there had been sufficient growth by cutting two quadrats (25 cm x 25 cm) from each plot to a height of 20 mm. After being dried at 70?C and weighed, the samples were analyzed for protein and ash content and *in-vitro* dry matter digestibility (IVDMD). Analyses of variance were performed on the data using GenStat (Lawes Agricultural Trust, Rothamstead Experimental Station). Where appropriate, data were $\log_{10}$ transformed to stabilize variances.

Results

The average EC's of the moderately-saline and highly-saline irrigation water were 21.7 dS/m and 62.5 dS/m, respectively. Soil EC values (1:5 in water) increased significantly from a pre-irrigation average of 1.49 dS/m, to 2.55 dS/m and 5.25 dS/m after the moderately-saline and highly-saline saline irrigation water, respectively, had been applied.

Salinity overall did not affect the protein contents (P>0.15) of the grasses (Table 1). *Distichlis* protein contents were lower than *Paspalum* and *Leptochloa* at each harvest (P<0.05). The *Leptochloa* and *Paspalum* ash contents were significantly higher than the *Distichlis* ash contents in all harvests (P<0.05). Overall, the ash content was found to increase significantly with salinity (P<0.05). *Distichlis* IVDMD's were found to be significantly lower than *Leptochloa* and *Paspalum* in all harvest (P<0.05). Salinity treatment was found to increase IVDMD in the first and third harvest (P<0.05), but not in the fourth harvest (P>0.3). The digestibility results presented in this paper have not been corrected for their soluble ash contents, and as such, may have been over-estimated.

Table 1. Protein and ash contents and digestibility of three grasses irrigated with moderately-saline and highly-saline water. The log_{10} transformed digestibility data for Harvest 4 are in parentheses.

	Grass	Salinity Level	Harvest 11	Harvest 22	Harvest 3	Harvest 4
Protein (%)	*Distichlis*	Moderate	10.2[b,c,2]	14.2	8.1[c]	8.0[b]
		High	9.7[c]	n.a.[3]	8.8[b,c]	9.1[a,b]
	Leptochloa	Moderate	11.6[a]	10.8	n.a.	n.a.
		High	10.8[a,b,c]	n.a.	n.a.	n.a.
	Paspalum	Moderate	11.1[a,b]	10.3	9.7[b]	10.1[a]
		High	11.1[a,b]	11.6	10.0[a]	10.1[a]
LSD(P=0.05)			1.15		1.35	1.25
Ash (%)	*Distichlis*	Moderate	20.1[d]	15.7	12.6[b,c]	15.7[b]
		High	24.7[c,d]	n.a.	10.4[c]	13.3[b]
	Leptochloa	Moderate	30.7[b,c]	28.1	n.a.	n.a.
		High	38.0[a]	n.a.	n.a.	n.a.

	Paspalum	Moderate	26.6[c,d]	14.3	15.7[b]	16.0[b]
		High	35.8[a,b]	19.7	21.00[a]	27.90[a]
LSD(P=0.05)			7.07		3.76	5.26
Digestibility	*Distichlis*	Moderate	55.7[c]	62.6	53.3[c]	53.1 (1.725)[b]
(%)		High	56.7[c]	n.a.	52.6[c]	50.9 (1.706)[c]
	Leptochloa	Moderate	64.5[b]	71.5	n.a.	n.a.
		High	69.1[a]	n.a.	n.a.	n.a.
	Paspalum	Moderate	65.2[a,b]	72.7	70.2[b]	69.1 (1.839)[a]
		High	67.3[a,b]	73.3	74.3[a]	70.7 (1.849)[a]
LSD(P=0.05)			4.28		2.13	(0.0143)

[1] No statistical analyses were conducted on the second harvest due to the high number of missing values.
[2] Means within each column with the same superscript are not significantly different (P=0.05).
[3] n.a. = not analysed

Dry matter production was found to differ significantly (P<0.001) between grass species. *Distichlis* produced significantly more dry matter than *Leptochloa* and *Paspalum* (P<0.05). *Distichlis* and *Paspalum* both produced more dry matter when irrigated with moderately-saline water than with highly-saline water (P<0.05) (Table 2).

Table 2. Total dry matter production of three grass species irrigated with moderately-saline and highly-saline water.

	Total Yield (kg DM/ha)[1]	
Salinity Level	Moderate	High
Distichlis	1444[a]	817[b]
Leptochloa	215[d]	256[d]
Paspalum	941[b]	558[c]

LSD(P=0.05)	203

[1] Treatments means with the same superscript are not significantly different (P=0.05).