USE OF SALINE WATER IN RICE BASED FARMING SYSTEMS

Final Report

September 1997

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Irrigation Research and Development

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CONTENTS

1. OBJECTIVES

i. To determine, across a range of soil types and watertable conditions, the effect of increasing the irrigation water salinity on the infiltration properties of rice soils.
ii. To determine the potential use of groundwater, pumped for watertable control, within a rice rotation.
iii. To develop and publish practical strategies for the management of groundwater, channel water and salinity in rice-based cropping systems.

The project had 2 field components:-

i. To determine the effect of water supply salinities on the infiltration properties of rice soils.
ii. To determine the potential for use of groundwater within a rice rotation.

2. METHODOLOGY

2.1 Water supply salinity

The infiltration rate of five water salinities (0.1, 0.25, 0.5, 1.0 and 2.0 dS/m) was monitored within 2 district rice crops each season. Details of the sites are indicated in Table 1. Water of the appropriate salinity was supplied to covered single ring infiltrometers via a hose with water depth maintained by utilising a constant head apparatus.

Table 1. Characteristics of field sites

Site	Season	Soil Type	Watertable Depth
1	1993-94	Non-self mulching clay	2.5 metres
2	1993-94	Red-brown earth	2.5
3	1994-95	Non-self mulching clay	>8
4	1994-95	Red-brown earth	>4
5	1995-96	Red-brown earth	>3
6	1995-96	Self-mulching clay	>3

Infiltration was measured for the duration of the surrounding rice crop. Soil was sampled to a depth of 3 m before and after the rice crop had been grown. Saturated paste extracts were prepared and analysed for EC_e and chloride.

2.2 Rice rotation experiment

The long term effects of irrigating with saline groundwater on soil salinity and crop productivity is being evaluated within a rice – fallow – wheat – sub clover – rice rotation. The experimental site, at the Murray Valley Field Station (10km NE of Deniliquin) was established with funds provided by RIRDC. The site is designed such that each phase of the rotation occurs each year in a separate block, allowing seasonal effects on irrigation management to be assessed.

Groundwater was applied to both the wheat and sub clover phases with channel supply water used to grow the following rice crop. There were 3 water salinity treatments applied to the wheat and sub clover:

1. control – channel water 0.15 dS/m
2. low salinity – 3 dS/m on wheat; 2 dS/m on sub clover
3. high salinity – 4.5 dS/m on wheat; 3 dS/m on sub clover.

3. RESULTS

3.1 Water supply salinity

Deep drainage was to be estimated from changes in the chloride profiles, using chloride mass balance modelling. However, preliminary results indicated that spatial variation of the profiles made use of any model difficult. Therefore results from the infiltrometers are presented.

During ponding for the rice crop the watertable rose to within 0.2 m of the soil surface at both the 1993-94 sites and to within 1 m at site 5 in 95-96. At the remaining 3 sites the watertable remained below the depths indicated in Table 1.

The data for infiltration rate (mm/day) was subjected to an analysis of variance using the GENSTAT statistical program. Although there was a trend in the data there was no statistical difference between the treatments. Treatments were then grouped into two levels; low EC (0.1, 0.25, 0.5 dS/M) and high EC (1.0, 2.0 dS/m) and reanalysed. The resultant analysis indicated a significant difference in infiltration rates between the high EC (1.1 mm/day) and the low EC (0.8 mm/day) water supply. At individual sites, there was a statistical difference between high and low EC supply water at sites 2 and 4. Both of these sites were on red-brown earths.

Table 2. Effect of water supply salinity on infiltration rate (mm/day) for individual sites.

		Site				
EC	1	2	3	4	5	6
Low	0.4	0.9	0.6	1.0	1.7	0.5
High	0.4	1.7	0.6	1.8	2.0	0.5

At the three sites with uniform clay texture profiles (no clay loam topsoil) the use of high EC water supply had no effect on infiltration rate (Table 2).

3.2 Rice Rotation Experiment

3.2.1 Effect of season on irrigation management

Climatic conditions experienced during the three seasons included in this report, 1993-94, 1994-95, 1995-96, varied considerably. Winter rainfall (leaching!) was 220, 50 and 185 mm respectively. Wheat grown in the wet spring of 1993 only required one spring irrigation. The contrasting drought in 1994 required four spring irrigations with two being applied in 1995. The sub clover phase received five, five and four autumn irrigations and one, three and two spring irrigations for 1993, 1994 and 1995 respectively.

3.2.2 Effect of saline groundwater on wheat production

There was no effect of irrigation with groundwater on wheat production in any of the three years. Grain yield was 6.4 t/ha in 1993, 6.9 t/ha in 1994 and 4.9 t/ha in 1995.

3.2.3 Effect of saline groundwater on sub clover production

In all years, irrigating with groundwater affected autumn production of sub clover. Data for 1995, for production from the germinating irrigation on 6 March to 17 May is presented in Table 3.

Table 3. Autumn production of sub clover (t/ha of dry matter) in 1995.

	Year of Production	
Water salinity	First	Second
Control (0.15 dS/m)	2.5 (970)[1]	3.1 (1910)
Low (2.0 dS/m)	2.0 (470)	2.7 (1110)
High (3.0 dS/m)	1.2 (470)	2.3 (830)

1 Seedlings per m^2

The reduction in growth was more severe in the first year pasture than in the second year pasture. The number of seedlings established was reduced by irrigation with groundwater (Table 3) with subsequent effects on production.

Winter production was not affected by the groundwater treatments.

There was some reduction in sub clover growth in the spring, especially in 1994 where winter leaching was negligible and three spring irrigations were applied. This reduction was not as pronounced as those observed in the autumn.

3.2.4 Effect of saline groundwater on rice production

1993-94. The rice crop yielded 8 t/ha, similar to the district average in an unfavourable season. There was no effect from irrigating the preceding wheat-sub clover phases with groundwater.
1994-95. There was no treatment effect on vegetative growth however those plots previously irrigated with saline groundwater yielded 11% less than the plots previously irrigated with channel water (10.2 t/ha v. 11.4 t/ha). This was the first occasion, from a possible three, that a yield reduction had been recorded. Soil salinity (EM38) measurements suggest that the ponding for the rice crop had not fully leached the rootzone of salt.

1995-96. Grain yield averaged 10.2 t/ha with no effect from irrigating the preceding wheat-sub clover phase with groundwater. It was possible that soil N supply (influenced by sub clover production) may have been implicated in the yield reduction measured for the 1994-95 rice crop. Therefore, five rates of nitrogen fertilizer were applied to all treatments before sowing the 1995-96 crop. An NIR tissue test at panicle initiation indicated that nitrogen topdressing was not required on any of the treatments – this was confirmed at harvest.

3.2.5 Effect of saline groundwater on soil salinity

Measurements recorded for Block 3 are presented as an example of trends in salinity/sodicity of the rootzone. Rootzone salinity (EC_e) increased over time during the wheat-sub clover phases of the rotation. The high salinity treatment increased from an initial value of 0.7 dS/m to 3.0 dS/m prior to ponding for the rice crop. Similarly the SAR increased from 1.7 to 9.5. Sampling after the rice crop showed that although rootzone EC_e had been reduced to the original level the SAR, whilst substantially lowered, remained above the initial level. The SAR was reduced to 4.0 dS/m a level significantly higher than the 1.7 dS/m recorded at the commencement of the rotation cycle. Values for the control treatment, which only received channel water, did not change during the four year cycle.

3.2.6 Interpretation and practical significance

Water supply salinities. Using water supply salinities above 0.5 dS/m significantly increased infiltration rates on two of the three sites with red-brown earth soil types. Although not statistically significant the infiltration rate at the third red-brown earth site was increased by 25%. The measured rates are lower than reported by Beecher (1991). The measurement SAR of the soil types used in the current experiment were much higher than reported by Beecher. Also, in this experiment the EC of the supply water was kept constant in the covered rings whilst the EC of the ponded bay water reported by Beecher increased to 3.7 dS/m during the growing season.

In a review paper, van der Lelij (1984) recommended that the salinity of irrigation supply should not be allowed to increase above 0.6 dS/m. Beecher (1993) has investigated the effect of saline irrigation water on the yield of soybeans, a crop known to be sensitive to salinity, and recommends that water >0.5 dS/m not be used.

Based on the results of this project and the above discussion it is recommended that channel water supply salinities not exceed 0.5 – 0.6 dS/m.

References

Beecher, HG (1991) Effect of saline water on rice yields and soil properties in the Murrumbidgee Valley. Australian Journal of Experimental Agriculture. 31:819-23.
Beecher, HG (1993) Effects of saline irrigation water on soybean yield and soil salinity in the Murrumbidgee Valley. Australian Journal of Experimental Agriculture. 33:85-91.
van der Lelij (1984) Soil permeability and drainage factors affecting irrigation water quality in the Murrumbidgee Valley of NSW. Proc. “Rootzone Limitations to Crop Production on Clay Soils (Eds. WA Muirhead and E Humphreys) A.S.S.S.I Riverina Branch pp.19-31.

Rice rotation experiment. This project has added an additional three years data to that obtained in the initial stage of the experiment (Slavich et al 1993). Results indicate no reduction in wheat yields from irrigation with groundwater up to 4.5

dS/m. A previous pilot study, reported by Slavich et al, 1993, had found that groundwater salinity of 6.5 dS/m did not affect wheat yields.

Sub clover production, particularly in the autumn, was reduced by irrigating with groundwater salinities of 2 and 3 dS/m.

Rice was effective in leaching the rootzone to an acceptable salinity for following crops. The soil SAR was also reduced but remained higher than that before groundwater was applied. This was also the scenario reported for the pilot study. The groundwater experiment has not progressed long enough to make firm recommendations on water salinities that can be used within rice rotations. It is planned to continue the experiment to the year 2000 by which time all four blocks would have progressed through two cycles of the four year rotation.

Reference

Slavich, P., Thompson, J., Petterson, G. and Griffin, D (1993). Gypsum and groundwater use in rice rotations. Final Report, Project DAN 69A to RIRDC.

4. ADOPTION

4.1 Water supply salinity.

The recommendation from this work should be adopted by water supply managers eg. Murray Irrigation Limited, Coleambally Irrigation, Goulburn Murray Water.

4.2 Rice Rotation Experiment.

This project has established guidelines for the use of saline groundwater on wheat and sub clover. It has also shown rice to be an effective leaching crop. However, because the soil SAR remains at an elevated level the build up of sodium over time is of concern. Further trends over a longer time frame are required.

Progress reports have been presented to the annual “review’ workshop of the Rice Research and Development Committee of RIRDC.

5. PUBLICATIONS

- Thompson, JA., Hume, IH., North SH. and Griffin, D. (1996). Groundwater use in rice rotations. Farmers Newsletter No. 147 p.23.

- Thompson, JA. and Hume, IH. (1996). Use of saline water in rice-based farming systems. Supplement on funded projects. WaterWheel 5. LWRRDC.

6. ADDITIONAL INFORMATION

Additional information can be obtained from the investigators –
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7. ACKNOWLEDGMENTS

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9. Landholders. The water supply salinity component of the project was undertaken within commercial rice fields. The provision of access to the fields and co-operation from the growers concerned is greatly appreciated.

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