



RICE CRC
FINAL RESEARCH REPORT

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SUMMARY

The concluding phase(s) of a rice rotation experiment presented the opportunity to assess the effect of consecutive crops of rice on the chemistry of the soil profile.

An experiment which aimed to determine the potential to use high salinity groundwater for the irrigation of the non-rice phases of a wheat - sub.clover - rice rotation, and then use rice, irrigated with low salinity channel water (<0.1 dS/m), as a leaching crop was undertaken. The rotation included a single rice crop between each cycle of the application of saline groundwater.

Although soil salinity of most horizons under saline treatments could be reduced by leaching in the rice phase (single crop), this was not true for sodicity. Average rootzone sodicity remained elevated above control values at the end of each cycle and increased following successive cycles.

This project was implemented to further assess the effectiveness of rice as a leaching crop. As the blocks completed two cycles within the rice rotation the opportunity to grow successive crops of rice was undertaken. At the time of soil sampling (May, 2000) separate blocks had grown one, two, three or four consecutive rice crops. Soil samples were taken from each plot and processed for electrical conductivity and sodium (Na) content.

Additional consecutive crops of rice resulted in more leaching of salt from the profile. After three crops sufficient salts had been leached to reduce EC_e to below 0.6 dS/m to at least the depth sampled in this project (90 cm). Similar values were measured after a fourth crop.

The levels of SAR_e measured after a second consecutive crop of rice were still higher than pre-treatment levels. Even after three and four crops of rice the SAR_e at profile depths below 60 cm, whilst reduced from the pre-treatment level, were still between 6 and 8.

1. BACKGROUND

The irrigation districts of southern NSW lie within the Murray and Murrumbidgee Valleys and cover 700,000 ha of irrigated country. The major industries dependent on irrigation water supplies are rice, dairying, and other cereal cropping. Rice is commonly grown in rotation with winter cereals and subterranean clover based pastures. The area sown to rice each year is approximately 100,000 ha, using from 60 to 80% of the total irrigation water supplied. Rice growing is restricted to the clay soils of the Riverine Plain and many of these soils are naturally sodic ie. high in exchangeable sodium, especially in the upper B horizon of duplex profiles. Much of the early soils research in the region was directed at improving the infiltration and physical properties of the soils using applied gypsum.

Shallow watertables (< 2 m) have developed under 250,000 ha of the irrigated land. There is considerable community concern as to the sustainability of the current landuse system. Land and water management plans have been developed for each irrigation 'district' by community working groups. The aim of these plans is to develop ecologically sustainable and productive irrigated agricultural systems by integrating a range of management options. The area of land affected by waterlogging and subsequent salinisation must be minimised to a level acceptable to the community. Also the landscape needs to be managed to minimise salt export in surface runoff.

The need for management practices which minimise deep drainage (below the rootzone and then potentially to the groundwater systems) of irrigation water and rainfall is recognised by the community, industry and Government. The need to control drainage water quality is also recognised.

A rotation experiment at Deniliquin had indicated that salts accumulated within and below the rootzone for both channel water and saline irrigation treatments. Sodification of the rootzone was rapid (Hume et al, 1998, Burrow and Surapaneni, 2001).

Although soil salinity of most horizons under saline treatments could be reduced by leaching in the rice phase, this was not true for sodicity. Average rootzone sodicity remained elevated above control values at the end of each cycle and increased between successive cycles (Burrow and Surapaneni, 2001). They concluded that ponded channel water, applied in a single season of rice production was unlikely to reduce SAR_e in the rootzone.

2 OBJECTIVES

An experiment which aimed to determine the potential to use high salinity shallow groundwater for the irrigation of the non-rice phases of a wheat - sub. clover - rice rotation, and then use rice, irrigated with low salinity channel water (< 0.1 dS/m), as a leaching crop was undertaken. This rotation included a single rice crop between each cycle of the application of saline groundwater to the non-rice phases.

This project was implemented to further assess the effectiveness of rice as a leaching crop. As the blocks completed two cycles within the rice rotation (see methodology) the opportunity to

grow successive rice crops was undertaken. At the time of soil sampling (May, 2000) separate blocks had completed one, two, three or four consecutive rice crops.

Soil samples were taken from each plot and processed for electrical conductivity and sodium (Na) content.

3 METHODOLOGY

The long term effect(s) of irrigating with saline groundwater on soil salinity and crop productivity was evaluated within a rice - fallow - wheat - sub.clover - rice rotation. The experiment, located at NSW Agriculture's Murray Valley Field Station (10 km NE of Deniliquin) was established in 1991. The site was designed so that each phase of the rotation occurred each year in a separate block, to allow for seasonal effects of irrigation management (number of irrigations) to be assessed.

Experience has shown that it is difficult, particularly in shallow watertable areas, to establish crops or pastures immediately after the harvest of a rice crop, with success strongly affected by rainfall. For this reason the experiment had a fallow period following the rice crop. The wheat was pre-irrigated and undersown with sub.clover. The sub.clover regenerated (usually with the aid of an irrigation) and was then irrigated for the following two years. It was green manured (ploughed in) in August before the sowing of the next rice crop in October. This provided two years of sub.clover pasture, sufficient to provide a significant contribution to the N requirement of the rice crop. This four year rotation is common practice in the Murray Valley irrigation districts.

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

1. Control – channel water (<0.15 dS/m)
2. Low salinity groundwater – 3 dS/m on wheat; 2 dS/m on sub. clover
3. High salinity groundwater – 4.5 dS/m on wheat; 3 dS/m on sub. clover

Following harvest of the final rice crop (2000) two soil cores (0-0.9 m) were obtained from each of the two replicate plots of each salinity treatment. The cores were divided into depth increments of 0.15 m. The samples from the four cores from each salinity treatment were bulked into a single sample from each block (4).

Each bulked sample was air-dried, ground and sieved to < 2 mm particle size. Saturated paste extracts were prepared using the method of Slavich and Petterson (1993) and the water content of the saturated paste determined by oven drying. The saturated paste extract was analysed for electrical conductivity (EC_e dS/m) using a conductivity bridge and for sodium adsorption ratio [SAR_e (mmol/L)^{0.5}] using atomic absorption spectrophotometry.

4 RESULTS

4.1 Soil type and watertable conditions

The predominant soil type is classified as a Birganbigil loam (Smith, 1945). There is a loam A horizon 5-10 cm depth. Although colour is variable below this depth the texture is a heavy clay (60%) to at least 3 m.

The watertable was less than 2 m and rose to between 1 and 1.5 m whilst water was ponded for rice (Slavich et al, 1993).

4.2 Profile description of EC_e before first rice crop

Prior to the application of groundwater the EC_e was less than 1 dS/m in the surface metre. The EC_e increased to 3-4 dS/m at 1.5 m with a further gradual increase to 5-6 dS/m at 3 m and below.

Initial SAR_e in the surface 30 cm was approximately 2. There was a strong gradient in SAR_e : to approximately 6 at 50 cm depth and up to 15 at 150 cm depth (Burrows and Surapaneni, 2001). This pattern of SAR_e distribution, is consistent with groundwater intrusions into the lower horizons (150 - 300 cm) of the profile (Burrows and Surapaneni, 2001)

4.3 After the rice crop(s)

4.3.1 EC_e

Results obtained from earlier work had shown that a single rice crop substantially reduced EC_e especially within the surface 30 cm of the soil profile. A second consecutive crop of rice further reduced the EC_e of the surface 30 cm as well as the deeper profile to at least 2 m (P G Slavich and J A Thompson, unpublished data). These levels were similar to those recorded on the control plots that had not been irrigated with groundwater.

Additional consecutive crops of rice resulted in more leaching of salt from the profile (Figure 1). After three crops sufficient salts had been leached to reduce EC_e to below 0.6 dS/m to at least the depth sampled in this project (90 cm). Similar values were measured after a fourth crop.

4.3.2 SAR_e

A single crop of rice reduced SAR_e values compared to those measured before the plots were ponded for rice. A second consecutive crop further reduced the SAR_e especially for the control and high salinity plots (J A Thompson, unpublished data). However, the levels measured on the plots where groundwater had been applied were still higher than pre-treatment levels.

A third consecutive crop of rice reduced the SAR_e of the top 30 cm of the profile to < 4 and to approximately 6 between 30 and 60 cm (Figure 2). The block which grew four crops of rice

measured similar values to those recorded on the block that had grown three crops. Even after three and four rice crops the SAR_e at profile depths below 60 cm, whilst reduced from the pre-treatment level, were still between 6 and 8.

Figure 1 Soil profile ECe after an increasing number of consecutive rice crops (see text for explanation of salinity treatments)

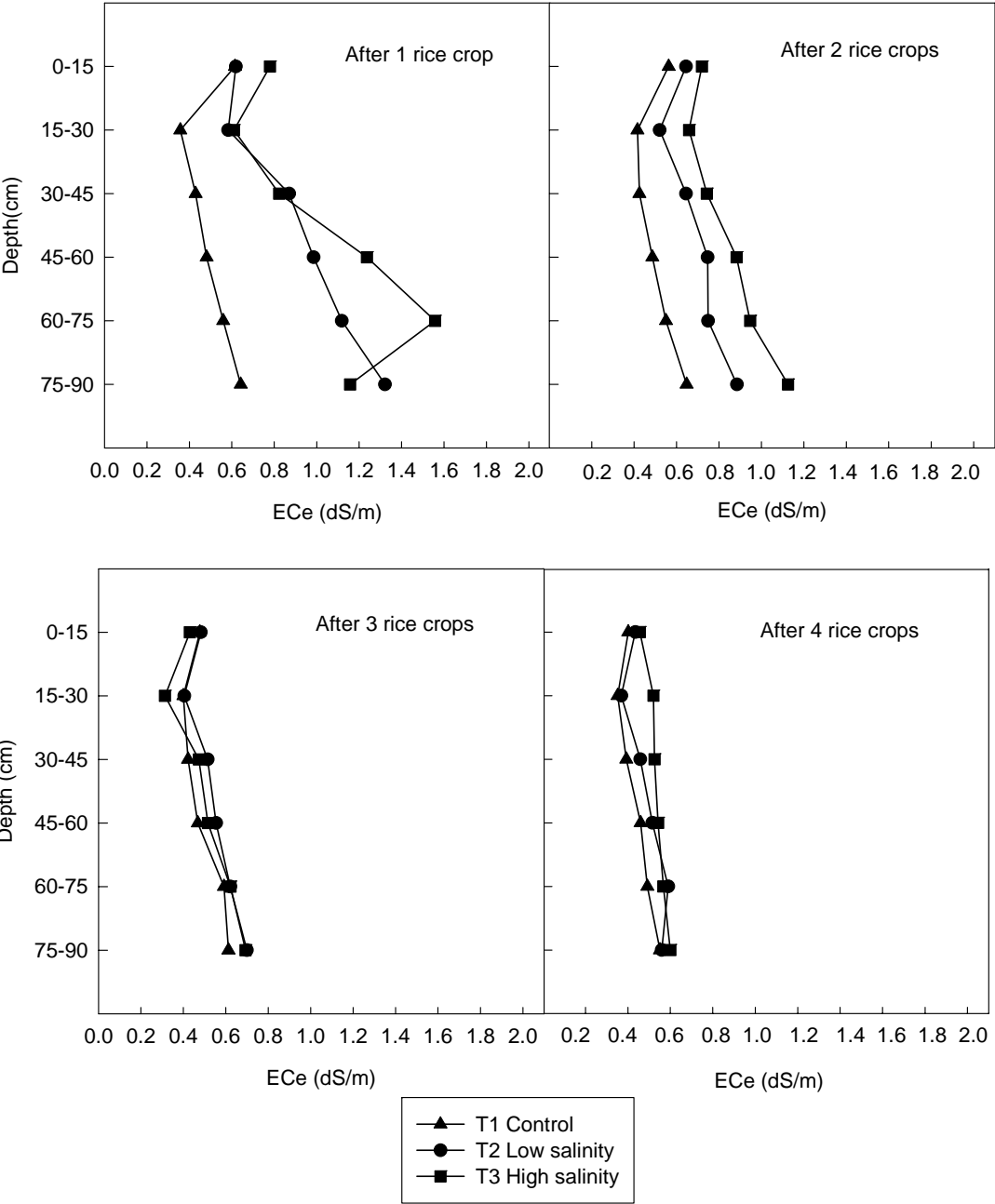
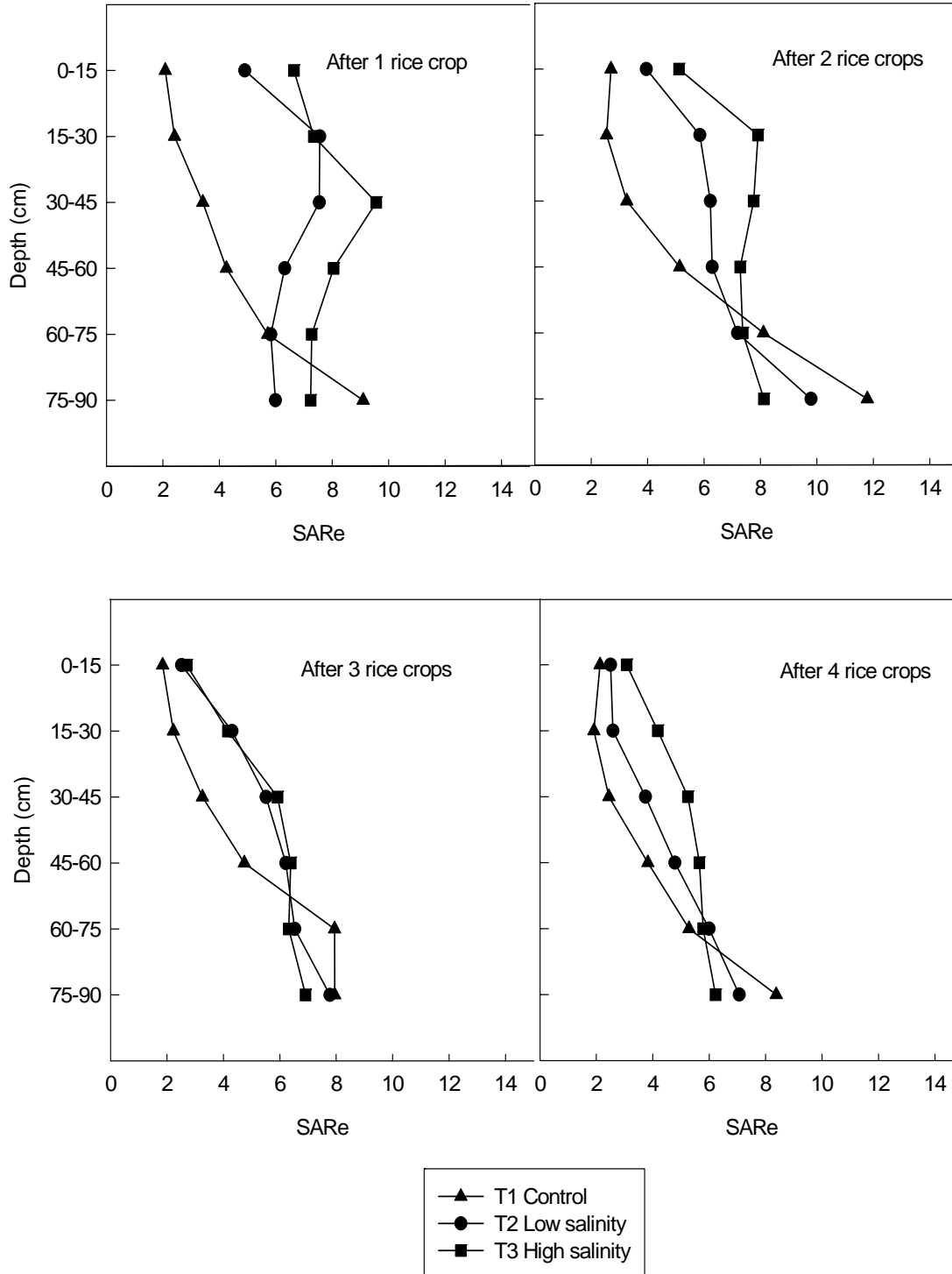


Figure 2 Soil profile SARE after an increasing number of consecutive rice crops
(see text for explanation of salinity treatment)



5 DISCUSSION

Whilst the results presented here in figures 1 and 2 are from separate blocks we are of the opinion that the results obtained are representative of the leaching capabilities of the rice crop.

Ponding water for rice production has shown to be effective in leaching salt from the rootzone to levels that should not be detrimental to the following crops. This was achieved after a single crop, however further leaching occurred with successive crops.

Lowering the level of soil sodicity required several consecutive crops. After a second crop the SAR_e within the rootzone for the following crops (0-60 cm) was still at or higher than 6. This value is equivalent to an ESP of at least 7 (Richards, 1954). After a third crop the SAR_e was below 5 (ESP approximately 6). An ESP of less than 6 is desirable to limit the effects of poor soil 'structure' on crop growth. Above this level crop emergence and infiltration of water are reduced. A ESP of less than 4 is required for optimum plant growth.

6 IMPLICATIONS AND RECOMMENDATIONS

This project has demonstrated the effectiveness of rice as a leaching crop especially for soil salinity.

The results suggest that it is more difficult to reduce soil sodicity to acceptable levels and that growers need to be mindful of the potential hazard of high soil sodicity when using saline groundwater.

7 INTELLECTUAL PROPERTY

There is no tangible intellectual property arising from this project. However, this report demonstrates that rice is a very effective leaching crop. The report will be published in the public domain, providing the opportunity to extend any benefits to growers through established networks.

8 ACKNOWLEDGEMENTS

We thank Vivien Naimo for her diligence in processing the soil samples collected for this project.

9 REFERENCES

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