A Case Study to Reduce Dryland Salinity on a Temora Farm

M.H. McCallum[1], J.S. Salmon[2] and J.F. Angus[1]

[1]CSIRO Plant Industry, Canberra, ACT.
[2]NSW Department of Land and Water Conservation, Temora, NSW.

ABSTRACT

Isolated outbreaks of dryland salinity have begun to occur on farms in southern NSW. On-farm strategies to quantify and reduce the impact of dryland salinity are reported for a case study near Temora. An electromagnetic survey revealed that a saline scald of about 0.4 ha was associated with a further 20 ha of high subsoil salinity. Crop production losses attributed to salinity in 1999 were 100% within the scald but decreased to 30% near the scald. Lucerne established in 100 ha around the scald lowered the watertable in one year, and the rain leached surface salt into the subsoil so that in 2000 crops grew in areas where they failed in the previous year. However in the winter of 2000, the watertable rose under the scald but not under the surrounding lucerne, indicating that control of recharge from higher in the catchment is needed to reduce discharge in addition to reduction of the local watertable. Methods that identify the location and size of the recharge area are needed if these scalds are to be minimised.

KEY WORDS

Salinity, salt-tolerance, watertable, lucerne, wheat, canola.

INTRODUCTION

The threat of dryland salinity in the Murray Darling basin has been widely discussed in the Salinity Audit (4) and related documents. The area of dryland salinity in New South Wales is predicted to increase 60-fold within 50 years, affecting both mixed-farming (300-600 mm annual rainfall) as well as permanent pasture regions (>600 mm). The reports also propose that there is little or nothing that 'conventional' agriculture can do to prevent the spread of salinity, and much of the agricultural landscape will need to be returned to woodland. Many people find these forecasts surprising for regions where there is little visible evidence of surface salinity at present. In the Temora district of southern NSW (540 mm annual rainfall) there are few saline scalds and landholders believe they can control salinity using perennial pastures to lower the watertable. Certainly this perception is supported by studies which indicated that lucerne was capable of controlling salinity in small catchments in North America (2). The present paper reports a case study in the Temora district that tested the impact of salinity on crop and pasture productivity and the effect of establishing lucerne in a saline-affected area.

MATERIALS AND METHODS

A saline scald on a farm near Temora first appeared in the late 1980's and by the late 1990s covered two patches with a combined area of 0.4 ha where a thin crust of salt covers the soil surface. The affected area is 50 m upslope from a road and at the foot of a 2 km long ~2% slope. In order to lower the watertable and reduce the spread of salinity, the landholder established lucerne in 1999 by undersowing it with wheat over 100 ha adjacent to, and uphill from, the scald. The extent and severity of salinity over the farm was measured as soil electrical conductivity (EC) using a motorbike-mounted electromagnetic induction sensor (EM31) attached to a GPS unit. The depth and salt content of the watertable were measured from piezometers installed in the scald and surrounding areas (Fig. 1). To quantify the impact of salinity on productivity, a range of crop and pasture species with reputed differences in salt-tolerance were sown in transects (2 x 160 m) through the scald and into surrounding areas in 1999. All species were sown and fertilised at district recommended rates. Weeds and insect pests were controlled as required using a range of herbicides and insecticides, and all chemicals were used at the recommended applications rates. The establishment, persistence and production of pastures were monitored. Separate areas of crop within a transect were harvested according to visual differences in growth. After harvest soil samples (0-30 cm) were collected in these areas to measure EC (1:5 extract).

RESULTS AND DISCUSSION

The extent of salinity on the farm

The scalded areas were identified as having high EC in the EM31 survey (Fig. 1). This map shows an additional area of 20 ha with high EC but with no visible evidence of scalding. This land, mostly in low-landscape positions near existing scalds and close to the road or drainage line, is at risk of also scalding. The source of groundwater under the scald is presumably the upper slopes to the east and southeast where the EM31 survey indicates low salinity.

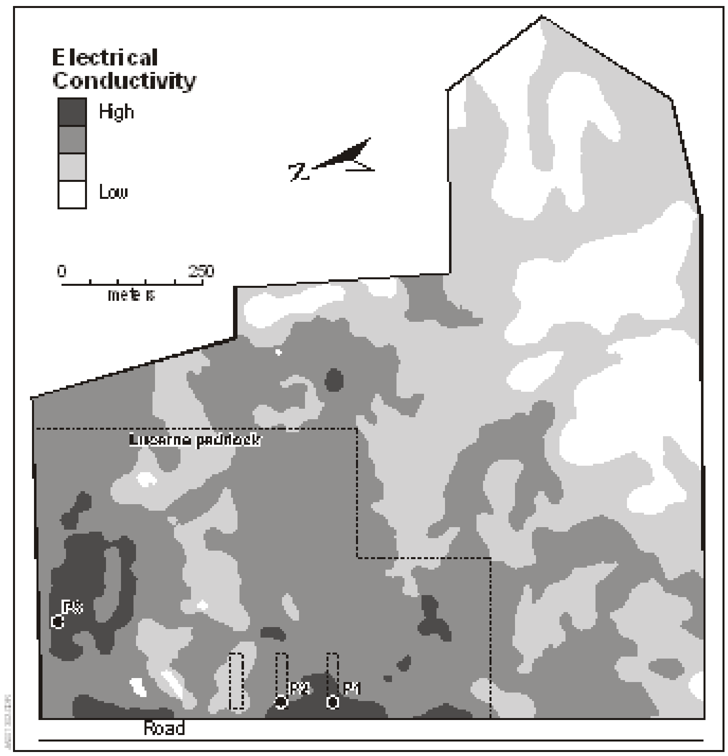

Figure 1. EM31 farm survey showing electrical conductivity, the area of established lucerne and the piezometers, labelled P, as referred to in Fig. 3; P1 and P2 are located in scalds and P3 is in lucerne. Dotted rectangles represent areas sown to crops and pastures. The land rises about 30 m over 2 km from west to east.

Impact of salinity on crop and pasture production

Plant establishment was poor for most crop and pasture species within the scald (EC >2 dS/m), and the growth and yield of surviving plants was limited. The exceptions were a sparse population of perennial grasses that are well-established productive plants (Table 1).

Table 1. Species and varieties of crops and pastures sown in salted and unsalted land in 1999. Density of the crop species was measured in 1999 and of the pastures in 2000.

Species	Cultivar	Plant density	Plant density in

		out of scald (m^{-2})	Scald (m^{-2})
Wheat	Janz	135	0
Canola	Oscar	44	0
Barley	Schooner	143	0
Safflower	Sironaria	27	0
Lucerne	Aurora	10	0
Lucerne	Salado	7	0
Phalaris	Sirosa	10	5
Phalaris	Salt-tolerant selection	6	2
Cocksfoot	Currie	10	1
Tall wheatgrass		6	3

All crop and pasture species tested established in areas outside the scald where EC was up to 1.2 dS/m. Plant productivity varied according to level of salinity and position in the landscape. Data for two crops (wheat, canola) are presented in Fig 2. Wheat was more salt tolerant than canola, as shown by the rate of yield decrease with increasing salinity. In addition to salinity, some of the areas within the transect were low-lying and subject to waterlogging during the year. For both crops, waterlogging alone appeared to decrease crop yield by 30%. Previously published crop responses to salinity, as shown as lines in Fig 2, were obtained using salty irrigation water applied to a non-salty soil, without waterlogging. The differences between our data and the published responses may reflect the combined effects of waterlogging and salinity, which can have a greater adverse effect of plant growth and survival than either of these two plant stresses alone (1). The effects of waterlogging and salinity are difficult to separate where dryland salinity is associated with discharge.

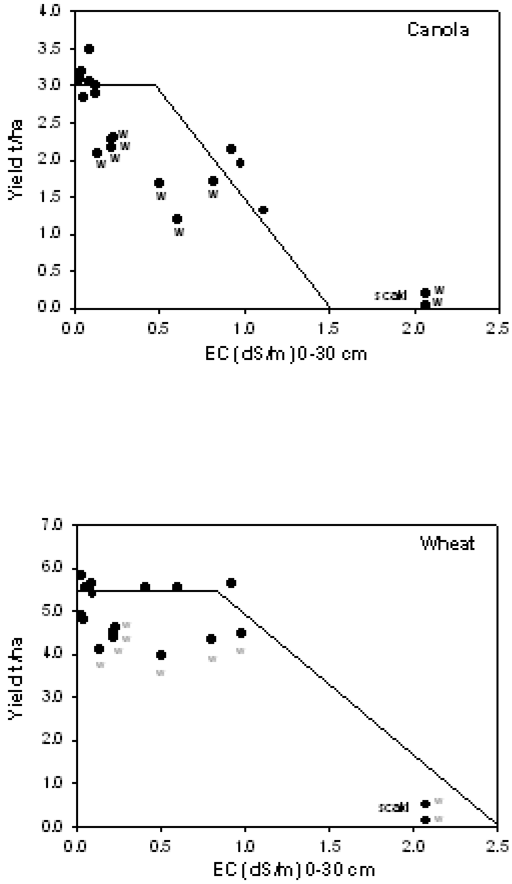

Figure 2. Yield of wheat and canola in relation to salinity. Each point represents machine yield where a crop was visually uniform for a distance of 5-10 m along a transect through a salt scald, and the mean electrical conductivity of the top 30 cm of soil in the plot. The lines represent published salt tolerance for wheat (3) and canola (5). Points marked with W represent waterlogged areas.

In general, there was a sharp boundary between normal vegetative growth and no growth at the edge of the scalds. The two exceptions were the graded response of canola and safflower, in contrast to the sharp growth reduction by the other crop species. The boundaries of growth of most species and varieties were similar, suggesting that there were no practical differences in tolerance for the levels of salt present. It was surprising to see little difference between barley and safflower that are reputed (3, 6) to be salt tolerant (data not shown), and less tolerant species such as wheat and canola. There was also no visible difference in growth between the lucerne cultivars Aurora and Salado at the border of the scalds, despite the selection for Salado to germinate and grow under saline conditions.

Using lucerne to reduce salinity

Piezometers were installed in the scalds and on fence lines beside the established lucerne. Between spring 1999 and autumn 2000 the watertable under the scalds fell from the surface to depths between 75 and 150 cm (Fig. 3). However, following several weeks of rainfall in winter 2000, the watertable rose to close to the surface under the scalds but not under the surrounding lucerne. The salinity of the groundwater under the scalds and lucerne was more stable than the height of the watertable over the period of measurement, but with some fluctuations, apparently reflecting pulses of salt or fresh water.

In 2000, crops emerged and grew in areas of the scald where there had been no emergence or growth in 1999. The reduction in surface salinity was presumably because salt had been leached by rain into the groundwater, as shown by pulses of salinity in Fig. 3. Weeds (annual ryegrass and capeweed) grew in the middle of the scald for the first time in many years and there was vigorous growth of isolated perennial plants listed in Table 1. The most vigorous were the two *Phalaris* lines and tall wheat grass.

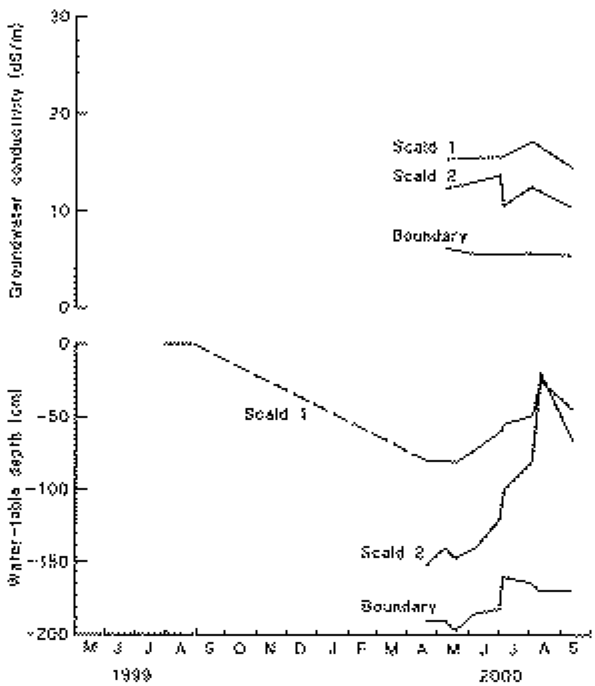

Figure 3. Watertable depth and groundwater salinity in 3 piezometers marked on Fig. 1.

CONCLUSIONS

There was little difference in salt tolerance between crop and pasture species at the levels of salinity found in the scalds. Attempts to continue cropping in similar scalded areas are likely to be unprofitable and will lead to increased risk of expanding salinity.

Growing lucerne near the scalds temporarily lowered the saline watertable and there was a clear reduction in the area of scald during a 12-18 month period. This improvement supports the belief of local landowners that salinised land can be rehabilitated. However the watertable rise beneath the scald during late winter 2000 indicated that the lucerne established near the discharge area will be insufficient for complete rehabilitation of the scald. A reduction in recharge is also required upslope, although methods to identify the location and size of recharge areas are needed.

ACKNOWLEDGMENTS

We are grateful for GRDC’s funding support and for the EM31 survey by Rod Sewell. Ross Pfieffer generously co-operated with access to land.

REFERENCES

1. Barrett-Lennard, E., Davidson, N. and Galloway, R. 1990. *J. Agric. W. Aust*. **31(2),** 56-61

2. Halvorson, A.D.and Reule C.A. 1980. *Soil Science Society of America Journal* **44**, 370-374

3. Maas E.V. 1984. *Californian Agriculture* **38**, 20-21

4. MDBC 1999. The Salinity Audit. (Murray Darling Basin Commission: Canberra)

5. Thomas P. 1984. Canola Growers Manual (Canola Council of Canada)

6. Shaw, R.J., Hughes, K.K., Thornburn, P.J. and Dowling, A.J. 1987. *Proceedings of the Brisbane regional salinity workshop*. Brisbane.