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Irrigating cotton with treated sewage

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As availability of irrigation water decreases due to a combination of drought and legislation, many cotton growers have considered using alternative sources of water for irrigation. One such alternative is ‘grey’ water or treated sewage effluent.

Treated sewage effluent contains large amounts of nitrogen and phosphorus which can be used by the crop. It can also contain moderate to high amounts of salts — particularly sodium and chloride salts.

So salinity and sodicity could increase in a field irrigated with treated sewage effluent if not managed carefully. In this article we present results of measurements made at ‘Federation Farm’, near Narrabri — a cotton farm established by the Narrabri Shire Council and share-farmed by the Narrabri Educational Trust. The farm is irrigated with treated sewage effluent produced at Narrabri Shire Council’s sewage treatment plant.

It started operating in May 2000. Prior to this the land was under rainfed pasture.

We measured water quality and soil changes from shortly after the start of the project until January 29, 2002.

Soil was sampled to a depth of 1.8 metres from paired plots, which had either been treated with 2.5 tonnes per hectare of gypsum in June 2000 or remained untreated. These treatments were repeated in three adjacent fields at ‘Federation Farm.’

The soils in the three fields were alkaline, self-mulching gray clays with excellent structure, with clay content differing between fields. Clay content in the surface 60 cm was 49 per cent in Field 1, 60 per cent in Field 2 and 54 per cent in

TABLE 1: Quality of water sampled from the head ditch during the 2001-02 cotton season at ‘Federation farm’

Date of irrigation	pH	ECw dS/m	K kg/ha	Ca kg/ha	Mg kg/ha	Na kg/ha	SAR	NO3-N* kg/ha
15/10/01	8.8	0.7	3.4	13.6	6.4	91.7	5.1	26.8
23/12/01	8.7	0.7	9.1	11.9	7.2	151.8	8.5	50.3
21/1/02	8.9	0.7	4.7	8.0	3.7	78.5	5.7	29.7
30/1/02	8.7	0.7	15.5	13.0	7.7	172.2	9.3	46.2
18/2/02	9.2	1.1	8.9	11.2	6.1	119.3	7.1	56.6
08/03/02	9.7	1.4	7.7	6.6	5.8	122.7	8.4	36.8
Seasonal sum			49.2	64.3	36.9	736.2		246.5

*130 kg of N/ha was applied in the form of a dry application of urea on 15/12/2001

Values are a mean of three fields. Nutrient entry to the field (in kg/ha) has been calculcted on the basis of an irrigation rate of one megalitre per hectare. (ECw is the electrolytic conductivity of the water, a measure of its salinity, and SAR is the sodium adsorption ratio, a measure of its sodicity. As a general rule of thumb irrigation water which has ECw < 0.4 and SAR < 4 is considered to be good to excellent).

FIGURE 1: Effect of gypsum and time on exchangeable sodium percentage (ESP)

Field 3. Wheat was sown in June 2000 and cotton in October 2001.

Water quality during the 2001–02 cotton season

Treated sewage irrigation water was alkaline, and initially, moderately saline and sodic. But as the season progressed, alkalinity, salinity and sodicity increased markedly (Table 1).

This is probably because treated sewage water was diluted with winter rainfall during the early part of the cotton season, whereas undiluted treated sewage effluent was used to irrigate the cotton later in the season. The results also show that relatively high amounts of sodium (Na) were added in irrigation water.

The amounts of calcium (Ca) and magnesium (Mg) were much lower than that added in bore and river irrigation water typical of the lower Namoi, whereas Na was higher. Potassium (K) was also higher (between two and three times) than in bore and river irrigation water.

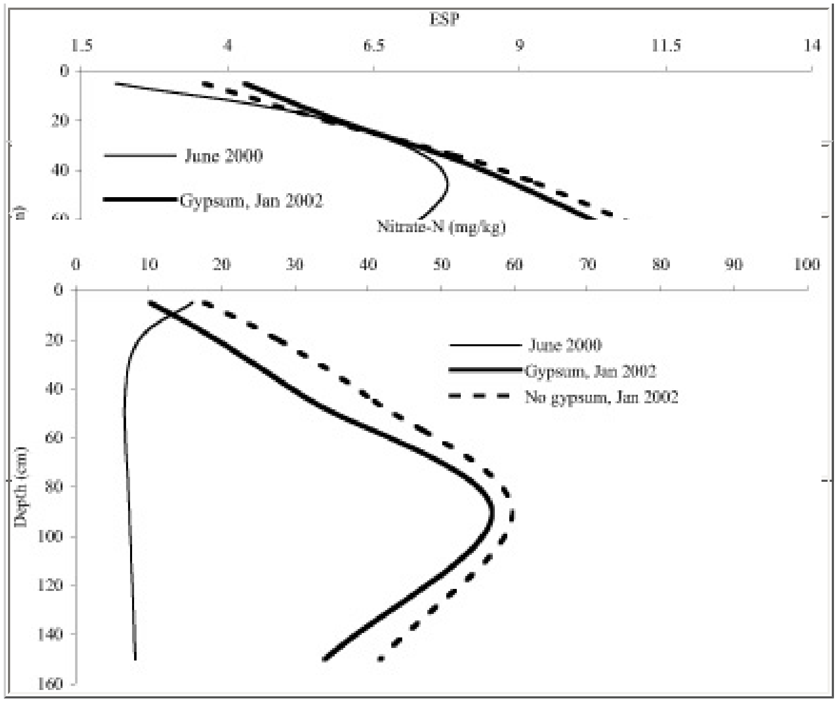
Treated sewage effluent may, therefore, be a potential source of additional K. Nitrate-N in treated sewage water was also high — between two and eight times higher than that measured in other commercial farms, even allowing for the urea applied as fertiliser.

In summary, compared with traditional water sources, treated sewage effluent appears to be a good source of N and K but is more saline and sodic.

As cotton seedlings are highly sensitive to salinity and the mature crop is relatively insensitive, either river or bore water of low salinity, or stored rainfall should be the preferred source of water for early season irrigation. As the crop matures and becomes more tolerant of salinity, treated sewage effluent can be used for irrigation.

Soil salinity, sodicity and nitrate-N

Relative changes in soil salinity, sodicity and nitrate-N differed between the three fields sampled and were mainly due to differences in clay content. But the general trends were



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Both sodicity, measured as ESP (Figure 1), and nitrate-N (Figure 2) increased markedly in the subsoil between June 2000 and January 2002. Sodicity almost doubled in the depths greater than 60 cm, whereas nitrate-N increased between two and six times in the depths greater than 20 cm.

A distinct nitrate-N bulge is also present at about a depth of one metre.

EC1:5, an indicator of salinity, while decreasing in the surface 10 cm, did not change significantly in spite of the observed salt loads (approximately four tonnes per hectare during 2001–02) in irrigation water. But this is not surprising when deep drainage rates are considered.

Average deep drainage out of the 180 cm depth in gypsum-treated plots was 64 mm, and in untreated plots was 42 mm and suggests that most of the salts which entered the root zone were leached out. Similar differences existed throughout the soil profile. The relatively high EC1:5 in the surface 10 cm during June 2000 is probably due to a high nutrient load after the pasture.

Gypsum application did not have any effect on sodicity and salinity, but resulted in significantly lower nitrate-N in the depths below 60 cm. The lower nitrate-N in gypsum-treated plots is a reflection of their higher drainage. The higher drainage, in turn, is due to the better soil structure which results from gypsum application.

But overall, the effects of gypsum application in 2000 were small or not measurable by January 2002, and suggests that more frequent and/or higher rates of gypsum are required at 'Federation Farm'. Alternatively a combination of lime and gypsum may result in longer-term effects. Other ameliorants such as polyacrylamide (PAM) should not be ruled out as well.

Conclusions

• Treated sewage irrigation water was moderately saline and sodic, and in comparison with bore and river water, had higher concentrations of Na, nitrate-N and K, and lower concentrations of Ca and Mg.

• Irrigation with treated sewage effluent caused nitrates to accumulate in the subsoil, increased soil sodicity but not salinity.

• Salinity did not increase because of salt leaching out of the root zone.

• A nitrate 'bulge' is present at a depth of about one metre.

• Gypsum applied in 2000 had no obvious effect on soil salinity and sodicity, and only a small effect on nitrate-N.

• Some possible management options, such as 'shandying' of effluent with rainfall or river water, more frequent application of gypsum and use of polyacrylamide (PAM), may be required.

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