

Salt and nutrient leaching under irrigated cotton

By Tim Weaver, Nilantha Hulugalle and Hossein Ghadiri

Cotton is mostly grown on self-mulching, cracking clay soils. In the past, it was widely assumed that under irrigation there was no deep drainage in these soils. Recently, several researchers have disagreed with this view.

Measurements made in southern Queensland and northwestern New South Wales show that deep drainage rates between nine and 151 mm per year are possible. At Warren, in the Macquarie Valley, deep drainage rates of 17 mm per year in a soil with 53 per cent clay, and 202 mm per year in a soil with 35 per cent clay have been measured under irrigated cotton.

Substantial amounts of salts and nutrients can also be transported with deep drainage. But detailed studies of nutrient and salt leaching are few, with most reporting only nitrates and chlorides. These studies suggest that under saturated or near saturated conditions, such as under irrigation, nutrient and salt leaching can be high.

The large amounts of nutrients which can be leached from the crop root zone means, in turn, that the costs to the farmer can be high. For example, nitrate-N leached in an irrigated field in south east Queensland was 227 kg per hectare per year. This is equivalent to 277 kg per hectare per year of anhydrous ammonia which has an estimated market value of \$194. On the other hand, salt leaching out of the cotton root zone is beneficial in that it allows a crop to grow unhindered. But leaching of salts with deep drainage may increase groundwater salinity.

Trial Sites

Nutrient and salt movements were monitored on several grey, self-mulching clay soils during the cotton seasons of 2000–01 and 2001–02. The first site was near Wee Waa, the second in a sodic soil near Merah North and a third near Narrabri. The Wee Waa site was sown with a cotton–wheat (N-fertilised) rotation with stubble incorporation. At the Merah North site, which was bore-irrigated, two treatments were studied — back-to-back cotton and a cotton–wheat rotation. The site near Narrabri was irrigated with treated sewage effluent and sown with a cotton–wheat (N-fertilised) rotation with standing stubble retained.

Measuring nutrient and salt leaching

Ceramic cup samplers (Figure 1) were used to

TABLE 1: Nutrients and salts leached out of the 1.2 metre depth (in kg per hectare) during the 2000–01 and 2001–02 cotton seasons

Season	Site and cropping system	Nitrate-N	Cl	K	Ca	Mg	Na
2000–01	Wee Waa/Cotton–wheat	130	1146	5	22	64	286
2000–01	Merah North/back-to-back cotton	174	10,457	5	70	77	1102
2000–01	Merah North/Cotton–wheat	129	3528	3	19	71	599
2001–02	Merah North/Cotton–wheat	26	4731	4	102	64	505
2001–02	Narrabri/Cotton–wheat						
	Field 1	8	677	2	21	14	*
	Field 2	4	563	1	5	8	69
	Field 3	44	1650	11	74	53	78

*Insufficient water in sample to obtain a result.

FIGURE 1: Ceramic cup samplers (A) used to extract soil water. The vacuum is maintained by a rubber stopper and tube sealed with a clamp (B). Soil water samples are removed by using a hand pump and a glass flask (C)



measure salts and nutrients in drainage water under irrigated cotton crops. These samplers are a cheaper alternative to field lysimeters, and relatively simple to install. They also cause little disturbance of the soil profile and allow continuous monitoring at different depths in the same profile.

Ceramic cup water samplers were installed under cotton crops at depths of 0.6, 0.9 and 1.2 metres, and water sampled at frequent intervals during both cotton seasons. But in this article we only report the results from the 1.2 metre depth.

The water samples were analysed for chloride, nitrate-N, potassium, calcium, magnesium and sodium concentrations. We also estimated seasonal deep drainage using a chloride mass balance model. The seasonal drainage was used to convert these concentrations to seasonal nutrient and salt leaching in kg per hectare.

Nutrients and Salts in Drainage Water

Seasonal drainage estimates during 2000–01 were 98 and 76 mm for back-to-back cotton and cotton–wheat, respectively, at Merah North and 117 mm for the cotton–wheat rotation at Wee Waa. During 2001–02 drainage estimates in three separate fields at the Narrabri site were 22, nine and 89 mm, and 29 mm at Merah North.

Seasonal leaching of nitrate-N was high (Table 1). But soil and plant N measured after a wheat crop was sown at both Wee Waa and Merah North during the following winter showed that it was able to recover most of the leached N.

The seasonal losses of calcium, magnesium and potassium (Table 1) were far less than that supplied in irrigation water. Irrigation water can add 20–30 kg per hectare of potassium, 100–140 kg per hectare of calcium and 70–110 kg per hectare of magnesium during a cotton season. At all three farms, deep drainage was able to leach excess salts out of the root zone.

About one tonne per hectare of chloride was added in irrigation water during the 2000–01 season at Wee Waa, and about six tonnes per hectare at Merah North.

During the 2001–02 season, about four tonnes per hectare of chloride was added in irrigation water at Merah North and 7.6 tonnes per hectare at the site near Narrabri.

Conclusions

Leaching of salts out of the root zone took place under irrigated cotton. If this did not take place, and given that salt loads in irrigation water can be high, soil salinisation would take place very quickly. So salt leaching with deep drainage is essential to maintain a sustainable cotton production system.

Nutrients also leached out of the cotton root zone. This is costly and requires suitable management strategies.

Deeper rooting crops like wheat can recover the nitrate-N that leaches below the cotton roots. If salts and nutrients pass beyond the reach of crops such as wheat, they may eventually leach into ground water systems.

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