A two zone paddock with productivity influenced by elevated sodium levels

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Methodology

A study site in the Eton irrigation area was selected on the basis of location and suitability for determining yield response to various nitrogen rates on low yielding sodic soils. A 3.8ha bed established to the variety Q208 (planted 2011) within the 18.3 ha study site was selected for the trial. The deep EC surface mapping layer was used to the selection of borehole sites for characterisation of the trial site (Figure 1).

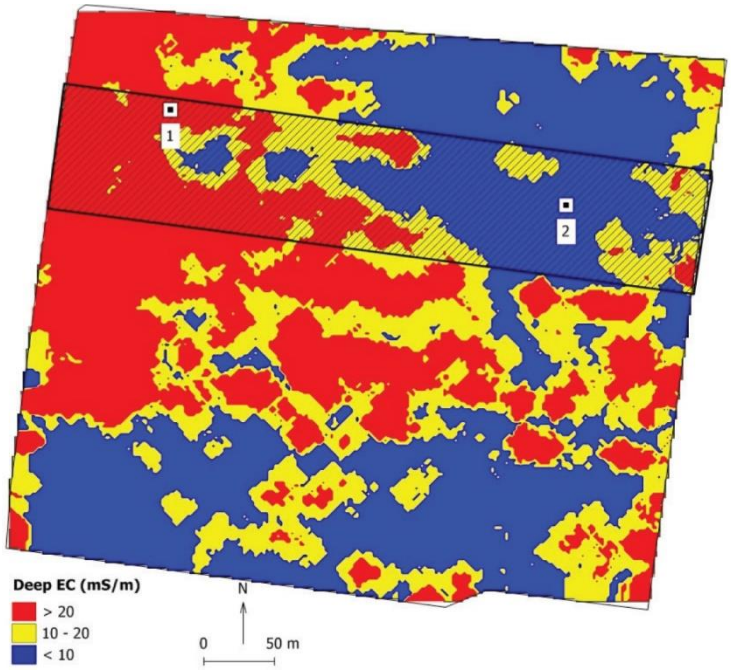

Figure 1. Location of 3.6 ha trial site (hatched area) over deep EC mapping layer and zone characterisation borehole locations

Samples for chemical soil tests and particle size analysis were extracted from the topsoil zone (0-25cm) and a further sample for particle size analysis from the lower sub-surface area (50-75 cm) at the borehole sites (Table 1)

Table 1. Chemical and physical site characterisation data

Attribute	**Borehole 1**		**Borehole 2**	
	Sampling depth (cm)		Sampling depth (cm)	
	0-25	50-75	0-25	50-75
Clay %	19	31	48	56
Exchangeable sodium percent (%)	6.9		1.6	
pH (1:5 water)	5.7		6	
Organic carbon %	0.83		1.5	
Phosphorus (BSES) mg/kg	51		30	
Potassium (Ammacet) (meq/100g)	0.16		0.45	
Potassium (nitric K) (meq/100g)	0.46		1.2	
Sulphate Sulphur (MCP) (mg/kg)	4.4		7.1	
Calcium (Amm-acet) (meq/100g)	3.9		15	

The trial design incorporated four nitrogen treatments; 90 kg N/ha, a VRA rate of 90 N kg N/ha applied to the low yielding (ESP of 6.9%) western side of the trial and 150 kg N/ha in

the higher yielding eastern side of the paddock, plus a 160 kg N/ha and 230 kg N/ha with three replications per treatment. Block length plots were randomised with 3 x 1.9 m rows/plot (Figure 2)

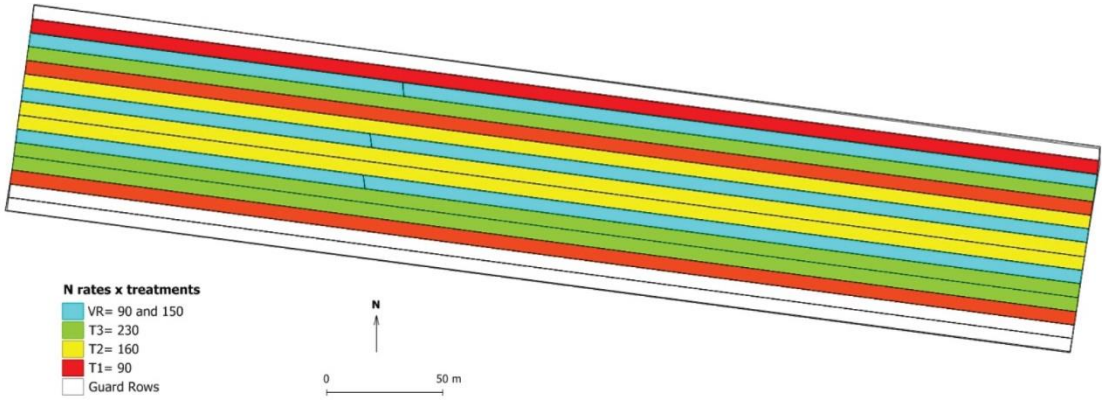

Figure 2. Trial design showing block length nitrogen treatments with three replications per Treatment

The site specific soil test results were utilised determine macro-nutrient requirements for the 1st ratoon basal application of phosphorus, potassium and sulphur using the Six Easy Steps (6ES) nutrient guidelines. Application rates were sufficient to ensure there were no deficiencies in phosphorus, potassium and sulphur across the two management zones The balance of the nitrogen for the four treatments (90, 160 and 230 kg N/ha and VRA rates) was applied as urea using a three row electronic controlled stool splitter. The trial was irrigated five times (totalling 1.5 ML/ha) between application of N treatments and the start of the wet season period.

Measuring yield responses to the four N treatments in the two defined management zones of the trial necessitated the establishment of site specific measurement rows to facilitate the commercial harvesting of the N treatments into a mill bin mounted on a tractor drawn weigh trailer. Satellite yield ratio and EC mapping layers were used to select representative yield measurement sites for two management zones (Figure 3). A hand-held Garmin GPS was utilised to locate the weigh bin harvest sites for each management zone. Two adjacent 20 m rows were marked out in the 1st replicate of each N treatment for the two management zones. Six stalks were randomly selected from N treatment measurement rows for small mill CCS determination.

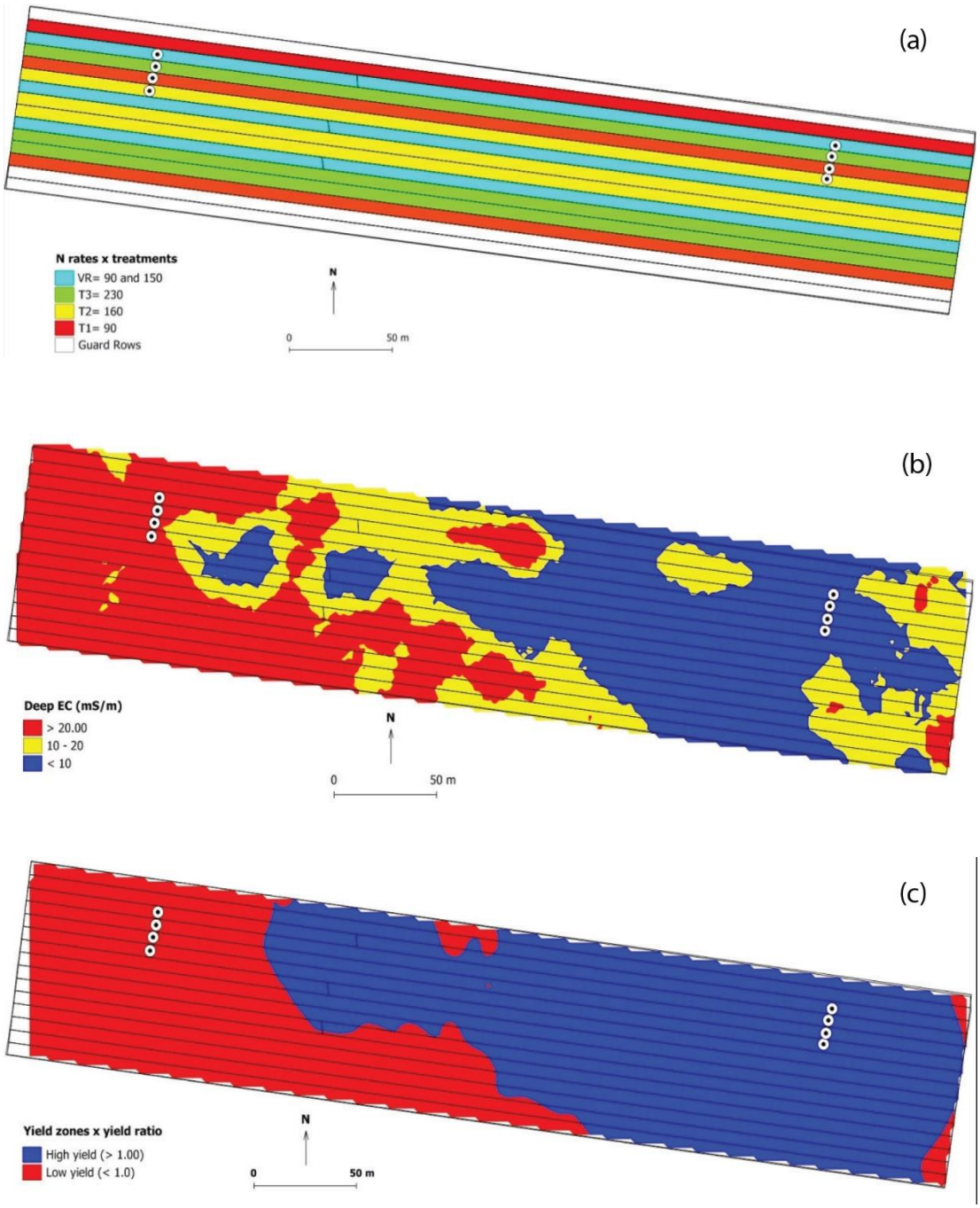

Figure 3. (a) Location of site specific weigh sites in relation to N treatments across management zones (b) Location of zonal weigh sites in relation to a five zone EC mapping layer (c) Location of zone specific weigh sites in relation to yield ratio patterns with the low yielding zone (red) with elevated sodic levels on the western side of the trial site

Results

In the low yielding zone with elevated ESP levels there was no yield response to increasing rates of nitrogen with only1 tc/ha difference in average yield across the N treatments. In the higher yielding section of the trial there was a 10 tc/ha (13 %) yield increase between the variable rate treatment (150kg N/ha) and the 90 N treatment (Figure 4)

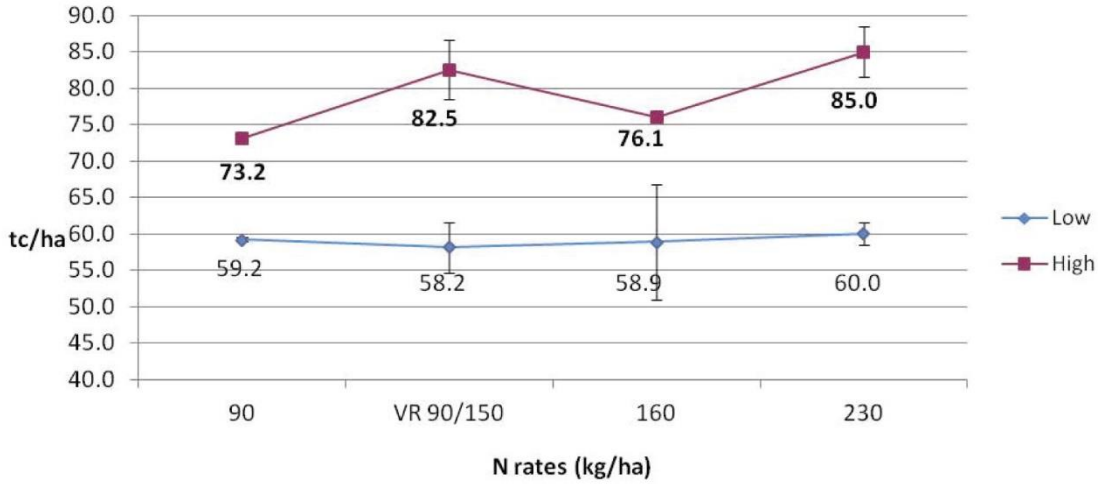

Figure 4. No yield response to increasing nitrogen rates in the sodic low yielding zone in contrast to an average 13% yield improvement between the low N rate and the variable rate of 150 kg N/ha in the higher yielding zone

The difference in yield achieved between the variable N rate in the higher yielding zone (150 kg N/ha) and the 160 N rate is not easily explained. It is possible that the location of the site specific measurement rows for the targeted weighing of the 160 N treatments (higher yielding zone) may have had slightly elevated sodic levels.

There was little variation in CCS values across N treatments in the low yielding zone and similarly, CCS values in the higher yielding zone were similar across N treatments. However, there was a 16% increase in average CCS between the low and high yielding zones (14.2% and 16.6% respectively) which indicates that elevated salt levels in the soil contribute to a depressed sucrose content in the crop (Figure 5).

Yield data from the balance of the treatment replicates was not collected due to logistical restrictions during the commercial harvesting of the trial block.

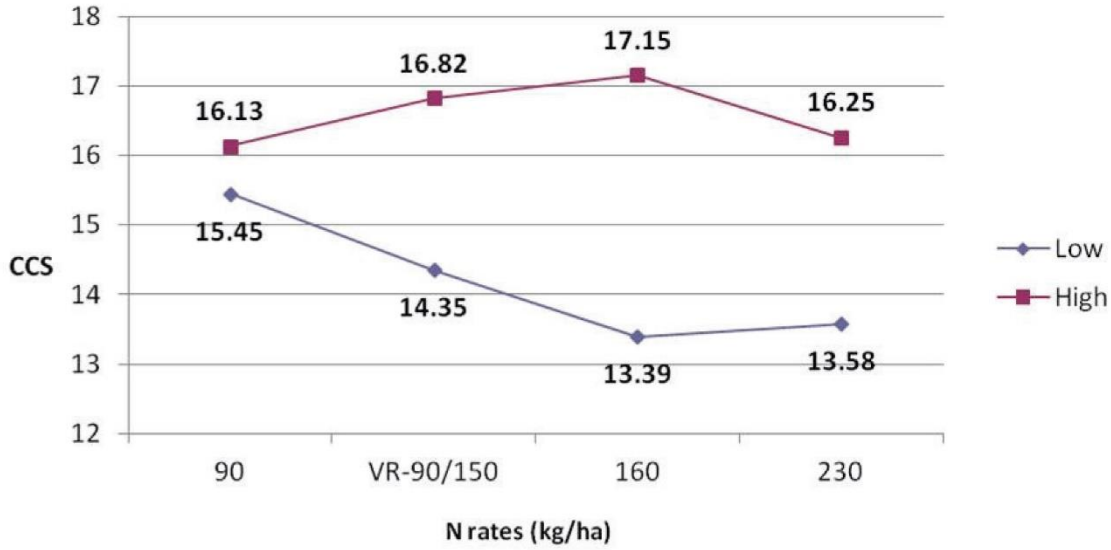

Figure 5. Variability in average CCS values across nitrogen treatments in the low and highyielding zones indicating a suppression in sucrose content attributed to elevated salt levels

The results from this trial show that a reduction in N rates in low yielding zones with elevated ESP levels had no negative yield implications and is a management option in a VRA program. The integration of this option will significantly improve the nitrogen use efficiency in defined sodic zones. Nitrogen use efficiency improvement of 44% between the 90 N treatments and the traditional grower input rate of 160 kg N/ha was achieved in this trial. The reduced cost of N inputs without loss of yield provides a positive financial return to the VRA grower and would achieve beneficial water quality outcomes (Figure 6 – only N inputs costs and marginal changes in harvesting costs were used in the dollar return/ha calculations)

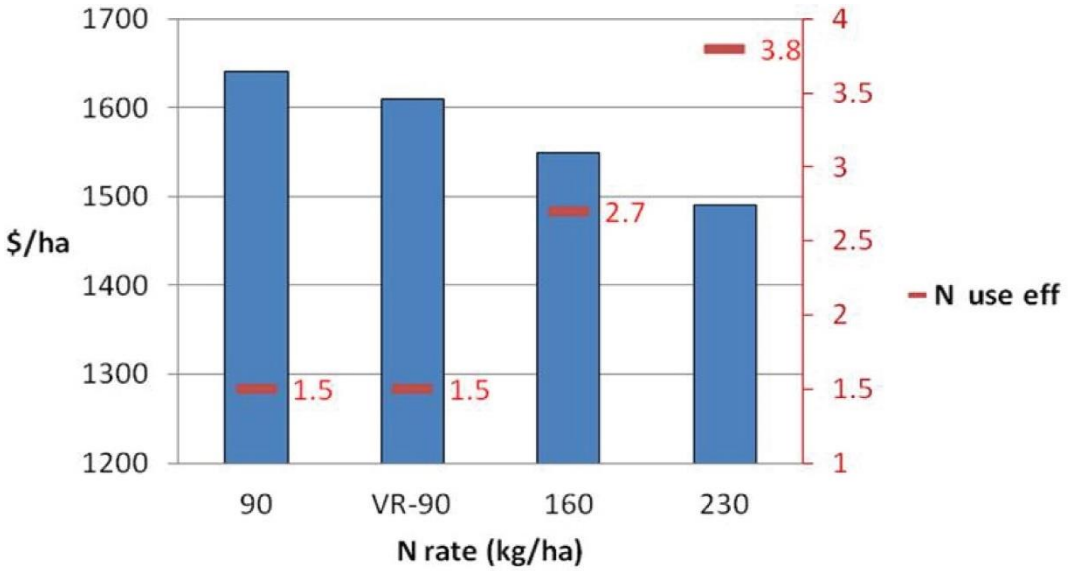

Figure 6. Reducing nitrogen rates in the low yielding sodic zone provided positive returns with the reduced nitrogen inputs and a significant improvement in nitrogen use efficiency

Discussion

The results of this trial show that where ground-truthing of EC mapping patterns and related yield ratio maps show a reduced yield potential attributed to elevated sodic levels an opportunity exists to manipulate N rates. In the low yielding sodic section of defined two-management zone trial area there was no response to increasing N rates despite a comprehensive irrigation program over the traditional dry period.

As suggested for defined low yielding anaerobic zones, the 1.4 kg of N/ton of cane multiplier may be a mechanism for allocating base N rates for low yield potential sodic zones within a VRA program. A base yield platform of 75 tc/ha for a low yielding sodic zones provides a minimum N rate of 105 to 110 kg N/ha. This application rate provides some flexibility for a grower considering VRA programs and is unlikely to result in a deterioration of the yield in these defined zones. This trial has been extended into the 2014/2014 season and two years of data will help underpin N rate recommendations for defined sodic management zones within a VRA program.

Acknowledgement

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