1995

Review of sodic soils research in the Queensland sugar industry

Cox, AZ

http://hdl.handle.net/11079/757

Downloaded from Sugar Research Australia Ltd eLibrary
## CONTENTS

<table>
<thead>
<tr>
<th>Page No.</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SUMMARY</td>
</tr>
<tr>
<td>1</td>
<td>1.0 INTRODUCTION</td>
</tr>
<tr>
<td>2</td>
<td>2.0 EFFECT OF SODICITY ON SUGARCANE YIELD</td>
</tr>
<tr>
<td></td>
<td>2.1 Cane yield investigations on a sodic soil</td>
</tr>
<tr>
<td></td>
<td>2.2 Growth responses of sugarcane to the SAR in flowing solution sand culture</td>
</tr>
<tr>
<td>4</td>
<td>3.0 INVESTIGATIONS INTO AMELIORATION OF SODIC SOILS</td>
</tr>
<tr>
<td></td>
<td>3.1 Burdekin research</td>
</tr>
<tr>
<td></td>
<td>3.1.1 First investigation (Gaynor research substation)</td>
</tr>
<tr>
<td></td>
<td>3.1.2 Second investigation (Mona Park research substation)</td>
</tr>
<tr>
<td></td>
<td>3.1.3 Commercial size trials (Burdekin)</td>
</tr>
<tr>
<td></td>
<td>3.1.4 Irrigation methods research</td>
</tr>
<tr>
<td>11</td>
<td>3.2 Mackay research</td>
</tr>
<tr>
<td>12</td>
<td>3.3 Proserpine research</td>
</tr>
<tr>
<td>13</td>
<td>4.0 EXTENSION PROGRAM</td>
</tr>
<tr>
<td>15</td>
<td>5.0 REFERENCES</td>
</tr>
</tbody>
</table>
**LIST OF TABLES**

| Table 1 | Correlation coefficient for the regression of soil assays on cane yield at three sampling depths 0-250 mm (A), 250-500 mm (B), 500-750 mm (C) | 3 |
| Table 2 | The effect of the SAR treatment on total dry matter and plant height at the final harvest | 4 |
| Table 3 | Yield (t/ha) of Q117 on different slopes at Gaynor | 5 |
| Table 4 | Crop yields (t/ha) by variety and crop class with and without gypsum amelioration | 5 |
| Table 5 | Selected properties of virgin and post virgin soil (gypsum applied 11.25 t/ha pre-planting after 55 months) at Gaynor substation site | 6 |
| Table 6 | Yields (t/ha) of crops on Dowie soils | 7 |
| Table 7 | Effect of gypsum and sugar yield in trials at Leichhardt Downs area of BRIA (sodic duplex soils) | 9 |
| Table 8 | The effect of gypsum on cane yield in the Northcote area trials (sodic duplex soils) | 9 |
| Table 9 | Effect of gypsum and lime application on cracking clay sodic at depth (2Uge) | 10 |
| Table 10 | Effect of irrigation method on cane and sugar yield | 11 |
| Table 12 | Plant and ratoon cane results | 13 |
(iii)

LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Relationship between exchangeable sodium percentage and cane yield at Mackay BSES (from Spalding, 1983)</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Rainfall chart for the Burdekin mm (June 1988 - May 1995)</td>
</tr>
</tbody>
</table>
SUMMARY

Increasing levels of sodium on the clay, in the absence of high levels of soluble salts, are not believed to be toxic to the cane plant. Any adverse effect on crop production is through deterioration of the soil structure (Crema, 1994). Under wet conditions, increased clay dispersion accompanies increasing exchangeable sodium percentage (ESP). This is associated with sealing and crusting in surface soils and dense subsurface clays which resist penetration of roots. Even if water does penetrate the surface, it is held very strongly in the very small pores formed in the dispersed soil. It is difficult for roots to withdraw this moisture. The end result of sodicity is similar to that of salinity, water stress. Both water infiltration and water storage are adversely affected.

Reclamation of sodic soils can be achieved by application of gypsum or lime to promote replacement of sodium on the clay particles by calcium, and hence improve soil structure. Research work indicates that sugarcane yields on sodic soils with ESP less than 25 can be improved by up to 20% with the application of gypsum 10 t/ha (Ham et al., 1995). Improvements in yield can also be achieved by improving surface and subsurface drainage to promote leaching of displaced sodium salts from the soil profile. Reduction of natural slope from 0.49% to 0.07% has also improved sugarcane yield by 24% over the crop cycle (Ham et al., 1995).

Research has developed ways of increasing production on sodic soils. With the expansion of the cane industry into marginal areas there has been an associated extension campaign, concentrating on farm planning and demonstrating the benefits of applied gypsum (Ham et al., 1995). A good example of this is in the Burdekin where the BSES program on sodic soils is estimated to have resulted in an extra 26,000 tonnes of cane to the Burdekin district in 1994 alone with a gross value to the industry of $1.02m.

1.0 INTRODUCTION

Sodic soil reduces the value and productivity of soils in the arid and semi-arid regions of the world. Sodic soils represent a significant proportion of existing and potential canelands of Australia - southern region 10%, Mackay 24%, Proserpine 15%, Burdekin 15% and Mareeba 10%. Sodicity could conservatively reduce the industry's production by 500,000 tonnes valued at over $22.5m (Ham et al., 1995). Recent BSES trial work showed that these losses could be reduced by 25% by using gypsum. This would result in a return of $5.5m to the industry, but there is only marginal cost/benefit in the short term by applying gypsum.

Sodicity in subsoils is often due to natural processes. The sodicity of both surface and subsoils is increasingly due to the recent use of saline ground water for irrigation, aggravated by management practices such as cultivation which accelerate structural degradation (Crema, 1994). Hence, secondary salinisation and sodification is increasing rapidly in many parts of Australia as a consequence of inappropriate irrigated agricultural practices and the clearing of native vegetation, often occurring together.

The Burdekin River Irrigation Area (BRIA) is the major expansion area for the Queensland sugar industry. Each year approximately 30 farms, totalling 3,000 ha, are released by DPI for irrigated agriculture. Since the start of the scheme in 1988 approximately 11,000 ha have been released with another 13,000 ha to be released in the short term. It is estimated that 35% of the soils in the BRIA are classified as sodic duplex soils (Donnollan, 1991). Donnollan, 1991 describes sodic soils as 'soils which are sodic (ESP > 6) in some part of the profile'
(McMahon et al., 1995). Based on this description, areas of sodic soil in cane growing areas of Australia are likely to be much higher than stated by Ham (1995) previously. This report summarises trial work carried out on sodic soils over the past 15 years. This suggests some direction for future work.

2.0 EFFECT OF SODICITY ON SUGARCANE YIELD

Sugarcane growth is reduced by sodicity; for every 1% increase in soil ESP at the 250-500 m depth, cane yield decreases 1.5 t/ha (Spalding, 1983).

Sodic soils occur in most cane growing districts. BSES research has shown that sodic layers which occur deeper than 600 mm in the profile generally do not restrict growth but may reduce drainage through the profile (Ham et al., 1995).

Field measurements at Mackay on strongly sodic soil at 250-500 mm under unirrigated conditions (Figure 1) showed yield was depressed by 23% where ESP = 15, yield was halved at ESP = 33 and cane growth had failed completely by ESP 66 (Spalding, 1983).

Figure 1 Relationship between exchangeable sodium percentage and cane yield at Mackay BSES (from Spalding, 1983)
2.1 Cane yield investigations on a sodic soil

Spalding (1983), investigated the effect of exchangeable sodium levels on sugarcane yield. In the Marian mill area in Mackay 15 plots were chosen in a block of cane land affected by sodium to represent high, medium and low yielding areas. The site comprised soils of the Allandale and Kinchant soil profile classes (Holz and Shields, 1985). In each plot cane yield and CCS were measured. Soil samples taken in 250 mm increments to a depth of 750 mm were analysed for specific electrical conductivity (SEC), pH, cation exchange capacity (CEC), and exchangeable cations (Na\(^+\), K\(^+\), Ca\(^{++}\), Mg\(^{++}\)).

Negative correlations of sodium-related soil assays with cane yield were higher at the 250-500 mm sampling depth than with other sampling depths. Yield was depressed by 23% where the soil sampled from 250-500 mm had an ESP of 15. Regression analysis showed a strong negative correlation of yield (t cane/ha) with ESP; reduction in crop yield of 1.5 t cane/ha with each percentage increase in ESP was measured. The results of these correlations are given in Table 1.

### Table 1

Correlation coefficient for the regression of soil assays on cane yield at three sampling depths 0-250 mm (A), 250-500 mm (B), 500-750 mm (C).

<table>
<thead>
<tr>
<th>Soil assay</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>-0.034</td>
<td>-0.841**</td>
<td>-0.743**</td>
</tr>
<tr>
<td>ESP</td>
<td>0.099</td>
<td>-0.837**</td>
<td>-0.844**</td>
</tr>
<tr>
<td>Na/cations</td>
<td>-0.533</td>
<td>-0.931**</td>
<td>-0.928**</td>
</tr>
<tr>
<td>Ca</td>
<td>0.685*</td>
<td>0.504</td>
<td>0.445</td>
</tr>
<tr>
<td>Ca% of CEC</td>
<td>0.582*</td>
<td>0.710*</td>
<td>0.855*</td>
</tr>
<tr>
<td>Ca/cations</td>
<td>0.793**</td>
<td>0.767**</td>
<td>0.952**</td>
</tr>
<tr>
<td>Ca/Mg</td>
<td>0.784**</td>
<td>0.842**</td>
<td>0.919**</td>
</tr>
</tbody>
</table>

* P < 0.05     ** P < 0.01

2.2 Growth responses of sugarcane to the SAR in flowing solution sand culture

In Tully, Crema (1994), carried out investigations to test current hypotheses that the harmful effect of sodic soils on sugarcane yields is due to physical deterioration of soil structure. These hypotheses were tested by determining the plant responses of sugarcane variety Q117 in sand culture. Using nutrient solutions maintained at a constant electrical conductivity non-inhibiting to plant growth, sodium absorption ratios (SAR) were varied to assess the effect of sodium levels on crop growth.
Increasing the SAR of nutrient solutions from 0-30 while holding EC and ionic strength constant, was found to have no significant effect on sugarcane grown in coarse sand over 12 weeks (Table 2). Thus sugarcane growth was not inhibited by Na\(^+\) concentrations up to 12 mM when Ca\(^{++}\) and Mg\(^{++}\) were each present at 76 uM.

Crema concluded from this that increasing levels of sodium, in the absence of high levels of soluble salts, are not toxic to the variety Q117, as long as other major cations are present at concentrations non-inhibiting to plant growth. He concluded that the major effect of sodic soils on the growth of sugarcane occurs as a result of the physical limitations associated with soil structural deterioration.

<table>
<thead>
<tr>
<th>SAR (g/plant)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total plant DM</td>
<td>7.65</td>
<td>8.41</td>
<td>9.38</td>
<td>7.56</td>
<td>8.07</td>
<td>7.24</td>
</tr>
<tr>
<td>Plant height (cm)</td>
<td>25.21</td>
<td>26.20</td>
<td>26.40</td>
<td>26.60</td>
<td>27.77</td>
<td>27.90</td>
</tr>
</tbody>
</table>

3.0 INVESTIGATIONS INTO AMELIORATION OF SODIC SOILS

3.1 Burdekin research

The Burdekin River Irrigation Area is currently the major irrigation development in Queensland. Sugarcane and horticulture are the major crops. Of these sugarcane occupies the greatest area, and sodic soil greatly reduces its productivity. Sodic duplex soils make up 35% of the new area being developed (Donnollan, 1991).

A research program was carried out by BSES in conjunction with Queensland Department of Primary Industries (QDPI) to improve the management of these soils. There were two trials carried out; firstly, an unreplicated commercial size trial was set up to determine limiting criteria for these soil types; a second replicated trial was then set out to find effective reclamation methods. The second trial looked at the cost/benefits of using a combination of gypsum application, drainage and cultural techniques to ameliorate these soils.

3.1.1 First investigation (Gaynor research substation)

The first investigations consist of a non-replicated trial to examine:

1. the effect of natural slope (0.49%) and reduced slope (0.07%) on the production of sugarcane, maize and soybeans (0.1%); and
2. the ameliorative effects of gypsum on these soils and the resulting changes in productivity of sugarcane, rice, maize and soybeans.

Investigations assessed the productive capacity and management limitations of these strongly sodic soils (ESP > 20 at 0.2-0.3 m (Ham et al., 1995)).

1. Sugarcane

Slope reduction from 0.49% to 0.07% improved sugarcane yield by 24% over the crop cycle. The results of this trial are given in Table 3.

<table>
<thead>
<tr>
<th>Crop</th>
<th>0.07% slope</th>
<th>0.49% slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant</td>
<td>106</td>
<td>93</td>
</tr>
<tr>
<td>First ratoon</td>
<td>64</td>
<td>50</td>
</tr>
<tr>
<td>Second ratoon</td>
<td>65</td>
<td>52</td>
</tr>
<tr>
<td>Third ratoon</td>
<td>34</td>
<td>21</td>
</tr>
</tbody>
</table>

Three commercial varieties Q96, Q117 and Q133 were planted in strips in each of the low slope plots. Q133 had the greatest yield throughout. Third ratoon yields were adversely affected by the late harvest of the previous crop. The application of gypsum (11.25 t/ha) to the 0.07% slope field further increased sugarcane yield by 14.4% for the crop cycle for variety Q117. Similar yield improvements at this slope and gypsum application were obtained for both of the other varieties. The results of this trial can be seen in Table 4.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Gypsum applied</th>
<th>No gypsum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gypsum applied</td>
<td>No gypsum</td>
</tr>
<tr>
<td>Q96</td>
<td>Q133</td>
<td>Q117</td>
</tr>
<tr>
<td>Plant</td>
<td>134.6</td>
<td>148.2</td>
</tr>
<tr>
<td>1st ratoon</td>
<td>79.9</td>
<td>87.7</td>
</tr>
</tbody>
</table>
Composite soil samples were collected from gypsum and no gypsum plots of the 0.07% slope. Samples were taken at 0.15 m increments to 1.65 m from plant to third ratoon crops. These were analysed for pH, electrical conductivity (1:5 soil: water suspensions), chloride content and sodium % cations. Table 5 displays the changes in these characteristics after 55 months of cropping (third ratoon) with the application of gypsum (11.25 t/ha).

Table 5
Selected properties of virgin and post virgin soil (gypsum applied 11.25 t/ha pre-planting after 55 months) at Gaynor substation site

<table>
<thead>
<tr>
<th>Soil property</th>
<th>Depth (m)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0-0.1</td>
<td>0.2-0.3</td>
<td>1.1-1.2</td>
<td>0.0-0.1</td>
<td>0.2-0.3</td>
<td>1.1-1.2</td>
</tr>
<tr>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>0.03</td>
<td>0.45</td>
<td>0.69</td>
</tr>
<tr>
<td>V</td>
<td>G@55</td>
<td>G@55</td>
<td>G@55</td>
<td>0.075</td>
<td>0.20</td>
<td>0.43</td>
</tr>
<tr>
<td>Gypsum</td>
<td>0.45</td>
<td>0.20</td>
<td>0.69</td>
<td>0.43</td>
<td>0.43</td>
<td>0.43</td>
</tr>
<tr>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>22</td>
<td>14</td>
<td>33</td>
</tr>
<tr>
<td>V</td>
<td>G@55</td>
<td>G@55</td>
<td>G@55</td>
<td>3</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Gypsum</td>
<td>320</td>
<td>30</td>
<td>1,100</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>20</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>V</td>
<td>G@55</td>
<td>G@55</td>
<td>G@55</td>
<td>10</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Gypsum</td>
<td>210</td>
<td>30</td>
<td>1,100</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

V = Virgin soil  
G@55 = G 11.25 t/ha after 55

Gypsum application rapidly reduced soil chloride levels, exchangeable sodium levels and electrical conductivity as can be seen in Table 5. Infiltration and soil water availability were also improved.

2. Other crops

Reducing slopes to 0.1% improved soybean plant establishment by 14%. Gypsum application (20 t/ha) to the 0.1% slope improved plant populations by >200% for maize, the effect of reduced slope on maize establishment was variable but improved 36.5% where gypsum was applied. Yield increases for maize and soybeans from gypsum application (20 t/ha) were 28.6% and 28.9% respectively (Ham et al., 1995).
3.1.2 Second investigation (Mona Park research substation)

The second investigation examined the benefits of a combination of gypsum application, drainage and cultural techniques in ameliorating sodic soils.

This 14 ha site was located on the northern bank of the Burdekin River. It contains soils of the Dowie and Barratta soil series. Irrigation rows are 960 m long. The first 320 m was strongly sodic Dowie soil (ESP > 25 by 0.25 m); the rest was a self mulching cracking Barratta clay.

A randomised block strip trial was established with treatments continuing across both soil types to compare their effects. Eight treatments were used:

1. Surface applied gypsum (10 t/ha)
2. As for 1 + deep ripping
3. As for 2 + subsurface drainage
4. Gypsum dissolved in irrigation water
5. As for 4 + deep ripping
6. As for 5 + subsurface drainage
7. Deep ripping alone
8. Control - no treatment

Application of gypsum (surface applied or in irrigation water) significantly improved first ratoon sugarcane yields by 18.5% and 24.6% respectively (Ham et al., 1995). Good responses were also evident in the second ratoon crop. Deep ripping failed to improve sugarcane yield.

The addition of subsurface drainage to the gypsum plus deep ripping treatments also failed to improve sugarcane yield.

Initially the dissolvenator was the cheapest way to apply gypsum using only 2 t/ha of gypsum per crop. However, by the end of the crop cycle there would be little difference in cost between the surface application and the application using the dissolvenator. Both sap flow and soil moisture extraction measurements during drying cycles showed improved soil water availability and deficit replacement due to gypsum application.

Table 6

Yields (t/ha) of crops on Dowie soils

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant *</th>
<th>First ratoon</th>
<th>Second ratoon</th>
<th>Third ratoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>50.4</td>
<td>92.2</td>
<td>88.6</td>
<td>80.2</td>
</tr>
<tr>
<td>R</td>
<td>49.9</td>
<td>96.3</td>
<td>92.7</td>
<td>82.9</td>
</tr>
<tr>
<td>D</td>
<td>42.1</td>
<td>114.9</td>
<td>102.1</td>
<td>83.0</td>
</tr>
<tr>
<td>D + R</td>
<td>46.4</td>
<td>112.9</td>
<td>101.4</td>
<td>91.6</td>
</tr>
</tbody>
</table>
C = control, R = ripping, D = gypsum via irrigation water, S = surface applied gypsum, M = subsurface drainage

* Note:- No significant responses occurred in the plant crop. The growth of the late planted crop was adversely affected by prolonged wet weather during December 1990, to March 1991, with 1,697 mm rainfall on 48 wet days.

Figure 2 Rainfall chart for the Burdekin mm (June 1988 - May 1995)
3.1.3 Commercial size trials (Burdekin)

To validate prior BSES research, commercial size trials comparing surface application of lime and gypsum were carried out in the BRIA. Of the four major trials carried out three were on sodic duplex soils (Tables 7 and 8) while the fourth was conducted on a 2Uge cracking clay which is sodic at depth (Table 9). In the three trials carried out in sodic duplex soils, gypsum proved to be the far superior product. However, on the cracking clays (sodic at depth) there was no response in plant cane from any treatment but in ratoons there was a response to all treatments. Results from these trials were extended widely to growers farming sodic soils (Tables 7, 8 and 9).
Table 7
Effect of gypsum and sugar yield in trials at Leichhardt Downs area of BRIA (sodic duplex soils)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Linton</th>
<th>Brotto</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T cane/ha</td>
<td>T CCS/ha</td>
</tr>
<tr>
<td>Gypsum 10 t/ha</td>
<td>37.70</td>
<td>6.20</td>
</tr>
<tr>
<td>Earth lime 12.5 t/ha</td>
<td>28.40</td>
<td>4.44</td>
</tr>
<tr>
<td>Untreated</td>
<td>17.70</td>
<td>2.96</td>
</tr>
</tbody>
</table>

Table 8
The effect of gypsum on cane yield in the Northcote area trials (sodic duplex soils)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T cane/ha</th>
<th>T CCS/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum 10 t/ha</td>
<td>68.1 a</td>
<td>9.4 a</td>
</tr>
<tr>
<td>Pulverised lime 7.5 t/ha</td>
<td>62.5 b</td>
<td>9.0 b</td>
</tr>
<tr>
<td>Pulverised + burnt lime 5.5 t/ha</td>
<td>61.9 bc</td>
<td>8.7 b</td>
</tr>
<tr>
<td>Untreated</td>
<td>59.6 c</td>
<td>8.4 c</td>
</tr>
</tbody>
</table>

Different letters following treatment data represents a significant difference P<0.05.
Table 9
Effect of gypsum and lime application on cracking clay sodic at depth (2Uge)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Yield t/ha</th>
<th>1st Ratoon Yield t/ha</th>
<th>* Cane t/ha increase over untreated area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth lime 25 t/ha</td>
<td>178</td>
<td>158</td>
<td>10</td>
</tr>
<tr>
<td>Earth lime 12.5 t/ha</td>
<td>173</td>
<td>148</td>
<td>7</td>
</tr>
<tr>
<td>Pulverised lime 7.5 t/ha</td>
<td>185</td>
<td>148</td>
<td>14</td>
</tr>
<tr>
<td>Gypsum 10 t/ha</td>
<td>172</td>
<td>150</td>
<td>10</td>
</tr>
<tr>
<td>Untreated</td>
<td>174</td>
<td>140</td>
<td></td>
</tr>
</tbody>
</table>

* Note:- Plant cane was a uniform block with no yield variation. In the first ratoon crop there was a yield gradient across the block, therefore responses are given as percent increase over the control plot beside the treated area.

3.1.4 Irrigation methods research

In 1992 a trial was established to investigate the effect of different irrigation methods for sodic soils on sugarcane production. The five irrigation systems compared were conventional furrow irrigation, trickle, surge, basin and a method called locally ‘peacup’ irrigation, where after normal furrow irrigation, water was allowed to trickle down the furrow for two or three days. The trial was conducted on a shallow duplex soil (2Ddb). Yields at harvest were obtained by weighing the centre two rows of each plot. The results from this replicated trial are given in Table 10.
Table 10

Effect of irrigation method on cane and sugar yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T cane/ha</th>
<th>T sugar/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trickle</td>
<td>116</td>
<td>19</td>
</tr>
<tr>
<td>Surge</td>
<td>113</td>
<td>18.9</td>
</tr>
<tr>
<td>Pea-cup</td>
<td>106</td>
<td>17.8</td>
</tr>
<tr>
<td>Basin</td>
<td>104</td>
<td>17.4</td>
</tr>
<tr>
<td>Flood</td>
<td>103</td>
<td>17.5</td>
</tr>
</tbody>
</table>

There was no significant difference (p<0.05) between treatments for cane CCS and sugar yield. There was however, a strong trend to higher yields with trickle and surge irrigation. As a result BSES staff did not recommend any changes to irrigation methods for farming sodic soils; further research on trickle and surge irrigation may be warranted for these soils.

3.2 Mackay research

A reclamation trial was established in January 1984 at Markey’s Road in Mackay on severely sodic soils (ESP = 50 at 250-500 mm). Another distinguishing feature of the area involved was a silcrete layer at about 1.5 m. Thus there could be no leaching of sodium ions at depth. This was the reason for including the lateral drains as part of the reclamation treatment. These drains caused water erosion in the sodic subsoil and were not effective, even though they were only 30 m long (Chapman, 1986).

The treatments used in this trial are as follows:

Gypsum 20 t/ha  
Gypsum 20 t/ha + slotted pipes  
Gypsum 20 t/ha + ash 150 t/ha  
Gypsum 20 t/ha + ash 150 t/ha + slotted pipes  
Ash 150 t/ha  
Ash 150 t/ha + nylex pipes  
Control * 2

The farm changed ownership in the late 1980’s and the earth works, which provided drainage for the trial site, were removed. Therefore, any long term effects of these drains could not be assessed.

The main effects of the treatments were to increase the calcium levels of both the top and subsoil and for ash to increase the levels of potassium in the top soil (Table 11). The levels of sodium in the subsoil have not been affected by the gypsum or ash treatments. The reduction in
ESP in the subsoil of the gypsum treatments is due to an increase in the calcium levels of the soil. The effect of the pipe treatment is negligible. However, there was a slight reduction in the conductivity and sodium levels in the subsoil where pipes were installed.

Table 11
Soil assayed March 1986.

(A) 0-250 mm (profile depth)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>SEC</th>
<th>Ca me%</th>
<th>Mg me%</th>
<th>Na me%</th>
<th>K me%</th>
<th>ESP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5.87</td>
<td>0.02</td>
<td>1.39</td>
<td>0.14</td>
<td>0.24</td>
<td>0.14</td>
<td>13</td>
</tr>
<tr>
<td>Gypsum*</td>
<td>5.64</td>
<td>0.11</td>
<td>3.55</td>
<td>0.12</td>
<td>0.11</td>
<td>0.11</td>
<td>3</td>
</tr>
<tr>
<td>Gypsum + Ash*</td>
<td>5.65</td>
<td>0.18</td>
<td>4.24</td>
<td>0.17</td>
<td>0.20</td>
<td>0.20</td>
<td>4</td>
</tr>
<tr>
<td>Ash*</td>
<td>6.34</td>
<td>0.09</td>
<td>1.83</td>
<td>0.22</td>
<td>0.23</td>
<td>0.31</td>
<td>8</td>
</tr>
</tbody>
</table>

(B) 250-500 mm (profile depth)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>SEC</th>
<th>Ca me%</th>
<th>Mg me%</th>
<th>Na me%</th>
<th>K me%</th>
<th>ESP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.45</td>
<td>0.09</td>
<td>1.54</td>
<td>0.34</td>
<td>2.45</td>
<td>0.05</td>
<td>56</td>
</tr>
<tr>
<td>Gypsum*</td>
<td>6.25</td>
<td>0.25</td>
<td>3.10</td>
<td>0.45</td>
<td>2.06</td>
<td>0.05</td>
<td>36</td>
</tr>
<tr>
<td>Gypsum + Ash*</td>
<td>5.88</td>
<td>0.26</td>
<td>2.59</td>
<td>0.44</td>
<td>2.18</td>
<td>0.05</td>
<td>40</td>
</tr>
<tr>
<td>Ash*</td>
<td>6.37</td>
<td>0.13</td>
<td>1.52</td>
<td>0.36</td>
<td>2.62</td>
<td>0.05</td>
<td>57</td>
</tr>
</tbody>
</table>

* Mean of pipes and no pipes treatments

3.3 Proserpine research

A reclamation trial was established in July 1992 at Proserpine (Bennett's Farm) on sodic soils (ESP = 33 at 250-500 mm). This was an unreplicated trial involving strips of lime and gypsum at various rates. A distinguishing feature of this trial was that it was carried out on acid soil (pH 5.5), hence the application of lime.

Treatments:
1. Untreated (control)
2. Gypsum 10 t/ha
3. Pulverised lime 7.5 t/ha
4. Pulverised lime 2.5 t/ha

Table 12
Plant and ratoon cane results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant cane 1993 t/ha</th>
<th>First ratoon 1994 t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>89</td>
<td>91</td>
</tr>
<tr>
<td>Gypsum 10 t/ha</td>
<td>108</td>
<td>98</td>
</tr>
<tr>
<td>Lime 7.5 t/ha</td>
<td>109</td>
<td>96</td>
</tr>
<tr>
<td>Lime 2.5 t/ha</td>
<td>109</td>
<td>95</td>
</tr>
</tbody>
</table>

Although unreplicated, there was a strong trend to improve yields due to treatments in the plant crop and to a lesser degree in the first ratoon (Table 12). The 2.5 t/ha lime treatment proved to be the most economical and can probably be attributed to the soil acidity. It was also noted that where treatments were applied, water penetration was greatly improved (Vitelli, 1992).

4.0 EXTENSION PROGRAM

The BSES staff also recognise the importance of developing a suitable extension campaign with the aims of:

1. improving new farm owners' understanding of the soils on their farm along with constraints and suitable production systems;
2. preventing degradation of these farms in the initial development phase;
3. providing advice to existing farmers on methods of improving production on sodic soils.

In the Burdekin River Irrigation Area (BRIA), 35% of the soils are classified as sodic duplex soils (Donnollan, 1991). For this reason a complete extension program was developed to provide support to new farm owners attempting to crop these areas. The basis of this program could be applied to other developing areas.

Firstly, target audiences were recognised as:

1. purchasers of farms
2. clearing and levelling contractors
Each segment had different interests and ideas on farm development and extension staff employed different extension strategies for the separate market segments. To ensure confusing information was not provided to clients, an integrated approach was undertaken by BSES, DPI and WRC. It was important that the skills of each organisation complemented each other, rather than worked competitively. Most group activities involve staff from each organisation.

Prior to 1990 there was little easily understood information provided to new land purchases in the BRIA resulting in poor land development practices. This lead to the development of an ‘Extension Officer’s’ kit by the WRC which contained all the relevant soils information for individual farms. This kit provided information to all people involved in farm development, which made initial farm planning easier and more informed.

After each auction, BSES staff organised workshops for new farm owners and a similar workshop was held for the laser levelling contractors. These workshops were designed to give participants exposure to technical people working in the BRIA and to generate awareness of the problems and strengths of the farming area. On the topic of sodic soils, the major message delivered at the workshop was that care needed to be taken during levelling to ensure the topsoil was not removed. This may involve considering different options in farm layout or investigating different levelling design options.

Many other extension strategies including bus tours, newspaper articles, radio interviews, discussion groups, videos, and field days were organised as part of the routine extension program focusing on sodic soils.

During this interactive phase many landowners were not convinced that gypsum was the most suitable ameliorant. This was partly because of the cost of the product and because a similar problem with water penetration on alluvial delta soils was being partially overcome with lime products. To validate prior BSES research and change this perception, BSES extension staff carried out three commercial size trials. In the three trials, conducted on local growers farms, gypsum was far superior for ameliorating sodic soils. Results from these trials were widely extended to other farmers farming sodic soils.

The BSES program on sodic soils has had two impacts. Firstly there has been a reduction in soil degradation on farms through better farm planning and the owner's understanding of the farm soils. The second impact has been increasing cane production through the application of gypsum as an amelioration strategy for sodic soils.

5.0 REFERENCES


