AN INTEGRATED APPROACH TO NUTRIENT MANAGEMENT IN THE AUSTRALIAN SUGAR INDUSTRY

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On-farm nutrient management in the Australian sugar industry has in the past been based on general recommendations for use across regions and soils. This approach, although simple to use, does not reflect the large diversity of conditions and soils that exist in the industry. Fertiliser inputs have historically been aimed largely at maximising cane production and achieving short-term economic gain rather than focussing on the long-term health of soils and the production system. More recently it has increasingly been recognised that sustainable sugar production is an essential component of on-farm profitability combining the maintenance of soil fertility and minimisation of off-site effects. It is now agreed that in a sustainable system fertiliser inputs should be used as a means of balancing the total nutrient resource available for optimum sugar production.

Over the past six years, scientists in the Cooperative Research Centre for Sustainable Sugar Production (CRC Sugar), of which BSES and CSR Sugar are participants, have been developing a multi-faceted approach aimed at achieving sustainable nutrient management. An integrated approach to nutrient management has been developed which combines longer-term nutrient management strategies and a number of tactical 'tools' (such as regular soil testing, leaf analysis and some useful 'rules of thumb') into a set of soil and site-specific nutrient recommendations.

In developing this approach, research, development and technology transfer initiatives have focused on five key areas:

- A review of the basis of fertiliser recommendations (Wood *et al.*, 1997; Schroeder *et al.*, 1998(a)) and fertiliser practices in the Australian industry (Schroeder *et al.*, 1998(b); Schroeder *et al.*, 1999).
- Recognition that soil type (based on easy to recognise field properties – colour, texture and position in the landscape (Wood *et al.*, 1997; Bruce, 1999; Schroeder, 1999; Schroeder and Kingston, 2000), and soil chemical properties (Nelson *et al.*, 1999) be used as the basis for varying rates of nutrients applied within the integrated approach.
- Development of soil/site specific fertiliser recommendations based on the re-evaluation of past data and the results of recent field, glasshouse and laboratory investigations (Schroeder and Wood, 2001; Schroeder and Wood, 2002). Simple but useful pedo-transfer functions are also being developed to enable extrapolation of recommendations to the industry as a whole.
- An extensive education program aimed at training extension and advisory staff in the principles of sustainable nutrient management. In excess of 200 people have successfully completed courses presented by CRC Sugar over the past four years.
- Encouraging growers to use soil testing (Schroeder *et al.*, 1998(b)), leaf analysis for advisory and nutrient trend purposes (Schroeder *et al.*, 1999) and better record keeping for more informed decision-making on-farm.

One example of advances made within the integrated approach to nutrient management is the development of soil specific nitrogen fertiliser recommendations. An important development was the recognition that soils in the Australian sugar industry differ in their ability to mineralise N according to organic matter content (Wood and Stewart, 1985; Schroeder and Wood, 2001). This used in combination with N requirement based on yield target, as suggested by Keating *et al.* (1997) - 1.4 kg N tonne^{-1} of cane up to 100 tonnes ha^{-1} and 1 kg N tonne^{-1} of cane thereafter - provides a logical basis for fine-tuning nitrogen inputs (Table 1).

Table 1. N application rates based on yield target (Keating *et al.*, 1999) and N mineralising potential (Schroeder and Wood, 2001).

Yield target (tonnes cane ha^{-1})	**N requirement (kg N ha^{-1})**
70	100
85	120
100	140
120	160
140	180
Organic C (%)	**Reduction in N application rate (kg ha^{-1})**
<0.8	0
0.8 – 1.6	20
1.6 – 2.4	40
>2.4	60

Similarly, with potassium it has been possible to use an easily recognisable soil property to categorise soils according to their K fertiliser requirements. Re-evaluation of data from past BSES fertiliser trials has shown that responses to applied K can be separated into two groups according to soil texture. The relationships shown in Fig 1 indicate that the use of two critical values for exchangeable K: 0.20 cmol(+) kg^{-1} (0.02M HCl) for sandy soils, and 0.30 cmol(+) kg^{-1} for heavier soils, would be more appropriate than the current single value for all soils.

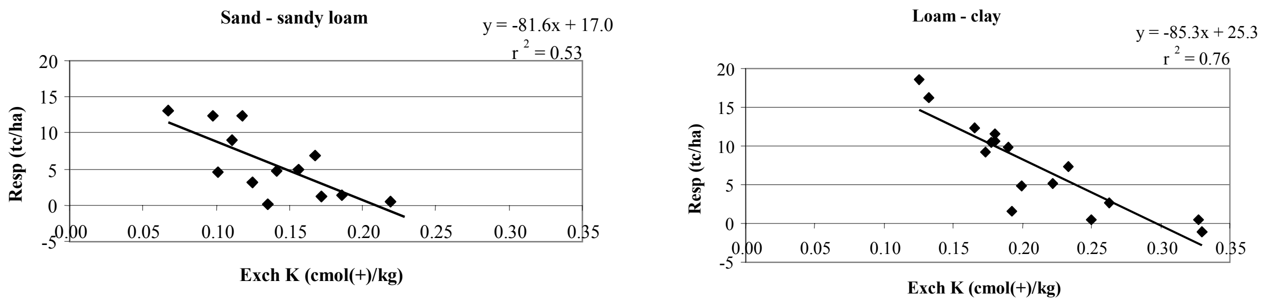

Figure 1. Yield response to applied K plotted against exchangeable K values for two soil textural categories. The data were obtained from past BSES phosphorus x potassium field trials and relate to 0.02M HCl as the extractant.

Leaf analysis is an example of one of the tools available to growers in an integrated approach to nutrient management. Used in conjunction with soil analysis it can provide a useful check on the adequacy of fertiliser recommendations and nutrient inputs. It enables nutrient imbalances to be identified and corrected, and trends to be monitored at the block, farm and regional levels. For example recent leaf analysis data (Figure 2) have shown that potassium levels in some districts are markedly deficient whilst in others are more than adequate. In northern New South Wales, third leaf K values were almost all below the critical value of 1.1% K. This is thought to be due to the relatively high soil Ca and Mg values inhibiting uptake of K. In the Central Region, third leaf K values were predominantly above the critical value. These high values were possibly associated with the soils' clay mineralogy, but are also related to the regular usage of Biodunder (effluent from the ethanol distillery which is high in K) as a source of fertiliser.

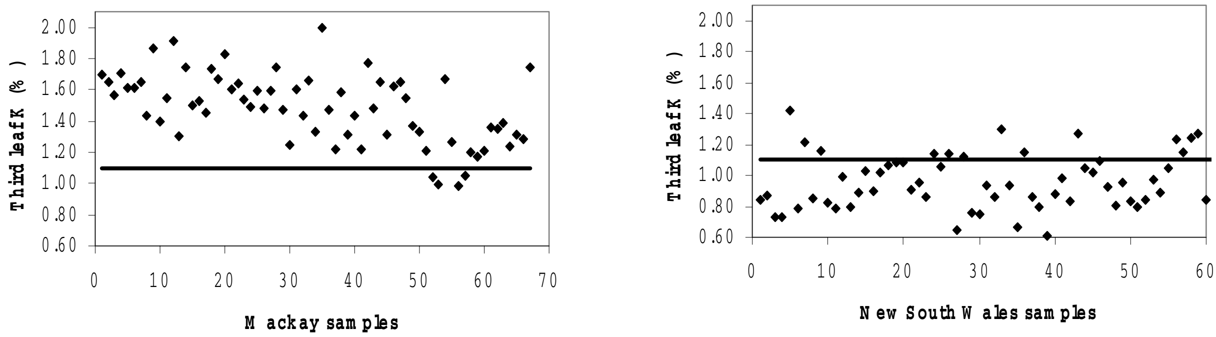

Figure 2. Third leaf K(%) values associated with samples collected from the Mackay and New South Wales cane growing districts during 2000 and 2001. The horizontal bold line represents the critical value (1.1% K).

For the nutrient management system to be fully integrated, nutrient recycling associated with trash retention (Mitchell and Larsen, 2000; Robertson and Thorburn, 2000), nutrient additions due to the use of by-products (Barry, 1999), and nutrient losses associated with certain soils, environmental conditions and fertiliser carriers (Bruce *et al.*, 1999; Reghenzani and Armour, 2002), will also need to be considered and accommodated in the package when and where necessary.

The integrated approach to nutrient management developed to date allows for sufficient flexibility to cover the range of on-farm management styles that exist in the Australian sugar industry. It also allows for future modifications to be easily introduced as further information becomes available. Future work is planned to incorporate the advances into a user-friendly decision support package that will assist growers and their advisors to make informed and logical decisions about nutrient inputs and application rates. Importantly the package will focus on supplying advice to ensure fully balanced nutritional management (covering all essential nutrients). Not only will implementation of this system improve productivity on-farm, but it will also signal the on-going willingness of the sugar industry to be environmentally responsible.

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