NITROGEN BALANCES IN SUGARCANE FARMING SYSTEMS AS AFFECTED BY NITROGEN FERTILISER APPLICATIONS

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Introduction

SUGARCANE REQUIRES large additions of fertiliser nitrogen (N). Once this N is applied to the soil, N cycling dynamics transform the N in many ways. Important pathways for the sugarcane industry are assimilation of N by the crop, changes in the soil N pool by immobilisation and mineralisation processes, and the losses of N from the crop-soil system to the environment (atmosphere, surface and ground water). For example, much of the N fertiliser applied can be immobilised by soil organic matter, even in the wet tropics (Meier *et al.*, 2006), and subsequently made available to the crop through mineralisation. The sugarcane crop also takes up large amounts of N. Thus the fate of N fertiliser is complex, and understanding N cycling is important for determining N fertiliser management strategies.

Monitoring of N fertiliser inputs, changes in soil N storage and N in crop off-take allows a simple N balance sheet to be constructed. N that is unaccounted for in the balance sheet can provide a qualitative assessment of the potential losses of N from the crop-soil system to the environment. Comparisons between treatments under the same environmental and management conditions allow an assessment of the production and environmental sustainability to be made. We calculated N balances in N fertiliser management experiments established in a wide range of environments to better understand the sustainability of N fertiliser management systems.

Methods

Data was taken from the studies of Thorburn *et al*. (2003, 2007). At all sites, soils were sampled to 1.5 or 2.0 m depth (in 0.3 m increments) prior to initial fertilisation and annually after harvest. Samples were analysed for mineral N and the annual change in total mineral N calculated. N removed from the site in harvested cane and, where applicable, burnt trash was calculated from measurements on N concentration and mass of crop samples (stem, cabbage, green leaves and dead leaves) obtained at harvest. In GCTB systems annual contributions of N from decomposing trash were assumed to equal the N required to grow the tops and leaves in the following crop, thus cancelling each other out. N unaccounted for in the balance was the difference between N fertiliser inputs, crop off-take and changes in soil mineral N.

Results and discussion

Example results are shown in Figure 1 for a long-term experiment with five different rates of N fertiliser applied, including a treatment with no N applied. In this latter treatment more N was removed from the site in crop off-take than was applied in fertiliser or

contributed from soil mineral N, so the N unaccounted for in the balance was negative (-57 kg/ha/yr). The implication is that at least this amount of N came from mineralisation of the soil organic matter, running down the N fertility of the soil. In the four other treatments with N fertiliser applied, there was an increasing amount of N unaccounted for in the N balance. In the highest N treatment (240 kg/ha applied), almost half of the fertiliser N was unaccounted for. Potential N losses from these treatments could have been greater if N mineralisation was similar to that in the zero-N treatment.

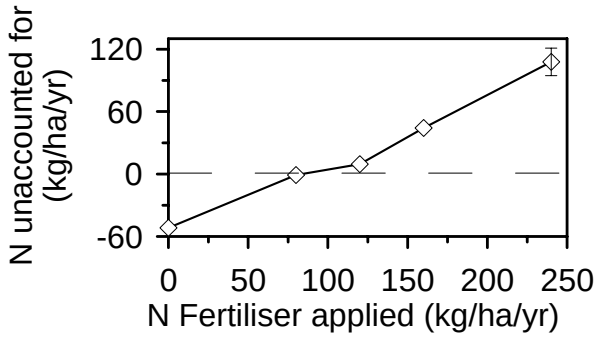

Fig. 1—Nitrogen unaccounted for in the average N balance as a function of different N fertiliser applications over four crops at Bundaberg (after Thorburn *et al.*, 2003)

The results of these balances have implications for sustainability of sugarcane production in Australia. For example, large amounts of N unaccounted for indicate the potential for N losses to the environment, with water quality and greenhouse gas implications. Negative N balances indicate over-reliance on mineralised N and hence degradation of the soil, a situation that is definitely not sustainable for production. Despite the relative simplicity of this technique, it can provide valuable information on the outcomes and sustainability of different N fertilisation management practices, and help to develop more sustainable N fertiliser management systems.

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REFERENCES

Meier EA, Thorburn PJ, Wegener MK, Basford KE (2006). The availability of nitrogen from sugarcane trash on contrasting soils in the wet tropics of North Queensland. *Nutrient Cycling in Agroecosystems* **75**, 101–114.

Thorburn PJ, Dart IK, Biggs IM, Baillie CP, Keating BA (2003). The fate of nitrogen applied to sugarcane by trickle irrigation. *Irrigation Science* **22**, 201–209.

Thorburn PJ, Webster AJ, Biggs IM, Biggs JS, Park SE, Spillman MF (2007) Innovative management of nitrogen fertiliser for a sustainable sugar industry. *Proceedings of the Australian Society of Sugar Cane Technologists* **29**, 85–96.