A monitoring system based on amino-N at harvest time to improve nitrogen management in sugarcane systems

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Abstract

The sugarcane industry is a major user of nitrogen fertiliser and has an interest in efficient fertilisation practice to limit costs and ensure a sensitive environment is not exposed to excessive N losses. Current N fertilisation recommendations are broad and unrelated to any field specific measures of plant or soil N status. This paper describes research aimed at developing a monitoring system that would enable growers to assess N status of sugarcane crops on a block or sub-block basis. The method is based on the concentrations of amino acid (amino-N) in cane juice, measured at harvest time as it is delivered to the sugar mill. This information is then used to adjust N management on a block-specific basis in future seasons. This paper focuses on the factors that influence amino-N in cane at both plot and mill scales and prospects for an amino-N assay to identify cane crops that have experienced either insufficient or excess N supply.

Keywords

Sugarcane, N fertilisation, amino-N, monitoring.

Introduction

Australian sugarcane growers apply approximately Aus$80M worth of nitrogen fertiliser annually, representing a total input in the vicinity of 80,000 tonnes N per year, and an average application rate of 180 kgN/ha/yr (4). N removal in the harvested cane is typically in the order of 80-90 kgN/ha for a 100 tonne cane/ha crop (2). N is also lost from the system during burning prior to harvest (quantities in the range 60-80 kgN/ha), a practice that is still employed on approximately 40% of the sugarlands. There is evidence that nitrogen supplied to the crop is in excess of crop demand in some instances, a natural tendency of growers anxious to avoid any risk of insufficient nitrogen limiting cane yields. In some cases there is evidence that excess nitrogen has found its way into groundwaters (6). Current N fertilisation recommendations do not take into account all the soil, management and climate factors known to influence N supply and demand and there are no proven crop or soil assays available to guide N fertiliser usage by cane farmers.

This paper reports on work aimed at developing a system for monitoring of N supply in cane crops, as a basis for better targeting N management. An assay is under development (1), based on the concentrations of N containing amino acids (primarily asparagine) in cane stems at harvest time . The use of crop N status as measured last season to guide N inputs in the coming season, is feasible in sugarcane systems because of both the large proportion of N uptake being cycled through soil organic N pools (3,5) and the relative stability of water supply in sugarcane production systems. Being able to better match nitrogen fertiliser supply to crop demand and soil supply holds promise of benefiting both growers and the community. Growers benefit through avoiding situations where nitrogen fertiliser may be wasted through excessive application, or the less likely situation where yield is limited because of insufficient nitrogen. Benefits are delivered to the wider community through less chance of nitrogen in excess of crop requirements finding its way into ground or surface waters.

EXPERIMENTAL DETAILS

Measurements of N status of cane crops, in particular the concentrations of amino-N, were obtained from experimental plots under defined management treatments (Table 1). Sample collection, processing and laboratory analysis methods were as described by Keating et al. (1). Mill scale sampling focused on the first expressed juice from No 1 mill (Table 2).

Table 1. Details of plot-scale studies of amino-N response to management factors.

Expt. Number	Location	No of samples	Treatments	Source (unpubl data)
1	BliBli	30	5 N rates x 2 years x 3 reps	G. Kingston
2	Fairymead	45	5 N rates via trickle x 3 years x 3 reps	P Thorburn
3	Bundaberg	72	6 varieties x 4 irrigation treatments x 3 reps	R. Ridge
4	Burdekin	108	6 varieties x 3 N rates x 6 reps	A Rattey

Table 2. Details of mill-scale studies of variation in amino-N status of cane supply.

No.	Mill	Year	No of samples	Tonnes cane	Sampling Times.[1]	Sampling period
1	Macknade	1996	624	46,953	5	Jul – Nov
2	Bingera	1997	119	14,005	5	Aug – Nov
3	Fairymead	1997	106	13,557	5	Aug – Nov
4	Millaquin	1997	98	10,011	5	Aug – Nov
5	Mulgrave	1998	298	-	*	Aug – Nov

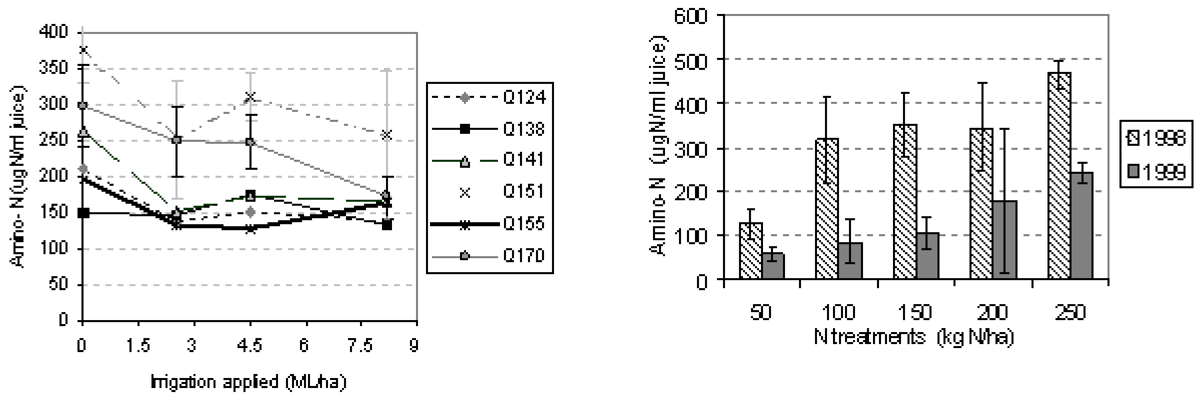
[1.] Samples collected over a 24 hr period of mill operations

* Approximately 2 samples collected at random every day

Results and Discussion

Factors influencing amino-N concentrations in harvested cane: plot scale

Amino-N concentrations in cane juice increased with increased rate of N fertilisation in a sequence of plant and ratoon crops (Expt. 1) at BliBli (Figure 1a). The higher N status of the plant crop, a common observation in sugarcane systems, was evident in the amino-N concentrations. Amino-N concentrations were elevated by strong water deficits associated with a zero irrigation treatment (Expt 3) in Bundaberg in a dry year (Figure 1b) Yields in this treatment were reduced to less than 50% of the irrigated crops . Two cultivars (Q151, Q170) exhibited higher amino-N concentrations than did the other four cultivars included in this trial.



(a) Plot scale Expt. 1.

(b) Plot scale Expt. 3. (see Table 1 for study details).

Figure 1. Amino-N responses to management treatments. Vertical bars indicate standard errors.

Cultivar effects on amino-N concentrations in cane juice were small in another study in the Burdekin (Expt 4), compared to the large differences associated with N fertiliser treatment (Figure 2). Interestingly, the differences that were seen were most pronounced at the highest N fertiliser rate, suggesting cultivars may differ in the ability to take up "luxury" levels of N.

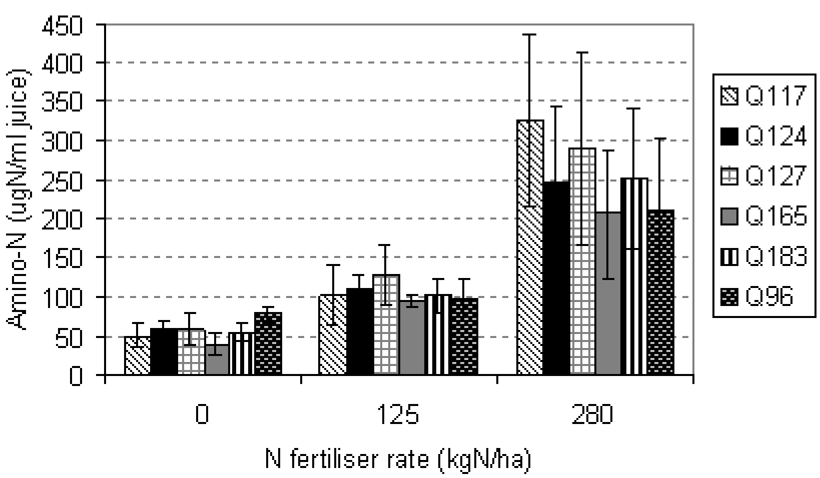


Figure 2. Amino-N response to N fertiliser rate in the cane juice of six cultivars grown in the Burdekin in 1999/2000. (see Table 1 for more details). Vertical bars indicate standard errors.

Keating et al. (1) reported a preliminary relationship between amino-N concentrations in cane juice at harvest and sugar yield, i.e. relative to yield with optimal N supply. This relationship was based on data from Ingham, Ayr and Bundaberg and these data are re-plotted with additional data from plot scale experiments 2 and 4 (Figure 3). Note depressed yields associated with amino-N concentrations less than 150mgN/ml juice and a long plateau of amino-N concentrations associated with luxury N uptake when N supply was not limiting sugar yield. Tentatively amino-N concentrations above 300 mgN/ml juice have been considered excessive.

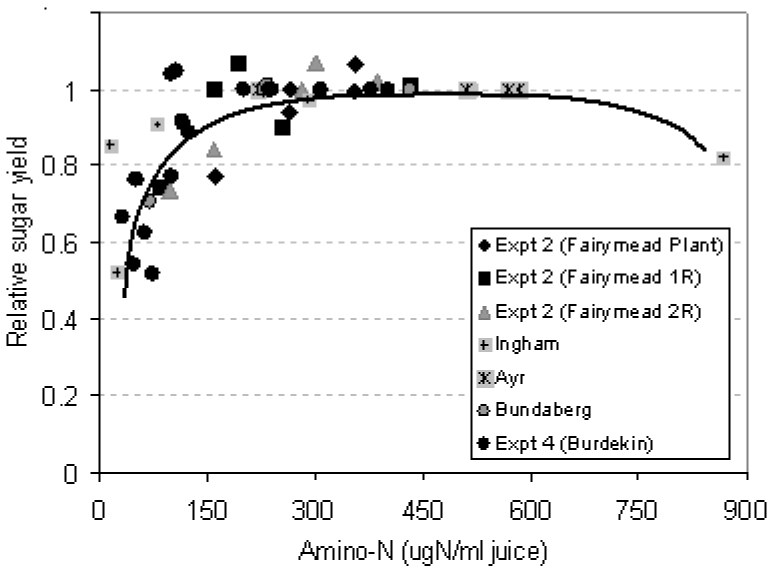


Figure 3. Sugar yield (as a fraction of yield in an N non-limiting treatment) versus amino-N in cane juice. Line indicates an idealised diagnostic response (see (1) for details of Ingham, Ayr and Bundaberg data).

Variation in amino-N concentrations in harvested cane: mill scale

Plot scale studies have suggested that monitoring of amino-N in harvested cane might provide an indicator of crop N status. Significant variation in amino-N must exist at the mill scale if this monitoring technique is going to be useful. Extensive monitoring of amino-N status in first expressed juice at five mills over three seasons (see Table 2 for details) shows amino-N concentrations ranging from approximately 100 to 700 ugN/ml juice (Figure 4). If an amino-N level in the range 150 to 300 ugN/ml of juice is tentatively set as a target range (Figure 3), the mill sampling indicates between 5 and 15% of samples fall below, and 30 to 60% lie above this target range. Work is continuing on use of Near Infrared Spectrography (1) for rapid and cost effective implementation of this monitoring scheme and on exploring the value of the additional information in on-farm decision making.

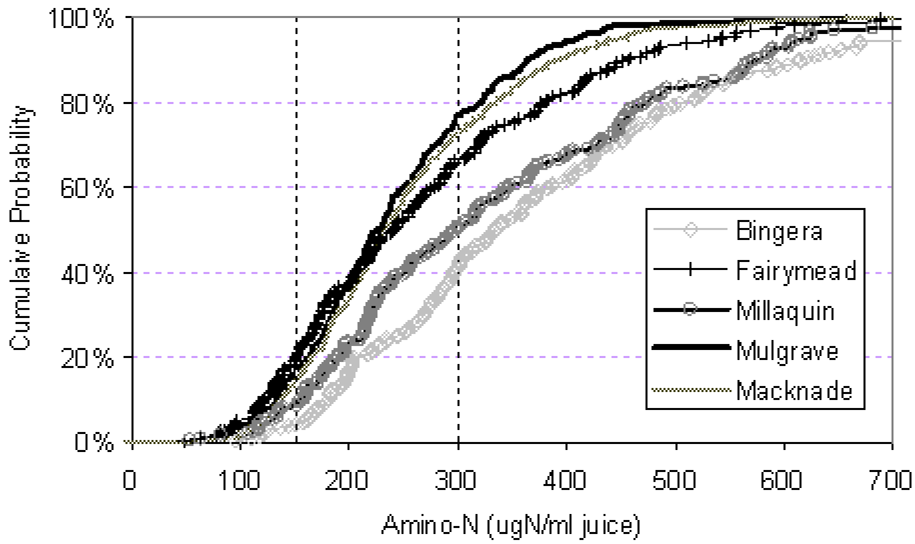


Figure 4. Cumulative distribution functions for amino-N in first expressed juice in five Qld sugar mills/ (see Table 2 for details of sampling). Mill scale data were adjusted to reflect the 20% lower amino-N extraction efficiency of No 1 mill compared to a laboratory based Carver Press (1).

Conclusions

A mill based monitoring technique to better inform N fertilisation practice in sugarcane crops continues to appear feasible. The data reported here highlight the large responses in amino-N in juice to crop N supply. Precision of assessment of N status will be influenced by cultivar and water regime, but these effects were small in comparison with the effects of N supply. The large variation in amino-N in bulk cane supply at mills suggests that there is considerable potential for improving N management, given that 30 to 60% of cane sampled contained what appears to be excessive concentrations of amino-N.

Acknowledgments

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