Suitable Biomass for a Sustainable Sugarcane Industry

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Fibre and Sucrose yield from selected SRA Sugarcane Genotypes

Introduction

A challenge facing all sugarcane mills that wish to diversify their income streams is to use the processing capacity for most of the year. The crushing season in Australia generally lasts about 22 weeks. For the Far Northern Milling Company, the problem is exaggerated by the fact that there is already a shortfall in available biomass during the short crushing season. One of the main objectives of the project is to identify genotypes that could contribute to increased total biomass production per unit land area (Project Overview). Previously we have described the plant crop performance of 17 genotypes in the Tablelands and Mossman production areas (Yield and composition of the sugarcane plant crop). Here we report on the biomass composition, bagasse and juice, as well as fibre yield, of the genotypes over a full cropping cycle. Yield will vary from season to season, and hence all data should be viewed as composition and performance relative to the industry standard Q208.

In this Update

Biomass yield

There is a significant variation in the moisture content of the different genotypes at the time of harvest. For that reason all yield data is expressed as tonne dry weight of cane per hectare.

The tonne dry weight yield per hectare over the cropping cycle (plant plus ratoon) of Q208 was 29.02 ± 1.14 and 25.99 ± 5.9 for Mossman and the Tablelands respectively. In the data presented in Fig 1 the yield data has been normalised against the yield from Q208 in both production environments.

At the Mossman site only 4 genotypes (QS08-7370, SRA32, QS10-7123 and QS10-8770) had a higher average cane production than Q208 (Fig 1). Only the yield from QS10-8770 was significantly higher (9.2%) than that of Q208. None of the other commercial standards in the trial did better than Q208.

Several genotypes did better than Q208 at the Tablelands site (Fig 1). Four genotypes (SRA3, QS10-7123, QS07-9185 and WSRA24) had a yield advantage of >20% over Q208. It is important to note that Q208 yield were lower at the Tablelands site than the Mossman site.

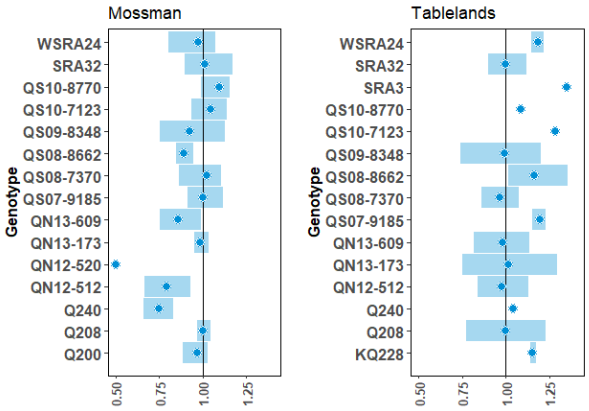

Figure 1: *Relative crop yield (TCH) of the cane genotypes included in the field trials in Mossman and Tablelands. The data is the average yield of the plant and ratoon crop. Data is expressed relative to that of Q208 which is the dominant in variety in the Mossman production system.*

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Fibre and sucrose content

An anova analysis showed that there was a significant difference in the Fibre content (%DW) between the genotypes at both the Mossman and Tablelands sites ($P<0.0001$) (Fig 2). There was a larger variation in the fibre component (% of total DW) at the Mossman than Tablelands site.

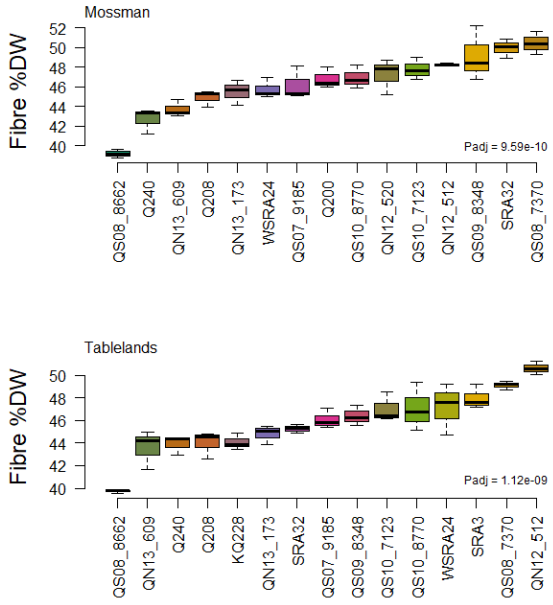

Figure 2: *Fibre content of the cane genotypes included in the field trials in Mossman and Tablelands. The data is the average fibre content expressed as a percentage of total dry weight of the plant and ratoon crop.*

Also noteworthy is that the experimental genotypes and most recent released SRA varieties are dominant at the high end of fibre content.

The anova analysis also showed that there was a significant difference in the sucrose content (%DW) between the genotypes at both the Mossman and Tablelands (Fig 3) sites ($P<0.0001$).

Because of the similar distribution in biomass composition of the genotypes (Fig 4), compositional data for each clone from both trial sites, and across the plant and ratoon crops, were pooled and analysed for correlation between biomass, sucrose and fibre content.

There is a significant negative correlation ($P<0.001$) between fibre and sucrose content in sugarcane (Fig 4). Although significant there is a much weaker correlation between fibre or sucrose content and biomass yield. Without exception the high fibre genotypes have the lowest sucrose content (Table 1). On average fibre and sucrose makes up more than 91% of total biomass in the tested sugarcane genotypes.

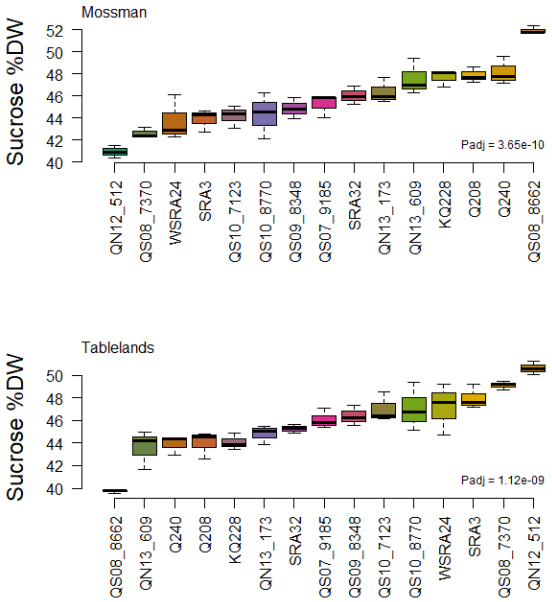

Figure 3: *Sucrose content of the cane genotypes included in the field trials in Mossman and Tablelands. The data is the average fibre content expressed as a percentage of total dry weight of the plant and ratoon crop.*

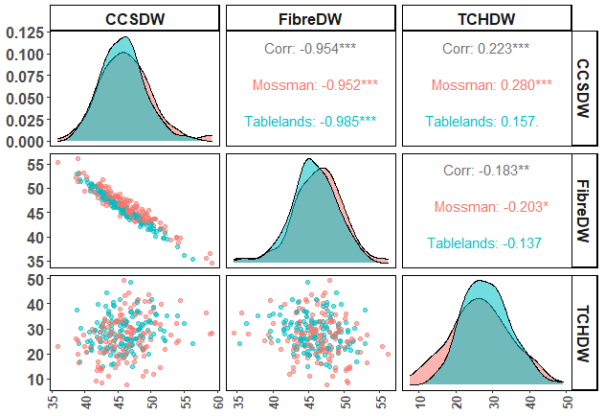

Figure 4: *A pairs plot of fibre, sucrose and cane yield on a dry weigh basis of 15 sugarcane genotypes at Mossman and in the Tablelands. All variables are quantitative, and the variables are plotted as scatterplots below the diagonal. The diagonal contains density plots reflecting the distribution of values at the two research sites. The correlation between the different quantitative values is presented above the diagonal. (*=P0.05), (**=P0.01) and (***=P0.001).*

Biomass production in grasses is directly related to the physiology of sink–source dynamics and whole-plant car-

bohydrate partitioning [4].

What constitutes sink strength or the magnitude of the 'demand function' is not well understood. However, it is widely accepted that it is the competitive ability of an organ to import photoassimilates and that this is the product of the sink size, and sink activity [2].

Sink strength (sucrose import into the internodes) is dependent on maintaining a low sucrose concentration in the cytosol [2, 1]. There are three important components of the 'demand' function in the internode i) use of sucrose for biosynthesis (cell wall and other cellular constituents) ii) respiration and iii) storage of sucrose in the vacuole [2].

The partitioning of carbon between fibre, surose and the other metabolic pools are directly related to the growth rate of the top six internodes (cabbage) of the culm [3].

In fact, sucrose accumulation is not a competitive metabolic 'demand' function but merely a reflection of surplus carbon after internode elongation terminates. A surplus carbon in the internode is dependent on maintaining of a sucrose gradient between the internodes and phloem, and healthy photosynthetic leaves [5]

Table 1: *The average fibre and sucrose content (%DW) of the sugarcane genotypes accross the Mossman and the Tablelands trials. The average composition of Q208 is highlighted in yellow*

Genotype	Fibre			Sucrose		
	% DW	SD	TUKEY	% DW	SD	TUKEY
QS08-7370	49.8	1.09	a	42.9	0.61	f
QN12-512	49.4	1.29	ab	42.8	2.06	f
SRA3	47.9	1.06	abcd	43.9	1.03	def
QS09-8348	47.8	2.40	abc	43.7	2.68	ef
SRA32	47.6	2.72	abc	44.6	1.87	def
QS10-7123	47.4	1.23	abcd	44.4	0.96	def
QN12-520	47.3	1.83	abcde	46.2	2.31	bcdef
QS10-8770	47.0	1.60	abcd	44.9	1.63	cdef
Q200	46.8	1.04	abcdef	45.7	1.54	bcdef
WSRA24	46.4	1.75	bcde	44.5	2.09	def
QS07-9185	46.1	1.20	cdef	46.0	1.55	bcdef
QN13-173	45.2	1.06	cdef	46.4	1.01	bcde
Q208	44.5	1.10	def	47.7	0.96	bcd
KQ228	44.1	0.73	cdef	47.7	0.77	bcde
QN13-609	43.7	1.24	ef	48.0	1.51	bc
Q240	43.3	1.20	f	49.0	1.76	b
QS08-8662	39.5	0.34	g	52.8	0.97	a

- Letters correspond to significant differences among groups after the TukeyHSD post hoc test.
- na = not applicable for that environment

Fibre and sucrose yield

It is evident that all of the SRA genotypes used in this study are indicative of type I Energy cane i.e. sugarcane varieties that have been bred to maximise sucrose and fibre yield [**?**, **?**, 7]. Huge gains in total biomass and bagasse will be dependent on a completely different type of cane that is very high in fibre and contains negligible sucrose levels [6, 7].

However, it is evident that gains can be made to increase total bagasse production if the industry is prepared to sacrifice some sucrose (Table 1).

The cane yields that we report from this study are limited as it only reflects one site from each of the two production environments (Fig 1). Nevertheless, to illustrate the potential gains that can be made to offset current bagasse shortfalls we have used the limited yield data to calculate fibre yields (Table 2).

For this purpose the cane yield (Tonne DW hectare $^{-1}$) was multiplied by the amount of fibre per tonne cane (%DW). When fibre yield of the different genotypes is compared to that of Q208 it is evident that up to 2 tonne hectare^{-1} and 5.3 tonne hectare^{-1} can be gained in Mossman and Tablelands respectively (Table 2). This represents a 15% and 47% gain for Mossman and the Tablelands, respectively.

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Table 2: *Fibre yield (Tonne hectare^{-1}) of the sugarcane genotypes included in the field trials in Mossman and the Tablelands. Yield from Q208 is highlighted in yellow. The ranking refers to the performance (fibre yield) of the genotype in the particular production environment.*

Genotype	Mossman			Tablelands		
	Tonne Hectare^{-1}	SD	Rank	Tonne Hectare^{-1}	SD	Rank
QS10-8770	14.9	1.53	1	13.4	5.29	5
QS08-7370	14.7	1.87	2	12.3	1.28	8
SRA32	14.5	2.04	3	11.7	1.35	13
QS10-7123	14.4	1.52	4	15.7	3.03	2
QS07-9185	13.3	1.87	5	14.2	0.24	4
QS09-8348	13.1	2.83	6	11.9	2.96	10
Q200	13.1	0.99	7	na	na	na
Q208	12.9	0.79	8	11.3	2.26	14
WSRA24	12.8	2.00	9	14.5	0.58	3
QN13-173	12.8	0.68	10	11.8	3.31	11
QN12-512	10.9	1.85	11	12.7	1.93	7
QN13-609	10.7	1.27	12	10.9	1.43	15
QS08-8662	10.0	0.45	13	12.0	1.74	9
Q240	9.2	1.12	14	11.8	4.13	12
QN12-520	6.8	1.80	15	na	na	na
KQ228	na	na	na	13.1	0.39	6
SRA3	na	na	na	16.6	2.10	1

- SD = Standard deviation
- na = not applicable for that environment

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