EVALUATION OF SUGARCANE FOR MATURITY EARLINESS

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ABSTRACT

Aiming at producing adequate sugar yield, the initial selection from 26 varieties of sugarcane was made over 14 months of growth on the bases of interrelated juice and sugar parameters including earliness age, high Pol % cane, purity and Commercial Cane Sugar (CCS) obtaining 12 superior varieties based on ≥ 15 pol % cane, purity (≥85%). Their maturity profiles showed that juice and cane parameters are significantly correlated. The first three varieties, Co 6806, Cadmus and Co 997, matured at <11 months (early maturing), and the remaining nine varieties; PS58, Co6519, BT65152, Q77N1232, Q136, Ragnar, Cassius, Q127 and PS57, matured at ≥11– 12 months (medium maturing). The overlapping of maturity age and prolonged production periods, would prolong the harvesting season and make the cropping season more efficient, as it allows for early harvest, maintaining varietal diversification and sustainable production. The results provide significant information for the possible extension of sugarcane commercial cultivation.

Key words: Maturity, production-period, & sugarcane.

INTRODUCTION

Evaluation for earliness and selection for early maturity, targeting high sucrose content at early age in sugarcane (*Saccharum* spp. L.) is a major objective in breeding programmes as demanded by sugar industries (Cuenya and Mariotti, 1986; Domaingue et al., 1998; Cox et al., 1990; Das et al., 1997). Cane maturity is determined by monitoring sugar yield parameters such as; Pol % cane , Brix % cane, commercial cane sugar (CCS) and ton cane per hectare (TCH). However, most researchers focus their evaluation on Pol % cane (Hunsigi, 1993; Mamet et al., 1996 and Das et al., 1997), and reported values ranged from 10.49 – 17.86.

Maturity age is relatively specific to industrial needs. For example, early maturing varieties are those ripening at 8-10 months in India (Das et al., 1997, Hunsigi, 1993), 10-11 months in Indonesia (Indriani and Sumiarsih, 1995), 12-14 months in Columbia (Calderon et al., 1996), 9-10 months in Mauritius (Soopramanien et al., 1990). During the initial stages, the portion of sugar, that is stored as sucrose, is small and increases as growth continues (Fernandes and Benda, 1985; Hunsigi, 1993).

Early maturing varieties have numerous benefits to both the growers and sugar industries. They provide an efficient and reliable means of achieving increased sugar yields at the beginning of the season (Mamet et al., 1996; Singh and Gupta, 1999), save the raw material required for a given crop cycle and allow earlier commencement of the harvesting and the processing season, and ensure profitability (Muchow et al., 1996; Singh and Singh, 1998; Gonzales and Galvez, 1998; Julien, 1972; Calderon et al., 1996;).

High correlations were reported by many workers between juice and yield parameters. Correlation values was 0.57 between yield and fibre, and -0.76 between sucrose and fibre (Tai et al., 1996), from r = 0.62 to 0.74 between fibre and Brix, from r = 0.79 to 0.87 between Pol and purity, from r

= 0.73 to 0.92 between Pol and Brix, and from r = 0.56 to 0.89 between purity and Brix (Julien, 1972; Tai et al., 1996; Mamet et al., 1996; Singh and Singh, 1998).

In this study, 26 varieties of sugarcane were evaluated for maturity earliness through monitoring sucrose accumulation and related parameters, Aiming at providing background information for the possible extension of sugarcane commercial cultivation.

MATERIALS AND METHODS

Plant materials and experimental location

Out of over 500 varieties and hybrids clones collected and conserved at Ramu Sugar Ltd, 26 varieties were selected based on their relative performance and history. Selected varieties included; RB-725143, JA60-5, R570, Q72N1325, B73385, Q77N 1232, Q136, Q135, B72177, Q127, BT65152, Q117, Cassius, Cadmus, CoJ64, PS57, PS58, PS59, Co1111, Co1148, Co1158, Co6519, BJ6732, Co6806, Co997, and Ragnar. These varieties were coded L1-L26 respectively. They were planted under uniform condition during the wet season, at the experimental farm of the Department of Agriculture, University of Technology, Lae, Papua New Guinea, located at an altitude of about 54 m.a.s.l. and 6º 45' S and 147º E, and the cane was planted in 10m-long rows and an inter-row spacing of 1.5 m.

Sampling procedure and yield estimate

Sampling was carried out at monthly interval for 10 months, started when cane was five (5) months old in April 1999 and ended in January 2000 when cane was 14 months old. Sampling was done after a minimum of 2 dry days from the day it was last rained, as to minimize fluctuation to rain/dry conditions. Cane stalk from 1 m of row length was slashed at ground level and topped in the last mature joint, as is done in commercial fields (Hebert and Rice, 1972), cleaned and weighed fresh. Ton cane per hectare was calculated as the product of 1.5 m^2 fresh cane to the one hectare of area.

Randomized complete block design (RCBD), with three blocks each contain 26 varieties, and each variety planted in three rows. Sampling was carried out by random selection of 1 m row length from which mixable cane was collected for cane and juice analysis. Linear and quadratic regressions on time were fitted to the data of Brix, Pol, purity and fibred by method of least squares were applied using Statistic 1.0 for Windows software.

Juice and dry matter analysis

Juice and dry matter analysis was carried out at Ramu Sugar Ltd., Ramu, Papua New Guinea. Cane was crushed using a JEFFCO and Juice was extracted from samples of 500 g of crushed cane was collected for analysis. For the purpose of juice analysis, the standard procedure of the Bureau of Sugar Experiment Stations (BSES, 1991), Australia, were adopted. Juice was mixed with lead acetate basic prior to Pol reading. Brix was measured by a refractometer (RFM-330, Bellingham & Stanley, Ltd., England), and Brix % juice was determined by applying standard temperature correction factor to Brix reading. Pol was measured by a saccharimeter (SUMA-PE98028, Tate Lyle Process Technology, UK), and Pol % juice was calculated by multiplying Pol reading with Pol factor according to Brix value.

RESULTS AND DISCUSSION

Patterns of juice, sugar and cane parameters

Over 14 months of growth, all the 26 varieties showed an increase at early growth stage in all juice parameters including Pol, Brix, purity and CCS. In later age, some varieties show a small increase in these parameters, some levelled off, and some varieties decreased. Similar trend was found among varieties in the development of TSH, showed continue increased over the growth period. The regression and correlation analysis was carried out at 8 months, when most varieties first reached 15 Pol % cane, 11 months, when most varieties reached their peaks of maturity, at the actual time when Pol % cane reached the peak, and at 14 months, end of sampling time (Table 1).

Table 1. Pattern of cane and juice parameters of 26 varieties of sugarcane

Variety Code	Var. Name	Pol % cane at peak	Maturity age, (peak pol % cane), (month)	TCH	TSH	Predicta-bility (R^2)
1	RB725143	14.25	11.5	127.3	16.92	0.8977
2	JA60-5	14.45	10.8	94.1	12.96	0.8388
3	R570	14.95	11.5	117.5	16.02	0.9043
4	Q72N1325	14.33	10.7	121.4	16.04	0.7818
5	B73385	14.00	11.2	107.8	14.39	0.8917
6	Q77N1232	15.69	11.3	127.3	18.91	0.8825
7	Q136	15.62	11.3	111.6	16.83	0.9123
8	Q135	14.27	11.2	125.7	17.53	0.8874
9	B72177	13.71	12.5	142.2	17.39	0.9756
10	Q127	17.06	11.7	126.4	20.65	0.8981
11	BT65152	16.91	11.2	131.8	20.75	0.9244
12	Q177	14.59	10.8	98.0	13.14	0.9089
13	Cassius	16.48	11.5	116.2	18.25	0.9628
14	Cadmus	17.12	10.9	104.3	17.67	0.9014
15	CoJ64	14.77	10.5	103.5	14.74	0.8809
16	PS57	15.75	12.2	116.3	16.67	0.9262
17	PS58	15.50	11.1	108.3	15.97	0.9208
18	PS59	14.64	11.3	110.0	15.45	0.9541
19	Co1111	12.72	11.4	96.2	11.38	0.8882
20	Co1148	12.20	11.4	129.1	14.45	0.9529
21	Co1158	12.52	13.2	149.9	16.4	0.9658
22	Co6519	16.80	11.1	114.6	19.04	0.9699
23	BJ6732	12.92	11.1	97.2	11.59	0.9458
24	Co6806	16.31	10.7	94.3	15.01	0.9100
25	Co997	16.33	10.9	123.7	20.22	0.9452
26	Ragnar	16.58	11.4	120.5	18.81	0.9583
Mean		15.02	10.50	115.97	16.43	0.7818
Min		12.20	13.20	94.10	11.38	0.9756
Max		17.12	11.32	149.90	20.75	0.9148
SD.		1.4675	0.5826	14.5912	2.5545	0.0435
SE.		0.2878	0.1143	2.8616	0.5010	0.0085

[a] E = Early, M = Medium, L = Late; [b] N/A = Not assessed

At peak Pol % cane, the association among variables was more highly significant compared to the other three time points, specially in the negative correlation between Pol % cane and fibre (r= -0.3573), Brix and fibre (r= -0.4134), purity and fibre (r= -0.1425), and CCS and fibre (r= -0.3288). Similar results were obtained by Sunil and Lawrence (1996), and Cuenya and Mariotti (1996).

Determining maturity earliness

The maturity age is determined by the age of cane when Pol % cane reaches a peak in the juice, where the highest point of the peak deteremines the maturity age (Acland, 1973; Hunsigi, 1993; Lingle and Irvine, 1994). Quadratic regressions of Pol % cane over 14 months growth period of the 26 varieties showed a steady increase over time in Pol % cane until reached a peak, then Pol % cane started to decrease thereafter, immediately or after sometime of stability.

Accordingly, the 26 varieties, were classified into three categories based on the earliness; early maturing (<11 months) including varieties L 2, 4, 12, 14, 15, 24, and 25; medium (11 to < 13 months) including varieties L 1, 3, 5, 6, 7, 8, 9, 10, 11, 13, 16, 17, 18, 19, 20, 22, 23, and 26; and late maturing (≥ 13 months) including variety L 21 (Table 2). Among these varieties, Cadmus and Co6806 were early maturing, and reached 15 Pol % cane as early as 8 months and maintained high Pol % cane up to the age of ≥ 13 months; whereas Q127, BT65152, and Cassius were medium maturing.

Under the experimental conditions, maturity occurred naturally in the absence of drought which would have forced sugarcane to mature earlier than normal (Hunsigi, 1993; Lingle and Irvine, 1994). Also, precaution had been taken to minimize fluctuation in juice quality by sampling cane after a minimum of 2 dry days. However, minor fluctuation around the smooth quadratic curve was observed. In practice, early maturing varieties allow harvesting to start earlier, mid maturing varieties form the core harvest, and late maturing varieties allow for extending the harvesting season. The sugar industry in India is based on covering (10; 81 and 9 %) of the area under sugarcane cultivation with early, mid and late maturing cane, respectively. The industry has a future plan to increase the area by early maturing cane to 20% (Singh and Gupta, 1999).

Maturity profile and production period

An early maturing variety with a prolonged production period, or overlapping of production periods among varieties would be desirable in prolonging the harvesting season an in making the cropping season more efficient, as it allows for early harvest and clearing land, which can be prepared for next crop (Hebert and Rice, 1972; Muchow et al., 1996; Singh and Singh, 1998; Gonzales and Galvez, 1998; Calderon et al., 1996; Hunsigi, 1993; Cuenya and Mariotti, 1996), however, varietal diversification should be maintained for sustainable production. Depending on the length of the production periods, an early maturing variety could also serve as mid-maturing or even late maturing variety. Similarly, a mid-maturing variety can serve as a late maturing variety. For example, the variety "Pindar" known as mid-maturing cane was sometimes used as early type, and the variety "Q57" known as early maturing cane was useful for mid-season harvesting (King et al., 1965). However, early maturing varieties are indispensable for a viable sugar

industry (Das et al., 1997), it remains important that early maturing varieties are made available to start the harvesting season early (Calderon et al., 1996; Singh and Singh, 1998). The maturity profiles of the 12 potential varieties showed that juice and cane parameters are variety-specific (Figure 1). The first three varieties matured in <11 months (early maturing), Co6806 (L 24), Cadmus (L14) and Co997 (L25), and the remaining nine varieties matured in ≥11 – 12 months (medium maturing), PS58, Co6519, BT65152, Q77N1232, Q136, Ragnar, Cassius, Q127 and PS57. The profiles reflect their maturity properties and development of relevant attributes over the growth period.

Table 2. Maturity profiles based on juice parameters of 26 varieties of sugarcane

Var. Code	Var. Name	Maturity category[a)]	Age, 15 Pol % cane first reached, (month)	Age, (Pol % cane declined to 15 (month)	Production period (month)
1	RB725143	M	N/A[b)]	N/A	N/A
2	JA60-5	E	N/A	N/A	N/A
3	R570	M	N/A	N/A	N/A
4	Q72N1325	E	N/A	N/A	N/A
5	B73385	M	N/A	N/A	N/A
6	Q77N1232	M	9.3	12.9	3.6
7	Q136	M	9.5	12.7	3.2
8	Q135	M	N/A	N/A	N/A
9	B72177	M	N/A	N/A	N/A
10	Q127	M	8.3	14.6	6.3
11	BT65152	M	8.0	13.8	5.8
12	Q177	E	N/A	N/A	N/A
13	Cassius	M	8.7	13.9	5.2
14	Cadmus	E	7.9	13.5	5.6
15	CoJ64	E	N/A	N/A	N/A
16	PS57	M	10.0	14.0	4.0
17	PS58	M	9.4	12.4	3.0
18	PS59	M	N/A	N/A	N/A
19	Co1111	M	N/A	N/A	N/A
20	Co1148	M	N/A	N/A	N/A
21	Co1158	L	N/A	N/A	N/A
22	Co6519	M	8.5	13.4	4.9
23	BJ6732	M	N/A	N/A	N/A
24	Co6806	E	7.9	13.0	5.1
25	Co997	E	8.6	12.9	4.3
26	Ragnar	M	8.9	13.4	4.5
Mean			7.90	12.40	3.00
Min			10.00	14.60	6.30
Max			8.75	13.38	4.63
SD.			0.6856	0.6298	1.0446
SE.			0.1979	0.1818	0.3016

[a)] E = Early, M = Medium, L = Late; [b)] N/A = Not assessed

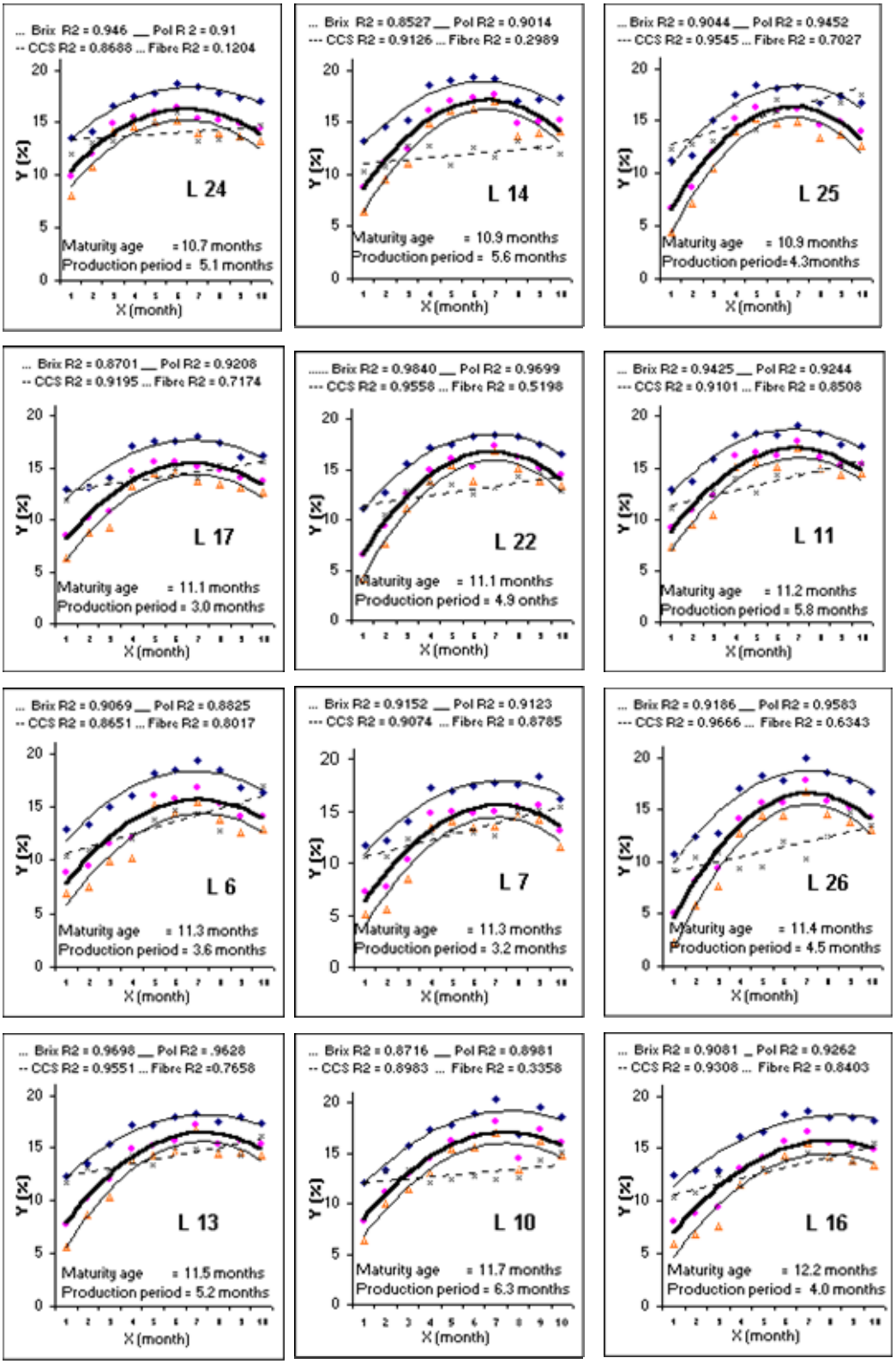

Figure 1. Curve showing trends of Pol, Brix, CCS and Fibre % cane of 12 potential varieties.

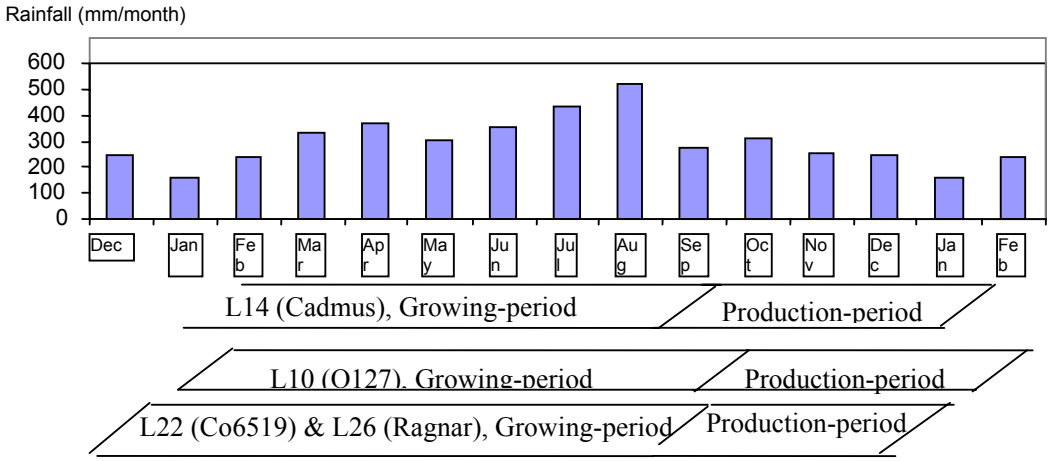

Figure 2. Possible cropping patterns involving four promising varieties of sugarcane with different maturity age and production period

Early maturing varieties with long production period would serve as mid-maturing or even late maturing variety. Similarly, a mid-maturing variety would serve as a late maturing variety. For example, the variety "Pindar" known as mid-maturing cane was sometimes used as early maturing type, and the variety "Q57" known as early maturing cane was useful for mid-season harvesting (King et al., 1965).

CONCLUSION

- Evaluation of 26 sugarcane varieties for maturity earliness and systematic selection of superior varieties maybe based on high Pol % cane of 15, high Brix % cane, high purity, high CCS, high TSH, indicating of obtaining 12 superior varieties.
- Their maturity profiles showed that three varieties of Co6806, Cadmus and Co997 as early maturing (<11 months) and the nine other varieties are medium maturing (matured at 11.1 to 11.7 months).
- The suggested cropping pattern offers an efficient cropping season and maintains varietal diversi-fication by combining variety having different maturity-earliness and production period for sustainable production.

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