

MATURITY DIFFERENCES BETWEEN VARIETIES IN THE SELECTION PROGRAMME

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Abstract

Cane quality data obtained from trials in the selection programme were examined to detect varieties with abnormally early or late maturing characteristics. All varieties studied reached peak sucrose content in September. However, the rate at which sucrose level increased during the season varied according to variety. In the variety CP66/1043, 11 month cane was millable by February, yielding an 11.0% sucrose content and a juice purity of 85%. Another variety 69W244 achieved these figures only in August but was a productive variety if harvested after August. Differences in rate of reaching maturity between varieties was marked in irrigated cane harvested annually, while differences were smaller in rainfed cane harvested on a longer cropping cycle. Early maturity tends to be a feature associated with varieties with a high inherent sucrose content but there were indications that early maturing characteristics may be present in varieties of average sucrose content. Although varieties showing useful extremes in early maturity are rare, sampling of selection trials early in the season to detect such varieties, is considered advisable.

Introduction

Sugarcane varieties are commonly designated as early, mid-season, or late maturing according to an assessment of their optimum time of harvest⁶. There are few, if any varieties that can be defined as early maturing in that the sucrose content of the variety reaches a maximum early in the season and then declines. Rather so called early varieties are those that have a relatively high sucrose content early in the season which continues to increase until the latter part of the season if not harvested.

Most of the research into maturing times of different varieties has been carried out in Florida, although Lingerfelt *et al*⁸ recommended optimum harvest times for varieties grown in the Dominican Republic. Herbert and Rice^{4, 5} studied the maturity patterns of both new and commercially grown varieties in Florida by comparing the sucrose levels of different parts of the stalk. Varieties with small differences in sucrose content between top and bottom parts of the stalk were considered to be mature. They found that varieties differed in degree of maturity particularly early in the season. Miller and James⁹ found recently that varieties which were recognised commercially as being early, mid or late season, differed in the time at which they reached the maximum yield of sucrose per hectare. They also noted that the early maturing varieties were seldom harvested when their sucrose yields were maximal but were harvested early because they had higher sucrose contents than other varieties at that time.

Gosnell and Koenig³ concluded that the optimum times for harvesting the four varieties grown in Zimbabwe were: NCo 310, August and September; CP29/116, November and December; Co 462, October to December and NCo 376 throughout the year. In a later trial Lonsdale and Gosnell⁷ showed that each of these varieties reached the maximum sucrose content at different times of the year.

In South Africa little attention has been given to varietal differences in time of maturity, partly because the average

age of cane at the time of harvesting is 19 months and differences in time of maturity are less important in such circumstances.

There is now considerable area of cane grown under irrigation on a twelve month cycle, and the breeding of varieties suited to relatively short cutting cycles could be justified here.

Variety Selection Programme

The selection programme practised at Mount Edgecombe is as described by Brett². The number of seedling tested annually has increased substantially and selection is carried out over a wider range of environmental conditions. The programme has been divided into northern and southern areas and new harvesting schedules have been introduced concurrently, so that cane quality can be studied more thoroughly throughout the season.

TABLE 1
Variety Selection Programme

	Selection Phase		Evaluation Phase	
	Site/No. of original seedlings	Crop cycle (months)	Secondary Variety Trials	Conditions
Northern areas	Pongola (45 000)	12	Eastern Tvl Swaziland (Mhlume) Swaziland (Ubombo) Pongola	Irrigated
Southern areas	Shakaskraal (25 000)	14	Shakaskraal Experiment Station	Rainfed + poor drainage
	Experiment Station (15 000)	14	U.V.S.	Deep soil Alluvium
	Mtunzini (25 000)	18	La Mercy Mtunzini	Average soil Poor drainage
	Central Field Station (25 000)	18	Central F. S.	Sandy soil
	Windy Hill (7 500)	24	Windy Hill	High altitude

The programme is divided into a selection phase and an evaluation phase (Table 1). The selection phase, which includes the four stages from single stools to the primary variety trial, involves the identification of clones which are of near commercial standard. These are tested further in the evaluation phase which involves secondary variety trials which last until the second or third ratoon crops.

The harvesting schedule for the secondary variety trials is arranged in such a way that cane quality data are obtained throughout the milling season (Table 2).

In the northern area programme, ratoon crops are harvested at 13 months (except those of the trial planted in spring at Pongola) which means the date of harvest changes

TABLE 2
Harvesting schedule for Plant Breeding Secondary Variety Trials

Selection Category	Trial Site	Month of sampling/harvesting									
		March	April	May	June	July	August	September	October	November	December
Northern areas	Eastern Transvaal ..	O _p *	O _p	X _p	X ₁	X ₂	X ₃				
	Mhlume	O _p	O _p	X _p	X ₁	X ₂	X ₃				
	Umbombo	O _p	O _p	X _p	X ₁	X ₂	X ₃				
	Pongola	O _p	O _p	X _p	X ₁	X ₂	X ₃				
	Pongola (Spring) ..	O ₃	O ₂	O ₃ O ₁	O ₂ O _p	O ₁	O _p X ₃	X ₂	X ₁	X _p	
Southern areas (18 month cycle)	Mtunzini	O _p	O _p	X _p	O ₁		O ₁			X ₁	
	Central Field Station	O _p	O _p	X _p	O ₁		O ₁			X ₁	
	Windy Hill	O _p	O _p	X _p	O ₁		O ₁			X ₁	
	La Mercy	O _p	O _p	X _p	O ₁		O ₁			X ₁	
Southern Areas (14 month cycle)	Shakaskraal	O _p	O _p O ₁	O ₁ X _p	O ₁ O ₂	O ₁	O ₂ X ₁	X ₁	X ₂		
	U.V.S.	O _p	O _p O ₁	O ₁ X _p	O ₁ O ₂	O ₁	O ₂ X ₁	X ₁	X ₂		
	Experiment Station ..	O _p	O _p O ₁	O ₁ X _p	O ₁ O ₂	O ₁	O ₂ X ₁	X ₁	X ₂		

X_p = Harvest Plant Cane O_p = Pre-harvest sample plant cane
 X_{1..3} = Harvest 1st...3rd ratoon O_{1..3} = Pre-harvest sample 1st...3rd ratoon
 * Pre-harvest sampling in first, second and third ratoons omitted for sake of clarity

by one month in successive ratoons. The trial planted in spring at Pongola is harvested after 11 months and so harvesting occurs one month earlier with each successive ratoon.

Trials within each selection category contain the same varieties and a monthly mean for any particular quality component may be calculated for each variety. The monthly mean values for all varieties may also be calculated to provide values for the average maturity curve. Assuming that a particular variety follows this average curve the predicted value in any particular month may be determined by the formula :

$$p_{ij} = V_i + (M_j - GM)$$

where p_{ij} is the predicted value for the ith variety in the jth month

V_i = the mean value for the ith variety for all sites.

M_j = the mean value for the jth month of all varieties.

GM = mean value for all varieties and all months.

The residual values expressing varietal deviation from the average were then calculated from the formula :

$$q_{ij} = v_{imj} - p_{ij}$$

where v_{imj} is the mean value for the ith variety in the jth month.

Varieties showing positive residual values had higher values than average for the character being examined, (early if occurring in the first part of the season) and negative values showed the variety to be lower than average.

Residual values were calculated for trials in the three selection categories which included a total of 103 varieties. Components studied were juice purity, sucrose percent cane, brix percent dry matter, dry matter percent cane and fibre percent cane.

Results

Differences in maturity between varieties were slight in the selection categories for rainfed cane. The low rainfall of 1979 and 1980 must have contributed to this result, because sucrose and purity levels were already high early in the season. In the trials with a cropping cycle of 18-months the average sucrose content was 14,0% and purity

TABLE 3
Table of residual values for purity showing varieties with highest and lowest values in rainfed selection category

Variety	Mar.	Apr.	May	July	Aug.	Nov.	Purity mean value
71L44 ..	-1,4	-1,2	-0,1	-1,0	1,6	2,1	84,3
70W1019 ..	1,8	1,6	0,1	-0,9	-1,3	-1,3	89,7
Trial							87,7

TABLE 4
Table of residual values for sucrose percent cane showing highest and lowest varieties in southern area selection category

Variety	Mar.	Apr.	May	July	Aug.	Nov.	Sucrose % mean
71L44 ..	-0,1	-0,3	-0,1	-0,2	0,5	0,2	11,8
70W1019 ..	0,3	0,8	0,2	-0,5	-0,6	-0,2	14,6
Trial							13,3

was 90% in May, and there was little difference in earliness of maturity between the varieties. Tables 3 and 4 show the varieties with the highest and lowest residual values.

Table 3 shows that the mean purity of 70W1019 was slightly higher than the trial average and occurred early in the season. This was not the case for variety 71L44. However, the advantages of early or late harvesting as far as sucrose levels are concerned, are negligible. This does not imply that the lower sucrose variety 71L44 was as suited to early cutting as 70W1019, because 71L44 may be of unacceptable milling quality early in the season, due to its low sucrose content.

Data obtained from the northern irrigated area selection category show much greater difference between varieties. The residuals for purity and sucrose percent cane for some of the varieties in these trials, are shown in Tables 5 and 6 respectively.

These figures show the advantage of cutting variety CP66/1043 early in the season; its best yield of sucrose relative to the other varieties in the trial would have been obtained in March. Assuming a constant cane yield, variety

TABLE 5
Table of residual values for purity for some of the northern irrigated category of varieties

Variety	Mar.	Apr.	May	July	Aug.	Oct.	Purity mean
CP66/1043	7,4	2,3	-0,3	-0,5	-5,5	-4,1	89,7
74F2243 ..	5,6	0,9	0,1	-0,2	-4,3	-2,0	84,9
74F2484 ..	-5,6	-4,7	-0,1	1,5	3,0	6,0	75,3
69W244 ..	-4,5	-2,0	-1,2	1,4	3,7	2,8	76,8
68W607 ..	1,9	2,0	1,7	-0,9	0,5	-5,0	73,5
Trial							79,8

TABLE 6
Table of residual values for sucrose percent cane for some of the northern area irrigated category of varieties

Variety	Mar.	Apr.	May	July	Aug.	Oct.	Sucrose % mean
CP66/1043	1,4	1,2	0,3	-0,7	-0,8	-0,4	15,6
74F2243 ..	0,6	0,1	-0,4	-0,1	-0,7	0,4	13,3
74F2484 ..	-0,9	-1,0	-0,2	0,1	0,6	1,3	10,1
69W244 ..	-0,4	-0,3	-0,2	-0,1	0,7	0,3	10,8
68W607 ..	1,2	0,8	0,7	0,3	-0,4	-2,6	9,1
Trial							11,5

TABLE 7
Sucrose yield of varieties harvested in March and September

Variety	Yield t ha	March harvest		September harvest	
		Sucrose % cane	Sucrose yield as % of trial	Sucrose % cane	Sucrose yield as % of trial
CP66/1043 ..	129	13,7	139	17,8	105
74F2243	140	10,7	118	16,3	104
69W244	170	7,1	95	13,7	107
74F2484	157	5,9	73	14,0	93
NCo 376	175	7,2	99	13,6	109

69W244 would similarly have yielded best, if harvested in August.

Amongst other varieties in the table are examples of a local variety 74F2243 showing earliness and a variety 74F2484 which compared most favourably with other varieties in the trial conducted in October.

The calculation of the residual values enables a number of varieties to be checked quickly for early or late maturing characteristics. Varieties identified as having these qualities may be examined more thoroughly. The purity and sucrose values of several varieties showing early and late maturing qualities have been plotted against time of year in Figures 1 and 2.

The introduced variety CP66/1043 is relatively mature in terms of juice purity in early February. In contrast 69W244 was immature in February but matured rapidly during the season and by September its degree of maturity was comparable with that of CP66/1043. The sucrose contents of these two varieties are shown in Figure 2. Cane variety CP66/1043 is millable in February whereas variety 69W244 has a sucrose content of only 5% at this stage. The variety 74F2243 is an example of a locally selected early variety while 74F2484 was a very late variety.

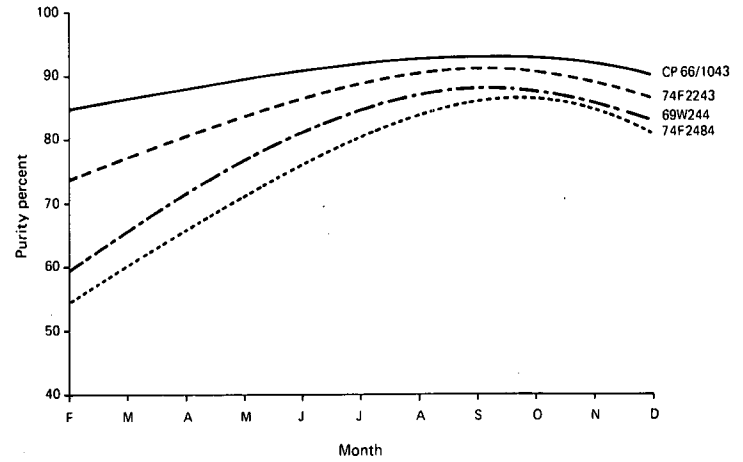


FIGURE 1 Purity of four varieties plotted against month of year.

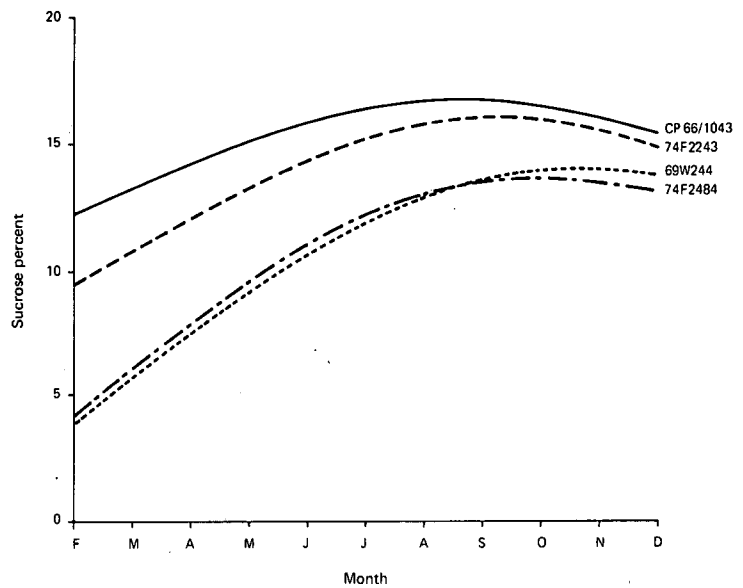


FIGURE 2 Sucrose content of four varieties plotted against month of year.

The effect on yield of sucrose per hectare of cutting these varieties at different times of year, was calculated for March and September harvests (Table 7).

Both CP66/1043 and 72F2243 outyielded NCo 376 substantially when harvested in March. When harvested in September however, both varieties yielded less than NCo 376. Although 74F2484 yielded less than NCo 376 at both harvesting times, the difference was considerably less in September than in March.

Other components of quality

Within any one trial, the average change in figures for fibre percent cane and brix percent dry matter was minimal during the season, despite marked differences between varieties. The dry matter percent cane, however, showed seasonal variation; low at the beginning of the season and rising to a peak in September. In addition there were considerable differences between varieties. The two varieties which differed most, are compared in Table 8.

There was a notable similarity between values for CP66/1043 in March and those of 69W244 in September. The cane of CP66/1043 had a relatively low water content in March. Not only was there more dry matter in the stalk than in variety 69W244, but there was also more brix in the dry matter and more sucrose in the brix, resulting in a much higher sucrose content in CP66/1043.

TABLE 8
Comparing quality analyses of two cane varieties in March and September

March				September			
CP66/1043		69W244		CP66/1043		69W244	
Dry matter % 26,2	Water % 73,8	Dry matter % 19,3	Water % 80,7	Dry matter % 29,5	Water % 70,5	Dry matter % 26,9	Water % 73,1
Brix % 15,3	Fibre % 10,9	Brix % 10,9	Fibre % 8,4	Brix % 19,4	Fibre % 10,1	Brix % 16,0	Fibre % 10,9
Sucrose % 13,7	Non-Sucrose % 1,6	Sucrose % 7,1	Non-Sucrose % 3,8	Sucrose % 17,8	Non-Sucrose % 1,6	Sucrose % 13,7	Non-Sucrose % 2,3

TABLE 9
Correlations between attributes of cane quality measured in March and September

Component	Sucrose % March	Sucrose % September	Dry matter % March	Dry matter % September	Fibre % March	Fibre % September
Sucrose % March	—	0,52	0,78	0,19	0,31	-0,37
Sucrose % September		—	0,49	0,74	0,24	-0,10
Dry matter % March			—	0,23	0,73	-0,29
Dry matter % September				—	0,21	0,57
Fibre % March					—	-0,004

Least significant difference (5%) 0,3

Regression analyses were carried out on the sucrose, dry matter and fibre components of cane quality.

Sucrose and dry matter contents of the cane correlated strongly particularly in March (Table 9). Sucrose content was positively correlated with fibre content early in the season but was independent of fibre content later in the season.

Discussion

The use of data from routine selection trials to investigate maturity patterns in varieties has limitations. Such data are collected from several trials sampled at different ages, sites, and stage of ratooning and trends of maturity may be confounded by these factors. However, comparisons between varieties may be made using the residual values since the effects of age, site, and stage of ratooning have been removed.

The present study was based on plant cane data and additional information for first, second, and third ratoon crops will result in a clearer understanding of varietal maturity. The larger number of quality determinations would permit a meaningful curve to be plotted for any particular variety, using multiple regression analysis techniques (Albertsen *et al*¹).

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