SUCROSE % CANE FOR THE SEASON AND OTHER QUALITY FACTORS AS RELATED TO RAIN PRIOR TO THE SEASON

By E. L. BROWNE

Illovo Sugar Estates Limited

Abstract

The relationships between final sucrose % cane for the season, and the rainfall prior to the start of the season are tested using statistical methods. A strong negative correlation is established between final sucrose % cane for the season and rainfall in February to May preceding the season. A strong positive relationship between moisture % cane for the season and rainfall in February to May preceding the season is established.

These findings lead to the hypothesis that the maturity potential of the cane is determined by rainfall conditions experienced by the cane plant in late summer and early autumn.

Introduction

The work reported in this paper was initiated after Hardy[10] at Doornkop found an interesting strong negative correlation ($r = -0{,}92$) between final sucrose % cane for his Estate and the rainfall recorded before the beginning of the season, viz. rainfall for March + $\frac{1}{2}$ (April + May), over a period of six years. Considering data from Illovo's Powerscourt and Coastal Sections, similar yet weaker correlations were found.

Following on the fact that the Doornkop results could be reproduced at Illovo it was decided to investigate the matter in more detail.

The information used in the exercise was recorded in four geographic areas which can be briefly described as:—

(1) Coastal Sections (Illovo): Being land lying between 0-75 metres above sea level and producing an 11 year mean of about 80 000 metric tons of cane annually. About one-fifth of the section is serviced by supplementary overhead spray irrigation, yet no account of this fact has been taken when considering the rainfall or moisture regime effects on cane quality.

(2) Powerscourt Section (Illovo) is a cooler upland section, situated at between 700 - 750 metres above sea level. The mean annual production from this section is 85 000 tons cane.

(3) Seven Oaks Section (Noodsberg) is situated in the Natal Midlands at an altitude of 900-1 000 metres above sea level, and supplies cane to the Jaagbaan factory of Noodsberg Sugar Company.

Meteorological data used were obtained from meteorological sites in each area. The time span covered was limited by the availability of meteorological data on a daily basis and for Coastal sections was 1961 to 1972, Powerscourt 1963 to 1972 and Seven Oaks 1966 to 1973. In the case of Seven Oaks, the first crop from the section was harvested in 1966.

In some instances, where greater detail of cane composition was needed, the Illovo Mill data were used. The Illovo Mill draws cane from its Coastal and Powerscourt Sections (described in 1 and 2 above) and also from Growers whose farms are situated mainly in the Eston and Mid-Illovo areas. While Eston and Mid-Illovo are further inland than Powerscourt, it has been assumed that the rainfall which accounts for the mill cane, is the average of Coastal plus Powerscourt rain.

Weather quality relationships

On reviewing the literature available on the subject, it is obvious that the relationships found in this study are by no means unique. Halais[8] reports that in Mauritius the dominant factors in determining cane maturity are the mean minimum temperatures during May to June and the rainfall during the period August to October. The latest available figures reported by Halais[9] are for the decade 1960 to 1970 and show a dependance as set out in equation (i):

$$\text{S.M. (f)} = 17{,}00 - 0{,}247\ \text{Tni} - 0{,}00339\ P_2 \quad \text{.....(i)}$$

where S.M. (f) = Sugar Made % Cane for the season,

Tni = Mean minimum temperature in °C for May, June, July,

and P_2 = Total rainfall in mm for August, September and October.

It must be noted that Halais feels that equation (i) above has no predictive value and can only be used to explain and rationalise the observed sugar made % cane values from year to year.

Chardon[3] in 1962, found that for the period 1948 to 1961, a strong negative correlation existed between mean average temperature in San Juan from January to March each year, and the yield of pounds of sugar per ton of cane for the island of Puerto Rico. Shoji and Samuels[11] in explaining decreased sugar yields in Puerto Rico for the period 1952 to 1963 found that temperature and rainfall were the most important climatic factors determining cane quality. Combining these two factors with length of season, they generated a regression equation (ii) which accounted for 83% of the variation in sucrose % cane for the season.

$S\%C = 49{,}14 - 0{,}5144X_1 - 0{,}0366X_2 - 0{,}0121X_3$... (ii)

Where $S\%C$ = Sucrose % cane for the season,

X_1 = mean minimum temperature December to April,

X_2 = rainfall in inches January to May,

X_3 = number of days in the grinding season.

"t" for X_1 = 10,57*

"t" for X_2 = 2,20

"t" for X_3 = 3,21

In South Africa, du Toit[5] has reported that weather conditions during March to June largely determine the sucrose content of the subsequent season. Considering the period 1928 to 1955, but excluding the 1934 locust invasion year, du Toit established a strong correlation coefficient (r = 0,801) between sucrose % cane for the season and the March to June hours of sunshine combined with March to June rainfall preceding the season.

Glover[6] has also reported sucrose weather relationships, but of a different nature. Studying the effect of rainfall on sucrose % cane Glover found that at two South African factories, namely Tongaat and Jaagbaan, a strong negative correlation existed between sucrose % cane and rainfall occurring six weeks prior to sucrose measurement.

The difference in the nature of Glover's report and that of the other reports is that Glover is reporting an immediate result of rainfall i.e. within six weeks of rainfall a sucrose decline occurs, where in the case of the other reports it is not an immediate effect which is reported but an effect which mainfests itself as a preconditioning of the cane for the whole season.

Results of initial analysis of Illovo data

The sucrose % cane data, used in the initial analysis are embodied in Table I. It must be noted that this sucrose % cane is the final figure of the whole season. Table II contains the monthly rainfall in millimetres recorded at the various meteorological sites and it also contains the mean soil moisture in millimetres by month in the various areas. It was decided to use soil moisture, as well as rainfall, as an indicator of wetness because when rainfall was used, especially on a monthly basis, it suffered from the fact that it did not take into account firstly the effectiveness of rainfall and secondly the weather that had occurred immediately prior to the period under consideration. Over longer periods, say 3 to 4 months, the problem was not as acute. For example if the April Coastal sections data in Table II for 1967 and 1968 are considered it will be seen that, while in April 1968 there was more rain than in April, 1967, the mean soil moisture in 1967 was higher than the corresponding characteristic for 1968. The reason for this apparent contradiction is that the 131 mm of rain recorded in April 1968 was not fully effective, in that 129 mm fell during the first few days of the month. This means that April was a dry month relative to the cane plant, and this is reflected in the lower mean soil moisture. The lesser rain in April 1967 was more evenly spread than in 1968, but more importantly, well distributed rains in March 1967 meant that the soil moisture reserve was high during the first part of April 1967, hence April 1967 was a wet month relative to the cane plant. This is indicated by the mean soil moisture for the month. The calculation of mean soil moisture was based on the method described by Thompson and Collings[12] but using the following constants: Total available moisture in the rooting zone was assumed to be 75 mm and the potential daily evapotranspiration

TABLE I

Final sucrose % cane for season, for various seasons from the Illovo Coastal and Powerscourt Sections and from Seven Oaks Estate

Season	Final Sucrose % cane for Season		
	Coastal	Powerscourt	Seven Oaks
1961-62	12,69	—	—
1962-63	12,55	—	—
1963-64	13,06	14,08	—
1964-65	14,35	13,20	—
1965-66	13,08	13,25	—
1966-67	13,62	13,45	11,70
1967-68	12,48	12,37	11,50
1968-69	13,34	13,31	11,80
1969-70	12,73	12,70	11,20
1970-71	13,76	14,27	13,80
1971-72	13,11	13,10	11,90
1972-73	—	—	12,80

TABLE II

Precipitation (P) per month and mean soil moisture (SM) per month in millimetres for the various centres

Year	COASTAL SECTIONS								POWERSCOURT SECTIONS								SEVEN OAKS ESTATE							
	Feb.		March		April		May		Feb.		March		April		May		Feb.		March		April		May	
	P	SM	P	SM	P	SM	P	SM	P	SM	P	SM	P	SM	P	SM	P	SM	P	SM	P	SM	P	SM
1961	44	56	104	31	269	60	62	59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1962	133	53	219	44	39	30	48	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1963	35	43	225	56	20	26	25	4	54	12	187	37	13	10	5	1	—	—	—	—	—	—	—	—
1964	34	42	66	14	72	18	14	16	53	35	62	12	86	17	4	6	—	—	—	—	—	—	—	—
1965	111	40	32	14	23	2	114	4	73	21	41	7	12	1	82	3	—	—	—	—	—	—	—	—
1966	75	49	17	2	73	25	124	28	82	51	12	2	35	3	90	25	129	63	53	21	98	53	50	37
1967	80	63	185	51	106	65	3	10	163	63	199	49	90	63	4	11	122	64	177	63	76	68	27	48
1968	81	54	209	55	131	37	13	1	78	51	104	48	19	5	4	1	78	38	100	54	50	32	5	1
1969	73	20	210	64	102	65	170	61	82	11	137	54	71	48	69	25	188	38	240	61	75	60	49	44
1970	71	30	36	3	37	6	143	15	44	23	37	3	28	2	43	13	106	68	56	62	58	36	42	44
1971	121	63	126	62	81	50	150	48	112	67	204	64	73	45	155	73	119	58	111	57	102	67	104	64
1972	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	119	37	103	57	73	47	76	59

was assumed to be 5,1 mm, 4,8 mm, 3,6 mm and 2,7 mm for February, March, April and May respectively, in all years for all centres. While the potential daily evapotranspiration obviously differs from year to year and from centre to centre, it is felt that the error introduced by assuming evapotranspiration to be the same in different centres and in different years, was not sufficient to invalidate the results of the investigation.

The results of the initial correlations of the data contained in Tables I and II have been summarised in Table III.

TABLE III

Coefficients of correlation between sucrose % cane for the season in a particular area and the rainfall and soil moisture for a particular period prior to the season, for the years 1961 - 1971 at Illovo, 1963-1971 at Powerscourt and 1966-1972 at Seven Oaks

Period	Coefficient of Correlation					
	Illovo		Powerscourt		Seven Oaks	
	Rainfall	Soil Moisture	Rainfall	Soil Moisture	Rainfall	Soil Moisture
February	−0,395	−0,274	−0,774*	−0,431	−0,434	+0,274
March	−0,600*	−0,614*	−0,375	−0,501	−0,631	+0,208
April	−0,271	−0,626*	−0,708*	−0,782*	−0,367	−0,583
May	−0,022	−0,325	−0,095	−0,219	−0,152	−0,310
M+½A+½M	−0,694*	−0,705*	−0,483	−0,600	−0,627	−0,329
M+A+M	−0,639*	—	−0,500	—	−0,565	—
F+M+A+M	−0,716*	−0,658*	−0,772*	−0,630	−0,551	+0,050
15 February - 15 March	—	−0,672*	—	−0,544	—	+0,665

*Statistically significant at 5% level

A study of these results reveals:

(i) On Coastal Sections, sucrose % cane for the season is fairly strongly negatively correlated with rainfall in March, but hardly so with rainfall in April and May as separate months, yet when rainfall over the longer period March+½ (April + May), or March, April, May is considered a negative correlation of some consequence is again established. With regard to rainfall, it appears that rainfall from February to May inclusive has the strongest correlation with final sucrose % cane recorded in the subsequent season. If it is a fact that wetness relative to the cane plant's requirement is the more precise factor to consider, then the usefulness of soil moisture as a measure of wetness is shown by the fact that in all cases the correlation coefficient is improved by using soil moisture rather than rainfall. This is especially the case when April is considered. Here the correlation coefficient is improved from −0,271 to −0,626 by the use of mean soil moisture as a measure of wetness. This does not hold true over the longer period February, March, April, May which is to be expected. As will be noted from Table III, one of the periods considered was that from 15 February to 15 March. The reason for choosing this period was that the weather experienced during this period determined whether or not cane would flower in the subsequent year[7]. Hence if weather, especially rainfall from 15 February to 15 March, could determine flowering in the subsequent season, there was a possibility that the same weather could determine sucrose % cane for the following season. From the data in Table III, that is a coefficient of correlation (r = −0,672), no definite conclusion can be drawn but when the regression of sucrose % cane for the season on mean soil moisture 15 February to 15 March is considered, then 85% of the variation in sucrose % cane for the season can be explained by the parabolic relationship described in the regression equation (iii).

$$S\ \%\ C\ (c)\ (f) = 15{,}215 - 0{,}107 SMC_{f\text{-}m} + 0{,}001 (SMC_{f\text{-}m})^2 \quad \ldots\ (iii)$$

where

S % C (c) (f) = Sucrose % cane for the season on Coastal Sections

and $SMC_{f\text{-}m}$ = Mean soil moisture 15 February to 15 March before the season on the Coast.

(ii) Turning to Powerscourt, the strong negative correlations between rainfall and sucrose % cane in the subsequent season are as to be expected for February and April rainfall but the weak relationship which results when March rainfall is considered by itself or in combination with other month's rainfall, is disturbing. On examination of the data it was found that the March rainfall, final sucrose % cane, correlation coefficient (r = −0,483) for the nine years studied could be improved to a highly significant level of r = −0,872 if the data for 1963-64 and 1971-72 seasons were ignored. Of note in these seasons was the fact that:—

(*a*) the mean age of cane in the 1963-64 season was 31,0 months compared to a nine year mean of 23,2 months. (Note 1971-72 season mean age = 24,8 months, not very different from the 9 year mean)

and (*b*) the rainfall in March, 1963 and 1971 was amongst the highest recorded over the nine years considered.

Another point of difference between Powerscourt and Coastal results is that the use of soil moisture as an indicator of wetness does not improve the relationship studied, and in fact generally reduces the strength of the relationship. The reason for this reversal at Powerscourt cannot be explained.

As was the case at Illovo the mean soil moisture recorded from 15 February to 15 March could be used to explain 64% of the variation in final sucrose % cane from season to season. This was the case where the parabolic regression equation (iv) was considered. (The linear equation only explains 29,6% of the variation):

$$S\,\%\,C\,(p)\,(f) = 14{,}57517 - 0{,}08871\ SMP_{f\text{-}m} + 0{,}00103\ (SMP_{f\text{-}m})^2 \quad \ldots\ldots \text{(iv)}$$

Where:

S % C (p) (f) = Sucrose % cane for the season for Powerscourt.

$S\ M\ P_{f\text{-}m}$ = Mean soil moisture for period 15 February to 15 March, prior to season at Powerscourt.

(iii) The data from Seven Oaks showed no statistically significant correlations. However the strength of the correlations of March rainfall and combinations of March and other periods of rainfall with sucrose is encouraging. The fact that all the correlation coefficients, with respect to season sucrose and rainfall prior to the season, were negative also points to a depressing effect of rainfall prior to the season on the sucrose % cane for the season. The complete lack of relationship and even of reversal of relationship which is evident when the correlation coefficients of mean soil moisture and sucrose for the season are considered, is perplexing.

The fact that the area is new, i.e. the soils were under wattle prior to 1965, and the higher altitude with cooler conditions may explain the lack of relationship, which was so evident when coastal conditions were considered. The cold factor was brought into the picture by calculating multiple linear regression equations using rainfall in March + ½ (April + May), which alone explained 40% of the final sucrose variation from year to year and the mean minimum temperatures recorded at Seven Oaks in March, April and May each year. While mean minimum temperature in March did not appear to increase the strength of the relationship i.e. ($R^2 = 0{,}39$), 63% and 55% of the variation in final sucrose could be accounted for by the introduction of a minimum temperature factor, for April and May respectively.

Length of season effects

The length of the season obviously has a strong effect on sucrose % cane for the season, in that the longer the season, the greater the proportion of lower sucrose % cane sent to the factory. On its own, length of season can only be used to explain some 25% of the variation in final sucrose % cane from year to year. This was established by studying 40 years of data from the Illovo factory. Combining length of season in days with the rainfall experienced in February, March, April and May on the Coast, 60% of the variation in final sucrose can be explained, relative to 50% when rainfall only is used.

At Powerscourt there is no improvement in the relationship by including length of season as a factor.

Longevity of weather effects on quality

While it can be seen that sucrose % cane can be affected by rainfall occurring 6 weeks earlier as reported by Glover,[6] the results of the initial analysis of Illovo Coastal data, and to a lesser degree the Powerscourt and Seven Oaks data, show that the final sucrose % cane for the season, appears to be related to weather conditions occurring early in the year. This agrees with du Toit's findings and the findings of Halais,[9] Shoji and Samuels[11] and Chardon.[3] In an effort to establish exactly how long the effects of weather early in the season are felt, correlations and regressions were calculated for the to-date sucrose % cane

TABLE IV

Sucrose % cane to-date at the end of each month and final season sucrose % cane from Illovo Coastal and Powerscourt Sections from 1966-67 to 71-72 Season

Season	Centre	SUCROSE % CANE TO-DATE											
		M	J	J	A	S	O	N	D	J	F	M	Final
	Coastal	13,84	13,53	13,72	13,83	13,99	14,07	14,18	14,10	14,00	13,83	13,62	13,62
1966-67	P'court	12,22	13,46	13,67	13,90	14,04	14,10	14,08	13,96	13,81	13,60	13,45	13,45
	Coastal	11,86	12,00	12,40	12,78	13,17	13,30	13,31	13,21	13,08	12,78	12,48	12,48
1967-68	P'court	12,17	12,32	12,50	12,60	12,73	12,85	12,90	12,86	12,77	12,60	12,37	12,37
	Coastal	12,01	13,22	13,55	13,57	13,60	13,65	13,56	13,48	13,46	13,34	—	13,34
1968-69	P'court	13,87	13,93	14,21	14,21	14,04	13,91	13,70	13,52	13,43	13,31	—	13,31
	Coastal	11,53	12,05	12,39	12,53	12,76	12,91	12,97	12,89	12,73	—	—	12,73
1969-70	P'court	12,44	12,58	12,82	13,10	13,15	13,10	12,90	12,75	12,70	—	—	12,70
	Coastal	12,43	13,38	13,50	13,73	13,99	14,00	14,01	13,87	13,76	—	—	13,76
1970-71	P'court	14,42	14,80	14,75	14,77	14,86	14,82	14,70	14,55	14,27	—	—	14,27
	Coastal	12,02	12,17	12,61	12,88	12,98	13,12	13,23	13,27	13,18	13,11	—	13,11
1971-72	P'court	12,17	12,43	12,69	12,73	12,85	12,94	13,07	13,14	13,10	13,10	—	13,10

by months on Coastal and Powerscourt Sections, and the rainfall in millimetres from February to May preceding the season. Table IV contains the to-date sucrose % cane by months and by Sections for the 6 years 1966-67 to 1971-72. The period under consideration is limited by the availability of monthly to-date sucrose by Sections.

TABLE V

Coefficients of correlation between sucrose % cane to-date at various month ends and the rainfall recorded in millimetres during February to May in the preceding period, at Illovo Coastal and Powerscourt Sections, during the years 1966 to 1971

To-date month end	Coefficient of Correlation "r"	
	Illovo	Powerscourt
May	−0,745	−0,922
June	−0,715	−0,902
July	−0,683	−0,912
August	−0,795	−0,948
September	−0,899	−0,936
October	−0,909	−0,916
November	−0,917	−0,728
December	−0,894	−0,778
January	−0,874	−0,771
Season	−0,616	−0,772

Level of significance, 4 D.F. 5% = 0,811
1% = 0,917

The results of the statistical analyses are set out in Table V.

One of the first observations to come out of the to-date sucrose % cane study was the importance of length of season. This factor has been discussed earlier in the paper. However, the more important finding is the fact that rainfall during February, March, April and May at the beginning of the season, has an increasing effect on the to-date sucrose % cane, through to November on the coast and through to August at Powerscourt, and a strong but lesser effect through to January on the Coast and October at Powerscourt.

From regression analysis, 84% of the variation of November to-date sucrose % cane on the coast and 86% at Powerscourt could be explained by regression equations (v) and (vi) respectively.

$$S \% C (c) (n) = 15,1698 - 0,00404 \, Pc \ldots . (v)$$

$$S \% C (p) (n) = 17,8450 - 0,0259 \, P_p + 0,000032 P_p{}^2 \ldots . (vi)$$

Where

S % C (c) (n) = Sucrose % cane to-date in November for Coastal sections.

S % C (p) (n) = Sucrose % cane to-date in November for Powerscourt Sections.

Pc = rainfall in millimetres from February to May at the Coast.

Pp = rainfall in millimetres from February to May at Powerscourt.

Initial hypothesis

From all the foregoing results it is therefore hypothesised that the weather conditions experienced during late summer and early autumn, especially the wetness of this period relative to the cane plant, condition the cane to react to sucrose determining stimuli that occur later in the season. In other words the "maturity potential" of the cane is determined before the season begins.

This hypothesis is supported by work done by Alexander [1,2] who showed that if the sucrose biosynthesis process was "shocked" or partially destroyed by an inhibitor, or stress then when the plant recovered it was possible for it to over-compensate by providing more biosynthesis potential than was originally available. This was shown firstly by using Diuron as an inhibitor of sucrose biosynthesis in *in vitro* studies. The inhibition was competitive and easily countered by adding fructose to the reaction digest. By adding still higher concentrations of fructose more sucrose could now be formed than was possible prior to the Diuron action. Secondly, Alexander has shown in a factorial experiment using 6-6 azaurical (growth inhibitor) and gibebrellic acid (growth stimulant) in combinations, that at high levels of the inhibitor, the stimulant did not overcome the inhibition but at low levels of the inhibitor, high levels of the stimulant caused plants to have an overcompensated recovery i.e. the repair job was better than the original.

If the cane plant can react as described above to artificial stress then the question is, "is it not feasible

TABLE VI

Sucrose, Moisture, Fibre, and other per cent cane and sucrose, fibre and other per cent dry matter, for 11 seasons at Illovo Mill

Season	Based on Cane				Based on dry matter		
	Sucrose %	Moisture %	Fibre %	Other %	Sucrose %	Fibre %	Other %
1961-62	13,05	72,12	13,51	1,32	46,83	48,48	4,69
1962-63	13,15	70,48	14,90	1,47	44,56	50,48	4,96
1963-64	13,58	70,11	14,83	1,48	45,44	49,61	4,95
1964-65	13,89	69,16	15,39	1,56	45,07	49,89	5,04
1965-66	13,48	69,98	14,89	1,65	44,93	49,62	5,45
1966-67	13,52	69,68	15,15	1,65	44,62	50,00	5,38
1967-68	12,47	70,96	14,68	1,89	42,97	50,57	6,46
1968-69	13,42	69,96	14,78	1,84	44,68	49,19	6,13
1969-70	12,72	71,01	14,50	1,77	43,88	50,00	6,12
1970-71	14,07	69,64	14,65	1,64	46,36	48,26	5,38
1971-72	13,14	71,52	13,64	1,70	46,18	47,91	5,91

to suggest that a water stress occurring albeit 6-7 months before measurement of maturity, can so condition the plant that it will produce high or low sucrose later in the season."

High or low sucrose is a function of (*a*) water content of the cane stalks and (b) sucrose % dry matter. Following on what must be regarded as a classical experiment by Clements[4] where he analysed the 9 lower internodes of cane stalks between 7 and 14 months of age in Hawaii, it was decided to analyse the Illovo Mill data from the 1961-62 to 1971-72 seasons. The results in terms of cane ripeness are given in Table VI.

From Table VI and from the work done by Clements[4] it can be stated that final sucrose % cane will depend upon: (i) the final apportionment of photosynthate, between sucrose, fibre and other dry matter. This apportionment appears to be about 45% to sucrose in mature cane, and (ii) the final moisture % of the cane.

In view of the hypothesis stated, tests were run to find out which of the two above sucrose % cane determinants, if any, was the stronger. The rainfall used, as the independent variable, was the mean of Coastal and Powerscourt rainfall, in millimetres recorded each year from February to May inclusive.

The following emerged from this study.

(i) The correlation coefficient between sucrose % cane and sucrose % dry matter was $r = 0{,}531$ which is not statistically significant.

(ii) Sucrose % dry matter for the season had a very weak correlation ($r = -0{,}264$) with rainfall in February to May.

(iii) Moisture % cane for the season was very strongly positively correlated with rainfall in the February to May period ($r = +0{,}975$). In fact 95% of the variation in moisture % cane from season to season could be explained by the linear equation (vii).

$$M\ \%\ C = 68{,}078 + 0{,}006663\ P\ c\text{-}p$$

Where M % C = moisture % cane for the season.

P c-p = rainfall in millimetres from February to May inclusive (mean Coastal and Powerscourt) prior to the season. Further if length of season were introduced, the equation could be expanded to:

$$M\ \%\ C = 67{,}8522 + 0{,}000945\ D + 0{,}006562\ P\ c\text{-}p$$

where

M % C = final moisture % cane for the season

D = the number of days in the season

and P c-p = rainfall in millimetres February to May inclusive (mean Coastal and Powerscourt) prior to the season.

(iv) Sucrose % cane for the season was strongly negatively correlated with rainfall February to May preceding the season ($r = -0{,}819$)

In the light of these findings the original hypothesis of cane conditioning by weather early in the season, can now be modified to: The moisture % cane for the season, which has a very strong influence on sucrose % cane for the season, appears to be predetermined by the rainfall conditions that the cane plant experiences in the period February to May each year. These weather conditions do not seem to be the prime determinants of the allocation of photosynthate between sucrose, fibre and other dry matter.

Conclusions

The findings of the study reported above, confirm what du Toit[5] reported in 1958. In their present form they are of little commercial importance. The reason for reporting these findings was really twofold:

Firstly, to suggest that the ripening of cane is being tackled at present at the wrong time of the year, and that chemical ripeners or water stress applied to the cane before the start of the cutting season may precondition the cane to give higher sucrose % cane base for the whole year.

Secondly, leading from the first to suggest that research into the changing metabolism of the cane plant during late summer and early autumn may reveal the factors which are responsible for preconditioning the cane to give high or low years. Knowing these factors could lead to controlling them and hence continuous high sucrose % cane years.

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REFERENCES

1. Alexander, A. G., 1967. High sucrose levels and abnormal enzyme activity as a function of nutritional stress in sugar cane. J. Agric. Univ. P.R. 51 (4) 325-333.
2. Alexander, A. G., 1968. The potential of sugar cane to produce sucrose. Proc. Int. Soc. Sug. Cane Technol. 13, 1-24.
3. Chardon, F., 1962. The why of decreasing yields in Puerto Rico. Sugar J. 25 (6) 32-39.
4. Clements H. F., 1962. The ripening of sugar cane. Sugar y Azucar 57 (3) 29-33.
5. Du Toit, J. L., 1958. Sucrose formation and concentration in sugar cane. Expt. Stat. of S. Afr. Sugar Ass. Bulletin No. 6.
6. Glover, J., 1971. Changes in sucrose % cane and yield of sucrose per unit area associated with cold, drought and ripening. Proc. Annual. Cong. S. Afr. Sugar Tech. Ass., 45, 158-164.
7. Gosnell, J. M., 1972. Flowering in Cane. R.S.A. Sugar News, 16, 1-5.
8. Halais P., 1969. Weather conditions and sugar production in 1969. Ann. Rep. Maur. Sugar. Res. Inst. 1969, 97-102.
9. Halais, P., 1970. Weather conditions and sugar production in 1970. Ann. Rep. Maur. Sug. Res. Inst. 1970, 125-130.
10. Hardy, G., 1972. Personal communication. Inter-Illovo Group Report.
11. Shoji K., and Samuels, G., 1965. A study of declining sucrose yields in Puerto Rico — Sugar y Azucar 60, 4, 121-125.
12. Thompson, G. D. and Collings, D.F., 1963. Supplementary Irrigation. Expt. Stat. of S. Afr. Sugar Ass. Bulletin No. 17