MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE

ANNUAL REPORT 1965

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Printed by:
CLAUDE MARRIER d'UNIENVILLE
THE MAURITIUS PRINTING CY. LTD.
37, Sir William Newton Street
Port Louis — Mauritius
1966

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MEMBERS EXECUTIVE BOARD

Sir André L. Nairac, C.B.E., Q.C., *Chairman, representing the Chamber of Agriculture*

Mr. M. D. ffrench-Mullen, *representing Government*

Mr. L. H. Garthwaite
Mr. R. de Chazal
Mr. René Noel
} *representing factory owners*

Mr. Georges Rouillard, *representing large planters*

Mr. S. Gaya
Mr. H. Lallmahomed
} *representing small planters*

MEMBERS RESEARCH ADVISORY COMMITTEE

Dr. P. O. Wiehe, C.B.E., *Chairman*

Mr. M. D. ffrench-Mullen, *representing the Department of Agriculture*

Mr. K. Lutchmeenaraidoo, *representing the Extension Service of the Department of Agriculture*

Mr. Auguste Harel, *representing the Chamber of Agriculture*

Mr. P. de L. d'Arifat
Mr. René Noël
} *representing the Société de Technologie Agricole et Sucrière*

and the senior staff of the Research Institute.

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REPORT OF THE CHAIRMAN

EXECUTIVE BOARD 1965

THE Board held 12 meetings during the year, one of which jointly with the Research Advisory Committee. The only changes on the Board were the replacement of Mr. B. D. Purmanun by Mr. Hamid Lallmahomed as representative of small planters, and the replacement by Mr. S. Staub of Mr. ffrench-Mullen from July to October, while the latter was on overseas leave.

ESTABLISHMENT

I am glad to record that several members of the staff obtained higher degrees in the course of the year : Mr. D. H. Parish, Ph. D. of Queen's University, Belfast ; Mr. C. Ricaud, Ph. D. in Plant Pathology, London University ; Mr. C. Mongelard, M.Sc. in Botany and D.I.C.; Mr. Y. Wong You Chong, the Associateship of the Royal Institute of Chemistry. In addition, Mr. E. F. George, our former Geneticist, obtained the Ph. D. of London University for work done at the Institute. There were few changes in the staff, although we were again faced by two resignations, the officers concerned having obtained posts outside Mauritius : Mr. W. de Groot resigned in May as Plant Breeder, having been offered and having accepted a post in Barbados, while Mr. Mamet also left the colony for Reunion and resigned as Field Officer. Mr. L. P. Noël, however, who had resigned in 1964 came back to the Institute and was appointed Associate Plant Breeder, and Mr. L. Thatcher was appointed Field Officer. Mrs G. Caine, who had attained retiring age, left the Institute in December after twelve years faithful service.

FINANCE

The increase in cess applied for by the Institute, and partially granted after a long delay, helped the Institute to finance its expenditure. It is to be noted however that the increase of 50 cents per ton of exported sugar — 25 cents short of the increase applied for — was further whittled down in the course of the year by the re-imposition of the Institute's contribution to the former «Phytalus Fund». The net increase of 40 cents per ton barely allowed the Institute to meet expenditure and precluded it from launching into some desirable activities — and this in spite of a crop larger than was anticipated, in fact the second best crop of the Colony. The Institute is therefore still financing its necessary expenditure by borrowing from the banks, and remains at the mercy of one of those drastic reductions in the crop which are always to be feared in our climatic conditions. Planters and millers have always shown themselves ready to support the Institute, and Government would be well advised to meditate the opinion expressed by a well-known agricultural journal in these words : «*Every support needs to be given to the Sugar Industry Research Institute by the estates and Government if it is to do its job as effectively as those serving competing sugar producing areas.*»

AIMÉ de SORNAY SCHOLARSHIP

Two candidates, Messrs. Gilles Gallet and Mohamed Goolam Hossen, came out third *ex-aequo* at the College Entrance Examinations, both fulfilling the conditions stipulated for the award of the Aimé de Sornay Scholarship. In view of the fact that no award had been made in 1964, the Board decided to grant a scholarship to each of the two candidates.

RESEARCH ADVISORY COMMITTEE

Messrs. G. P. Langlois and Adrien Wiehe who had represented the Chamber of Agriculture and the Société de Technologie Agricole et Sucrière respectively on the Research Advisory Committee since its inception in 1954, retired and were replaced by Messrs. Auguste Harel and René Noël. I would like to place on record my sincere thanks to Messrs. Langlois and Wiehe for the services they have rendered to the Institute during these twelve years.

Lastly, I would like to record my deep appreciation of the competence and whole-hearted devotion with which the Director and his staff carried out, once again, their important, and often delicate, functions during the year under review.

Chairman

25th January, 1966.

REVENUE AND EXPENDITURE ACCOUNT

YEAR ENDED 31st DECEMBER, 1965

Running & Administrative Expenses ...	1,732,280.66	Cess on Sugar exported		2,028,582.62
Herbarium Expenses	4,991.05	Miscellaneous receipts		34,839.72
Interest Paid	48,397.31			
Leave and Missions Fund	125,000.—			
Depreciation	144,103.31			
Excess of Revenue over Expenditure ...	8,650.01			
Rs.	2,063,422.34		Rs.	2,063,422.34

BALANCE SHEET

AS AT 31st DECEMBER, 1965

ACCUMULATED FUNDS	1,349,118.98	FIXED ASSETS (at cost less Depreciation and amounts written off)		
REVENUE FUNDS	88,437.10	Land & Buildings ...	1,479,169.79	
		Equipment	62,214.93	
AIME DE SORNAY FOUNDATION ...	25,000.—	Agricultural Machinery and Vehicles	41,390.—	
LOAN FROM ANGLO MAURITIUS ASSURANCE SOCIETY LTD. ...	128,243.—			1,582,774.72
		CURRENT ASSETS		
GOVERNMENT OF MAURITIUS (Purchase of Buildings) ...	114,947.55	Sundry Debtors	141,544.49	
		Aimé de Sornay Foundation Account	25,000.—	
BANK OVERDRAFT	66,574.93	Cash at Banks & in hand ...	23,002.35	
				189,546.84
Rs.	1,772,321.56		Rs.	1,772,321.56

(sd) JEAN ESPITALIER-NOEL
(sd) GEORGES ROUILLARD } *Board Members*
(sd) P. O. WIEHE *Director*

AUDITORS' REPORT

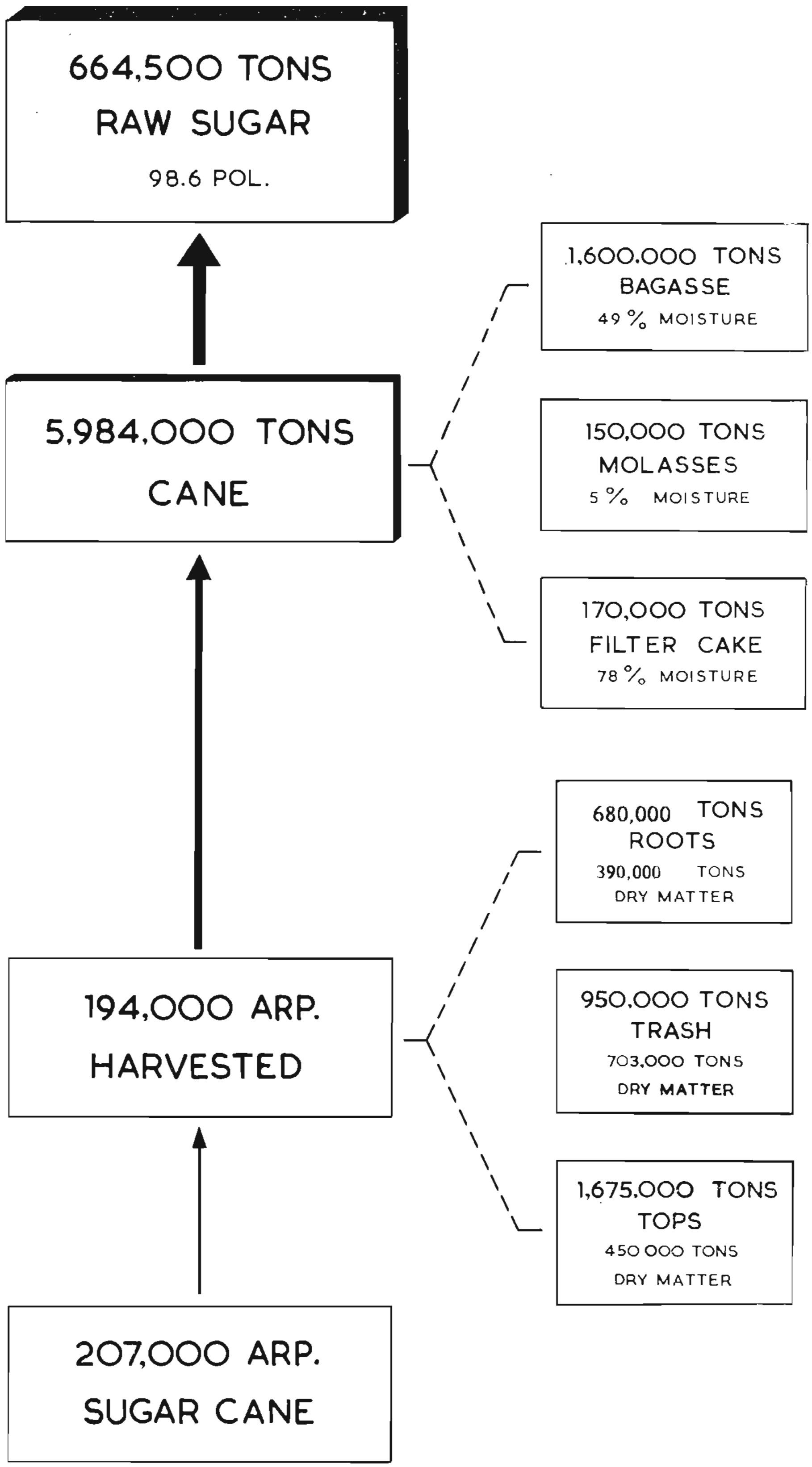
We have examined the Books and Accounts of the Institute for the year ended 31st December 1965, and have obtained all the information and explanations we have required. In our opinion, proper books of accounts have been kept by the Institute so far as appears from our examination of those books, and the foregoing Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs as at 31st December 1965, according to the best of our information and the explanations given to us, and as shown by the Books and Accounts of the Institute.

P.R.C. DU MÉE, C.A. (S.A.), F.S.A.A.

DE CHAZAL DU MÉE & Co.

Chartered Accountants

Port Louis,
Mauritius,
19th March, 1966.



Production of cane, sugar, and associated products of the sugar industry in 1965

INTRODUCTION

THE 1965 SUGAR CROP

THE area under sugar cane cultivation in Mauritius has now reached 207,000 arpents, of which 93.7% was reaped in 1965 to produce 5,984,489 tons of cane, the highest weight so far recorded in the island.

On the other hand, sucrose content (12.69% cane) was one of the lowest experienced in recent years*; nine tons of cane were required to produce a ton of sugar in 1965 as opposed to a normal ratio of 8.4. As a consequence, the total sugar output of 664,000 metric tons was below normal expectations.

An analysis of the major climatic factors affecting growth and maturity during the year reveals several points of interest which are summarized below.

During the vegetative period from November 1964 to June 1965, the monthly distribution of rainfall over the island as a whole did not depart much from normal, the rainfall deficits amounting to 14.08 inches as opposed to an average of 15.00 inches during the last 90 years. These deficits, however, were locally more pronounced, particularly along the coastal areas of the island in February and March.

Cane growth was adversely affected by the lower temperatures which prevailed almost continuously from November to June 1965, and which averaged 0.6°C below normal.

The tropical depression *Rose* which occurred in early May did not produce wind speeds higher than the critical limit of 30 miles per hour during one hour at any of the stations where anemometers are situated.

From July to November, climatic conditions were most abnormal, the sum of monthly rainfall excesses reaching 14.12 inches, the highest observed from data available since 1875. To aggravate matters, minimum air temperatures were above normal, while the daily range of temperature was low throughout the harvest season. Ripening of the cane was therefore seriously affected as may be seen from the following data :

		Sugar manufactured % cane	
		Normal	*1965*
Island	...	11.9	11.1
West...	...	12.4	11.5
North	...	12.1	10.8
East ...	...	11.7	11.2
South	...	11.6	11.0
Centre	...	12.2	11.6

It is probable, however, that the warm and wet harvest season which was experienced in 1965 favoured cane growth, thus compensating to some extent some of the negative factors which had prevailed earlier in the season.

The more important data concerning the 1965 sugar crop are compared to those of 1964 in the table below, while several features of interest relating to cane and sugar production are illustrated graphically in figs. 1 to 7.

	1965	*1964*
Area cultivated, arpents	207,000	206,900
Area harvested, ,,		
Estates	100,600	99,809
Planters ...	93,498	95,602
Total	194,098	195,411
Weight of canes, metric tons	5,984,489	4,375,014

* Except in 1960

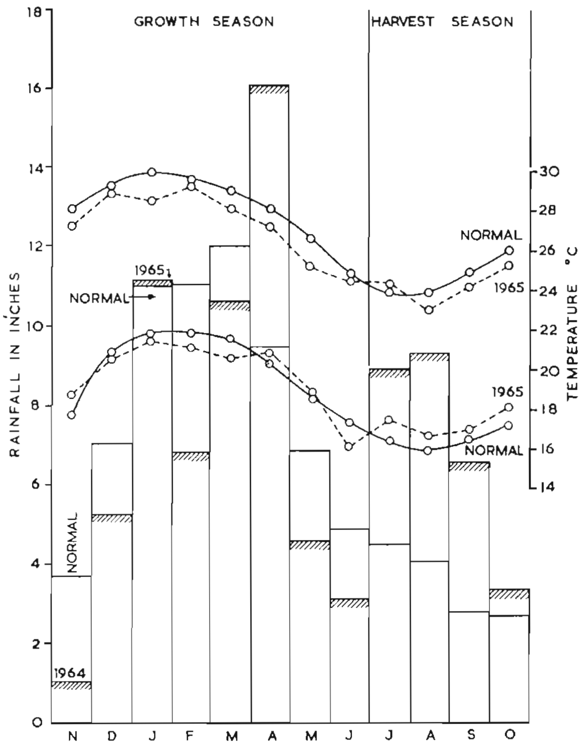


Fig. 1. Rainfall, maximum and minimum temperatures, during the growing and harvest season of 1965.

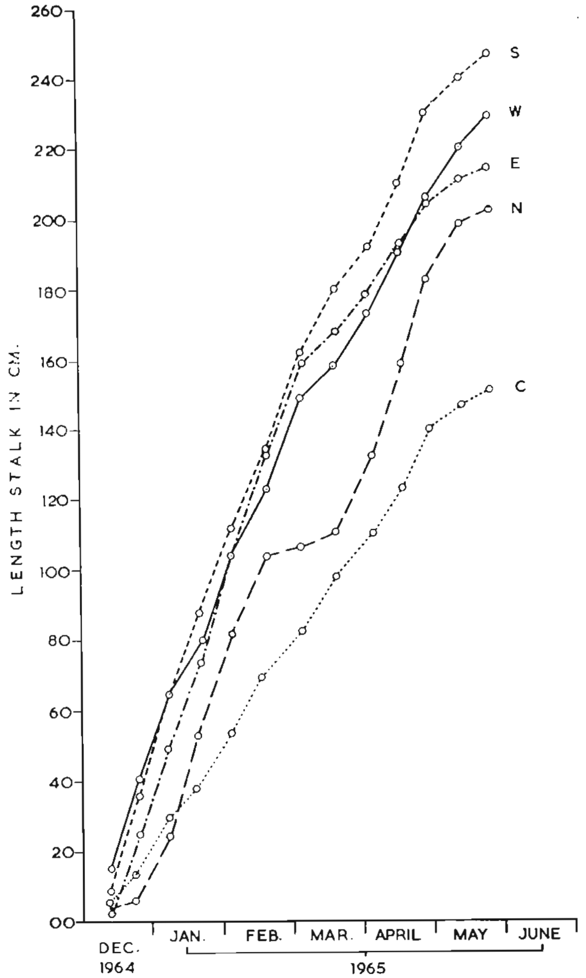


Fig. 2. Elongation of cane stalks during the growing season of 1965 in each of the five sectors of the island.

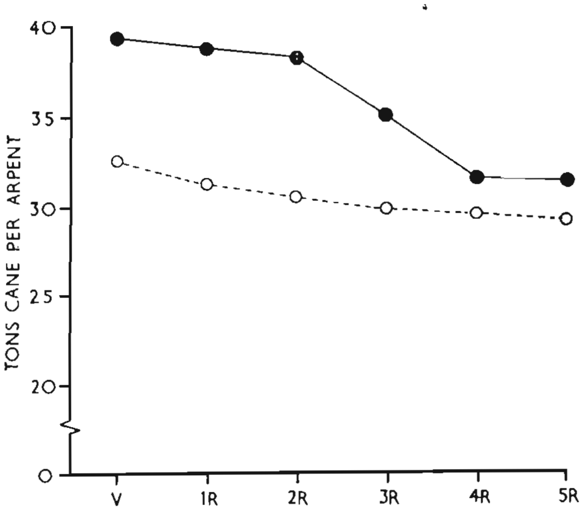


Fig. 3. Cane yields in 1965 (plain line) compared to the average 1959-1964 for all estates of the island (broken line).

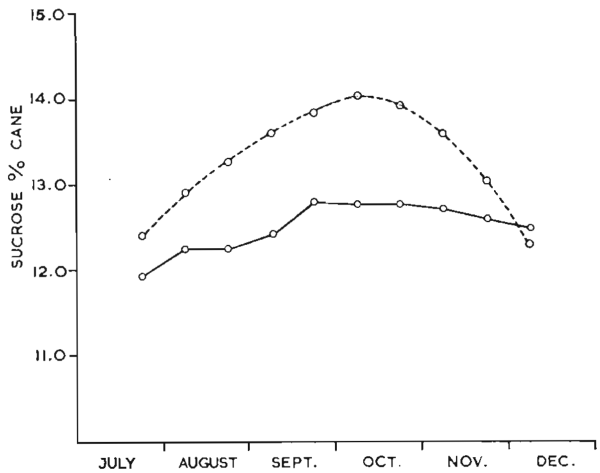


Fig. 4. Variation in sucrose content. Plain line : 1965 ; broken line : average 1959-1964.

	1965	*1964*
Tons cane per arpent :		
Estates	35.7	26.2
Planters ...	25.6	18.7
Average, Island ...	30.8	22.4
Sugar recovered % cane	11.10	11.85
Tons sugar per arpent :		
Estates	3.96	3.10
Planters ...	2.91	2.19
Average, Island ...	3.42	2.65
Duration of harvest, days	156	121
Tons cane per hour ...	100.6	95.4
Tons cane crushed weekly	268,700	252,900
Sucrose % cane ...	12.49	13.45
Fibre % cane... ...	12.95	13.84
Molasses % cane ...	2.53	2.60
Filter cake % cane ...	2.90	3.40
Purity mixed juice ...	88.0	86.4
Reduced mill extraction	96.0	96.2
Sucrose % bagasse ...	1.93	2.03
Reduced boiling house recovery... ...	88.8	90.0
Reduced overall recovery	85.3	86.6
Total sucrose losses % cane	1.55	1.73
Tons sugar 98.6 pol. ...	664,460	518,994

The following are some observations deduced from an analysis of figs. 1 to 7.

Fig. 1 Rainfall and temperature in 1965 as compared to normal. It will be observed that temperatures were generally below average during the growing season, while the daily range of air temperature was smaller than normal during the harvest season, coupled with higher minimum temperatures. Rainfall was considerably in excess from July to October.

Fig. 2 Elongation of cane stalks in the five sectors of Mauritius during the cane growing season of 1965. Growth was almost normal in all sectors, except in the North where deficient rainfall in February and March caused a marked retardation in elongation.

Fig. 3 Yields of cane in virgins and 5 ratoons compared to the average for 1959-1964 (1960 excluded). These data are an average for the 23 estates of the island representing the following acreages : virgins 12,479 arpents, 1st R. 12,823 ; 2nd R. 13,693 ; 3rd R. 15,480 ; 4th R. 13,682 ; 5th R. 11,180. It is probable that the sudden decrease in yield after the 2nd ratoons is due to the smaller acreage of high yielding varieties such as M. 202/46 and M.93/48 in the older ratoons. Reference to Table XII of the Appendix will indicate the varietal composition of the ratoon crop, thus 3rd ratoons in 1965 were planted in 1961, etc.

Fig. 4 Fluctuations in sucrose content throughout the harvest season of 1965 are compared to the previous 5 - year average (excluding 1960). Ripening of the cane did not occur because of heavy rains from July to October. For the same weight of cane crushed, the area between the two curves is equivalent to a shortfall of approximately 50,000 tons sugar.

Fig. 5 The relative yields of sugar per arpent (metric tons of 98.6 pol.) of planters and estates in 1965 are shown separately for each sector, and for the island as a whole. The largest difference occurred in the East (—1.71 tons sugar), and the smallest in the West (—0.68 tons sugar). On the average, estates produced 1.06 tons more sugar/arpent than planters in 1965.

Fig. 6 Sugar manufactured % cane in the different sectors of the island in 1965 compared to the island's normal (11.9 %), and to the sectors' normals. Sucrose content was below average in all sectors, and particularly so in the North.

Fig. 7 The area occupied by different cane varieties in 1965 is shown in comparison with areas planted during the year. The ratio between these two figures gives a correct appreciation of the extension or regression of a particular variety.

Effect of rainfall excesses on cane quality. The abnormally high rainfall which occurred from July to November provided extreme data which had hitherto been lacking to determine the true relation existing between rainfall excesses and cane quality. Thus the relationship between these two factors is not linear but logarithmic. By using data available since 1950 a high positive correlation was found (r = 0.936) between cane quality and the logarithm of rain excesses for the island as a whole. Individual equations for each of the five sectors were also worked out, and are presented in this report.

Sugar production forecast. The data issued regularly by the Institute since 1955 in *Weekly Bulletin of Crop Evolution* have been used to develop equations relating sugar yields obtaining on estates at a given date to final yield for the island as a whole.

From the appropriate regressions, it is now possible to predict within reasonable limits the sugar production of the island, and of four out of the five sectors, as soon as harvest begins. Forecast for the North is more hazardous because of the relatively larger fluctuations in sugar yield brought about by climatic variations. Additional data essential to forecast the sugar crop are (i) total area to be harvested, and (ii) the ratio of island yield to estate yield which has increased from 0.80 in 1955 to 0.86 in 1966.

THE CANE VARIETY POSITION

One of the most pressing questions which the Institute has to face at the moment is the replacement of M.147/44 because of its susceptibility to gumming disease. The incidence of gummosis and its effects on M.147/44 in 1965 are discussed briefly elsewhere in this Introduction, and more fully in the Pathology section. As stated in the 1964 Annual Report, this problem is more acute in the drier parts of Mauritius where M.147/44 has been an outstanding variety, producing in those areas more sugar per acre than any variety hitherto cultivated. The hopes placed on M.442/51 as a substitute for M.147/44 have so far been fulfilled, inasmuch as the performance of this variety in 1965 has confirmed that it has an equal sugar potential under dry conditions. But M.442/51 is a medium to late-maturer, and it is desirable therefore that it should be complemented by other early maturing varieties. In this connection, observation plots have been established in 1965 at six sites in the coastal area where rainfall does not normally exceed 50″ per annum. The drought resistance of 112 varieties is being studied in order to establish trials and propagation plots of the more promising varieties.

Concerning varieties under commercial cultivation, it is interesting to note (*vide* Table XI of Appendix) that 65 % of the cane area was occupied in 1965 by varieties released since 1956. The present status of commercial varieties is as follows :

(*a*) *Varieties which are declining in importance :*

M.147/44, because of its susceptibility to gummosis ; occupied 29 % of the cultivated area and produced 32 % of the 1965 crop ;

M.134/32, yields of which were in 1965 inferior to the island average, from 15 % in the North to 8 % in the East ; now occupies 5 % of the cultivated area, and constituted 4 % of the 1965 cane crop ;

B.3337, highly susceptible to gummosis and yellow spot ; cultivated only in the super-humid zone and occupying 5 % of the cane area ;

B.34104, susceptible to gummosis ; present distribution 2 % of cultivated area, chiefly in the West.

(*b*) *Varieties which are at present in equilibrium*

Ebène1/37, now occupies 11 % of the cultivated area from the previous high level of 25 % ; cane yields in 1965 were 2.3 tons per acre less than the island average, but

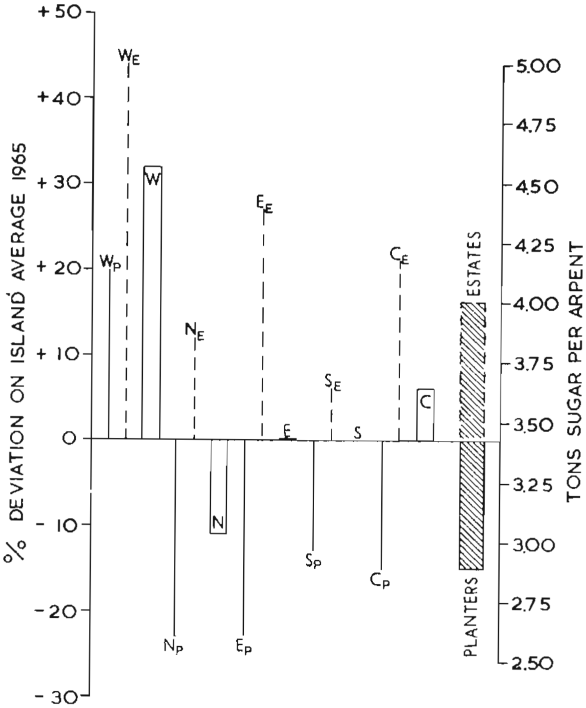


Fig. 5. Relative yields of sugar per arpent in different sectors. Island yield = 3.42 tons of 98.6 pol sugar. Plain line : planters ; broken line : estates ; columns : sector average ; shaded column: average island yield of planters and estates.

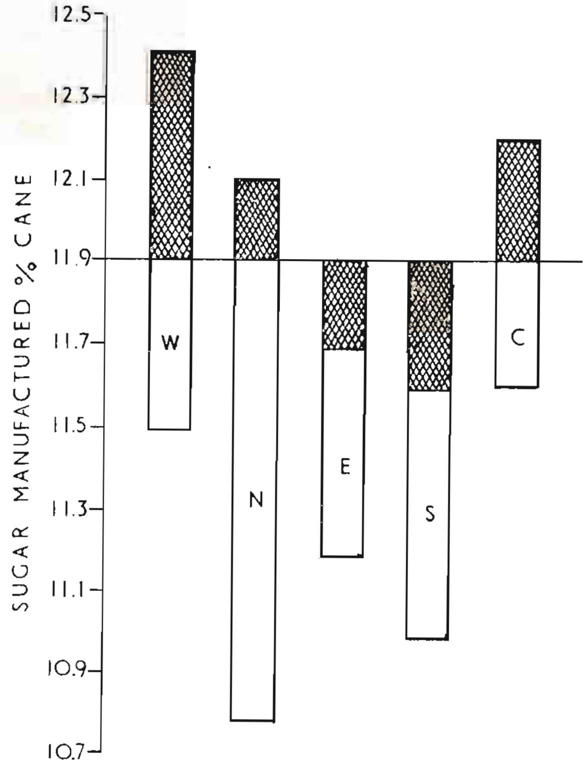


Fig. 6. Sugar manufactured % cane in each sector in 1965 (plain columns) compared to island's and sectors' normals (black columns).

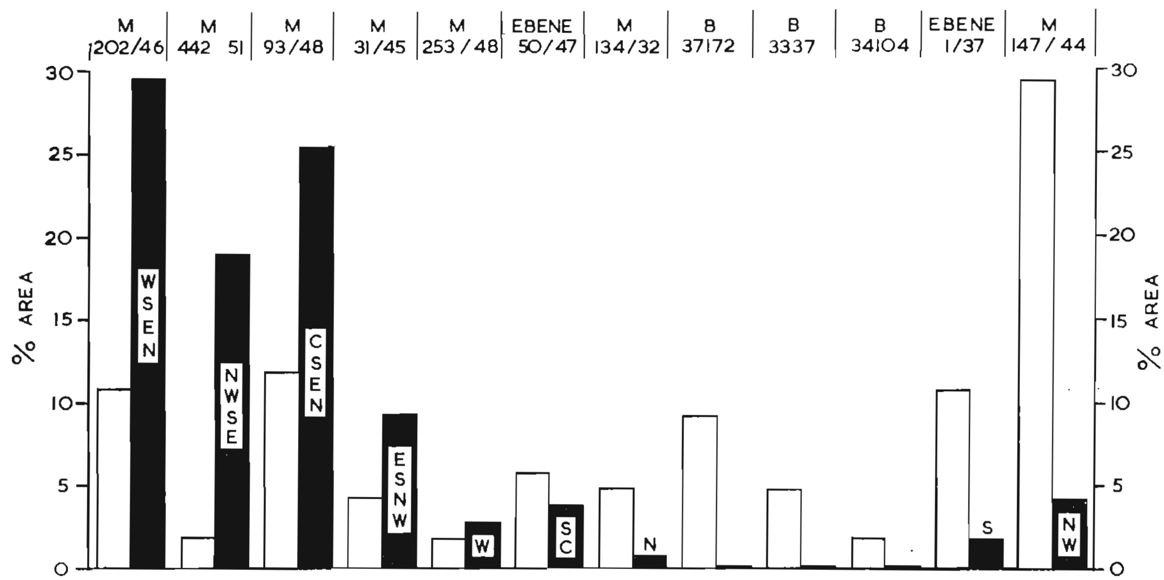


Fig. 7. Present varietal trend in Mauritius illustrated by area cultivated (plain columns) and area planted in 1965 (black columns). Data refer to estates (area cultivated : 109,000 arpents ; area planted : 13,400 arpents). Letters denote sectors which are arranged in descending order, according to the relative magnitude of plantations.

sucrose content is high ; this variety will probably be maintained for several years at its present level ;

Ebène50/47, occupies 6% of the cultivated area, but requires restricted environmental conditions when sugar yields may be very high; in 1965 contributed 6% of total cane crop ;

M.253/48, of very restricted distribution (2%), generally in irrigated areas ; cane yields were 5% above the general average in 1965 ; low sugar, early and late in the season ;

B.37172, which is at present cultivated over an area representing 9% of the total ; will probably be maintained for some time in the humid zone ; a useful variety for late harvest ; although gumming stripes are often abundant, no cases of systemic infection have been observed ; susceptible to root disease complex ; yields in 1965 were slighty above average (0.4 TCA).

(*c*) *Varieties which are gaining in importance :*

M.31/45, occupied 4% of the cultivated area in 1965 and yields were 3% above average ; although the popularity of this variety declined in recent years, several of its attributes are now being rediscovered. Very susceptible to stalk borer ;

M.202/46, occupies 11% of the cultivated area, and produced the highest average cane yields in 1965 (39.2 tons per arpent) ; its susceptibility to leaf scald requires special attention ;

M.93/48, is the most popular variety at present in the super-humid zone and occupies 12% of the toal cane area ; average yields in 1965 were 2% above the island mean; susceptible to stalk borer;

M.99/48, which is recommended for the super-humid zone, chiefly as a substitute for B.3337 ; susceptible to yellow spot ;

M.442/51, a variety which tolerates dry conditions and is a medium to late-maturer ; such characteristics were confirmed by experimental results in 1965 ; its pale yellow foliage together with susceptibility to rust and to attacks by thrips are not conducive to an attractive appearance, but in the end, it is the sugar that counts and M.442/51 has a high potential.

Some interesting data concerning the present status of these varieties are tabulated below, while the present trend in varieties is shown graphically in fig. 7.

	% Area Cultivated	*% Area planted*	*% Cane Crushed*	*Cane Yield TCA**
Group (*a*)				
M.147/44	29	4	34	36.5
M.134/32	5	1	4	32.7
B.3337	5	—	4	27.5
B.34104	2	—	2	34.4
Group (*b*)				
Ebène 1/37	11	2	11	33.4
Ebène 50/47	6	4	6	36.2
M.253/48	2	3	2	37.8
B.37172	9	—	10	36.1
Group (*c*)				
M.31/45	4	9	4	36.6
M.202/46	11	29	11	39.2
M.93/48	12	26	11	36.5
M.99/48	< 1	3	—	—
M.442/51	2	19	—	39.0

The following promising new varieties, which are resistant to both forms of gummosis, have been "short listed", on the basis of their overall agronomic performance, for consideration by the Cane Release Committee. They will be

* Average all varieties, island 35.7

included in a series of Final Variety Trials to be established early in 1966 :

M.409/51	(M.112/34 x D/109)
M.658/51	(B.34104 x M.213/40)
M.13/53	(M.60/44 x M.72/31)
M.13/56	(M.241/40 x M.147/44)
Ebène 74/56	(Ebène 1/37 x M.147/44)
N.Co:376	(Co. 421 x Co. 312)

The varieties Ebène 88/56 and Ebène 118/56 which have been mentioned in previous reports appear to have outstanding qualities, but their susceptibility to leaf scald represents a serious hazard as to their commercial future. The results of promising varieties in variety trials are summarized in the Cane Breeding section of this report.

CANE BREEDING AND SELECTION

Flowering was below normal in 1965 with the result that although a total of approximately 1,250 crosses were made, the number of combinations decreased to 293. These crosses involved the use of 74 varieties as female, 33 as male, and 13 as both male and female parents. However, a large number of crosses per combination were made in order to obtain a greater number of seedlings for assessing more precisely the value of these combinations, some of which are being known to yield few seedlings. In addition, more nobilisation lines were tried, involving newly imported *robustums* and *spontaneums* as well as existing stock.

In order to streamline the selection procedure and keep the number of seedlings at various stages of selection at a manageable level, it was decided to curtail considerably the 1965 sowing programme. To that effect, the only fuzz sown was derived from crosses involving interesting nobilisation lines and from special crosses made in an attempt to obtain information on the inheritance of resistance to gummosis. The bulk of the fuzz was dried and stored in the deep freeze unit. Sowing and potting of seedlings were carried out at Réduit only. The seedlings are to be planted in the field in March 1966.

An appraisal of breeding records, as mentioned in the 1964 report, has been progressing satisfactorily and is continuing. So far, results obtained in first selection trials from 1953 to 1964 have been recorded on punch cards, and a working list produced, involving 141 combinations derived from 27 male and 32 female parents, and 11 used as both male and female. Other stages in selection are being recorded in the same way with a view to future analysis in order to assess the breeding behaviour of parents. Emphasis has been placed on research in the physiology of flowering. To that effect, several experiments were laid down, involving various techniques, as a first step in an attempt towards a better understanding of the mechanism of flowering in sugar cane, knowledge which may lead to a more precise control of flowering for breeding purposes.

The number of seedlings and varieties now in course of selection is as follows :

(i)	Seedlings from 1963-1964 series, planted in March 1965 (mostly in bunches of 3)		102,578
(ii)	1962-1963 series. Varieties in bunch selection plots.		23,574
(iii)	1960-1963 series. Varieties in propagation plots for selection in first ratoons		6,938*
(iv)	1957-1961 series. Varieties in first selection trials to be selected in second ratoons		682**
(v)	Varieties in multiplication plots for establishing field trials in 1966 :		
	1957-1959 series	35	
	Foreign varieties	5	
		——	40

* 3,443 varieties are planted in two environments, and the remaining 52 in only one

** From this number, 86 varieties are tested in two environments, making a total of 596 different varieties

(vi) Varieties in trials on estates

1946-1958	166	
Ebène varieties	10	
Foreign varieties	13	
	——	189

With the valuable co-operation of FUEL and Mon Désert-Alma Estates, a proportion of seedlings at various stages of selection were planted and selected on the two estates. Furthermore, a breeding plot comprising 72 noble varieties out of a total of 77 available, was established at Médine S.E. under conditions very favourable for growth, and a male plot (25 varieties) at Pailles, where it is hoped that the prevailing environment will enhance flowering and lead to better male fertility.

It is gratifying to record that, of the varieties approaching commercial status, none show a sucrose content below that of M.147/44, while several appear to be outstandingly rich. Unfortunately two promising varieties, which showed susceptibility to gummosis, have been discarded, and another two are fairly susceptible.

	STANDARD VARIETY *M.147/44* *Deviations from standard*			STANDARD VARIETY *Ebène 1/37* *Deviations from standard*			STANDARD VARIETY *M.93/48* *Deviations from standard*		
	No. of observations in ratoons	*I.R.S.C.**	*Profitable sugar***	*No. of observations in ratoons*	*I.R.S.C.**	*Profitable sugar***	*No. of observations in ratoons*	*I.R.S.C.**	*Profitable sugar***
M.409/51	13	+ 1.1	+ 0.30	3	+ 0.4	+ 0.21	—	—	—
M.658/51	7	+ 0.7	— 0.18	3	— 0.5	+ 0.27	—	—	—
M.13/53	8	+ 1.2	+ 0.16	3	+ 0.1	— 0.05	1	+ 0.09	+ 0.06
M.356/53	4	+ 1.9	+ 0.60	—	—	—	3	+ 1.1	+ 0.22
M.13/56	5	+ 0.5	+ 0.37	1	— 1.0	— 0.58	1	— 0.9	— 1.02
Ebène 88/56	5	+ 1.0	+ 0.04	—	—	—	1	— 0.5	— 0.46
Ebène 118/56	5	+ 1.9	+ 0.23	—	—	—	4	+ 0.7	— 0.15
N.Co 376	7	+ 0.3	— 0.05	4	— 0.4	+ 0.27	—	—	—

* Industrial recoverable sugar % cane

** $= \text{TCA} \times \frac{\text{IRSC}-4}{100}$

CANE DISEASES

The abnormal weather conditions which prevailed during the maturing season had a marked influence on the disease status of cane plantations. Excess rainfall and supranormal temperature during winter have, on the one hand, favoured certain diseases while the extended growing season has increased tolerance to others, such as gummosis.

Yellow spot was spectacular on B.3337 in the super-humid zone. The first symptoms appeared at the beginning of March and the reduction in assimilating leaf area, the premature defoliation, and the shorter growing season in the uplands, led to a marked reduction in yield. Commercial varieties affected in order of severity are B.3337, Ebène 50/47 and M.99/48. It has been observed that the onset of infection occurs later in the last two varieties.

The three commercial varieties susceptible to rust disease, M.442/51, M.147/44 and M.202/46, again showed infection during the first stages of growth. However, as the cane usually recovers early in the growing season, the disease does not seem to affect yields.

Smut was encountered on several varieties in observation plots, as well as on a few seedlings in propagation plots and variety trials established in the sub-humid zone.

Gumming disease. Environmental conditions, having extended the growing season into the winter months, the disease was much less severe than in 1964, particularly in such a vigorous variety as M.147/44 which showed a reduced incidence of systemic infection as indicated by leaf chlorosis. However, the characteristic leaf striping was observed all over the island indicating a widespread epidemic. Furthermore, several cases of severe systemic infection with abundant oozing of gum were observed on B.3337 in the super-humid zone, as well as on M.147/44 in the sub-humid area, and on a few seedlings in variety trials, thus indicating that the disease can be damaging under different environmental conditions.

Out of the 267 varieties tested to the new strain, 25% reacted as susceptible, but it should be pointed out that infection in the M.147/44 control plots was lower than expected, probably because of environmental conditions. Experimental evidence confirmed that the difference between the two strains of the bacterium is one of virulence rather than of varietal susceptibility. Thus 21% of the varieties tested reacted as much more susceptible to the new strain, 32% as more susceptible, 17% as slightly more susceptible and 31% showed an identical reaction.

The routine testing of varieties coming out of First Selection Trials was continued, and 42 varieties were included in trials in two localities to assess their reaction to the old and new strains; a few promising varieties already tested were re-included in these trials. The project of testing seedlings at the Propagation Plot stage had to be abandoned on account of the practical difficulties encountered in running at the same time a selection plot for agronomic performance and disease reaction. The trial was therefore established as an independent experiment at the First Selection Trial stage, and 377 varieties coming out of the Propagation Plots were included. Their reaction is being tested to the new strain of the organism.

Observations on the development of systemic infection showed that : (i) chlorosis does not necessarily follow systemic infection ; (ii) early chlorosis in ratoons is largely due to knife infection, particularly when young shoots have been cut above the growing point; and (iii) stools with systemic infection play an important part in the carry-over of the disease from one season to the next, especially in the early stages of growth.

Attempts to isolate bacteriophages from infected leaves and soil in the immediate vicinity of diseased plants have so far been unsuccessful.

A two-week course was conducted in order to train field assistants employed by Government for the control of gumming disease in small planters' fields.

Leaf scald. The outbreak of leaf scald, also believed to be due to a new strain of the bacterium, has been spreading gradually over the island. The commercial varieties M.202/46 and M.147/44 are susceptible. A few seedlings in variety trials contracted infection during the year.

Surveys and rogueing in M.202/46 on one estate revealed a maximum incidence of 24 diseased stools per arpent with an average incidence of two to three stools per arpent. Subsequent rogueings in general brought down the number to an insignificant level. On another estate, the maximum number of stools rogued was 68 per arpent, with an average of five per arpent.

Surveys conducted at the Central Nursery as well as on several B nurseries on estates in the variety M.202/46 have failed to reveal the presence of the disease.

The disease is spread mainly by knives at harvest and in the preparation of cuttings, and by infected cuttings at planting time. It has therefor been recommended that nurseries be regularly surveyed, and infected stools eliminated at an early date. The importance of knife sterilization, already recommended in the control of ratoon stunting, has again been emphasized.

Chlorotic streak. Examination of the root system of plants which had contracted infection in water culture revealed the frequent occurrence of a Chytrid which has not been identified yet. Several cases of transmission were also obtained in the soil with plants grown in pots, the rate of spread was however slower than in culture solution.

The disease was severe in areas liable to water-logging in the super-humid zone, with death of young tillers, or of entire stools, particularly in the variety Ebène 1/37. This is attributed to the exceptionally wet winter.

The routine testing of hot-water treatment tanks was continued.

Fusarium stem rot or Wilt. Several reports of dying cane in fields approaching harvest were investigated in the humid and super-humid zones. The overall symptoms were suggestive of root disease or white grub (*Clemora smithi*) damage. The outbreaks, although spectacular, were restricted to poorly drained areas. The fungus *Fusarium moniliforme* was isolated from the base of infected stalks. Although M.202/46 seemed to be more prone to infection, similar symptoms were also observed on the following varieties : M.134/32, Ebène 1/37, B.37172, M.93/48.

Soil microflora. Studies, initiated in 1960, on the fungal flora of the sugar cane rhizosphere have continued. Attemps to detect quantitative differences between the total fungal flora in rhizosphere of plants receiving organic fertilization, as opposed to inorganic fertilization, have been inconclusive. A list of saprophytic fungi isolated from cane rhizosphere, and of those frequently isolated from diseased roots, is given in the Cane Disease section of this report.

Ratoon stunting disease. No experiments were laid down in 1965 as it was necessary to obtain results from the gumming disease trials before drawing up a list of resistant promising varieties for inclusion in the R.S.D. trials.

In spite of the setback caused by the outbreak of gumming disease, with the result that the relatively large area of nursery established under the susceptible M.147/44 was lost to planters, due credit must be given to authorities of the Central Nursery for the rapid replacement of susceptible by resistant varieties. As a result of this prompt action, nearly 3,000 tons of planting material were supplied to estates and planters in 1965 as compared to 3,400 tons in 1964 and 1,900 tons in 1963. A total of approximately 150 arpents were under A and B nurseries in 1965 for supply of planting material in 1966. Over 200 tons of cuttings were treated at the Central Hot-Water Treatment Station in 1965 to plant 42 arpents of land at the Central Nursery.

The beneficial effect of using R.S.D.-free cuttings to establish plantations is illustrated by cane yields obtained on one estate in the South where a comparison could be established between fields of M.147/44 planted with cuttings derived from nurseries and from untreated canes. The comparison was based on a total of 85 fields representing an area of 650 arpents in 3rd, 4th and 5th ratoons. The average difference in cane yield was 9.5 tons per arpent in favour of treated canes. No comparison could be established for canes at an earlier stage in the crop cycle, as all fields had been planted with treated cuttings.

In connection with hot-water treatment of cuttings both against R.S.D. and chlorotic streak it should be recalled, as stated on previous occasions, that there is no danger of spreading the gummosis or leaf scald pathogen, these bacteria being destroyed in the bath, at the time/temperature combination used.

No evidence could be obtained that the L.H.W.T. favoured cane arrowing, either in nurseries or at subsequent generations, as observed in other sugar cane countries.

Quarantine. The following varieties introduced in 1964 are undergoing 18 months' quarantine period for eventual release in April 1966.

Country of Origin	*Varieties*
Australia	Q.61, 54N.7103 (Q.79), 53B.45, Triton.
West Indies	B.47-135, B.47-258, B.50-112, B.54-142, B.57-36, B.57-150, D.141-46, D.37-45.
Hawaii	H.38-2915, H.47-4991, H.49-104, Mol. 5801, Mol. 6053, Mol.5843, 51N.G.56, 51N.G.63
Fiji	51R.124, 51R.182, 53R.4040 (Spartan), 53R.4132 (Homer).
United States	C.L.41-223, C.L.41-142, C.P. 29-116, C.P.44-101, R.469, P.R.999.
India	Co.475, Co.527, Co.740, Co.997, Co. 1007.
Taiwan	F.135, F.148, F.149, F.150, F.152.
Madagascar	R.447.

Two varieties failed to germinate, and one was destroyed after showing leaf symptoms suggestive of mosaic.

CANE PESTS

Attacks of army worms and locusts occurred on a limited scale. The former were, as usual, in fields of young ratoons which had been burnt at harvest 4 to 5 weeks earlier. Severe armyworm attack has been frequent in recent years and may reduce cane yields appreciably. It is avoidable by inspection of burnt fields for the first few weeks after harvest and application of insecticide as soon as defoliation becomes apparent. The small scattered attacks by newly hatched nymphs of the red locust which occurred at the end of the year were suppressed by means of insecticide. This again is an insect which has been unusually active recently and demands immediate suppression when detected in numbers.

A field survey to assess the incidence of damage by the stalk moth-borer was carried out during the crop season, nearly 200 fields being sampled to determine the intensity of injury on millable stalks. The data acquired, with those for 1964, require further analysis before conclusions of a general nature may be drawn on the extent of damage and loss caused by the insect. However, the intensity of injury to millable stalks in 1965 was markedly less than that for 1964, the average percentage of stalks and internodes bored being 26%, and 2.3% respectively, as opposed to 38% and 4.7% in 1964.

Diatraeophaga striatalis, the Tachinid parasite of the stalk borer introduced from Java in 1961 and 1964, was not recovered in the field and does not seem to have established itself. About 90 flies received from IRAT, Réunion, were released in September, and another attempt to establish the parasite will be made in 1966. The application of biological control methods against the stalk borer, in particular, was discussed with Dr. F.J. Simmonds of the Commonwealth Institute of Biological Control early in the year. A plan to study the insect and acquire basic information on its natural enemies in Indonesia, where it is indigenous, was formulated, but unsettled conditions in that area prevent implementation of this scheme for the time being.

The scale insect continues to be troublesome in the Central Cane Nursery where conditions favour its multiplication. Preventing infestation by use of insecticides does not seem very practicable, although it is under consideration. The main difficulties lie with the resistant nature of the insect to insecticides and its sheltered position under the leaf sheaths which aggravates the problem of insecticide application. A simple device for injecting insecticide into the piped irrigation water prior to its overhead dispersion was elaborated and is being used to test the efficacy of malathion applied in this way.

Further experiments to determine the effect of scale-infested setts on germination served to confirm the results of those done last year. Reduced germination occurs if setts are appreciably infested, but is negligible if the scales are removed by manipulation, washing, or are killed by H.W.T. An insecticidal dip may also be used to good effect. Live scales on planted setts often persist for months and eventually spread to the above-ground parts of the developing plants. Infestation in plant cane is thus encouraged by the presence of live scales on the setts, although this can be of consequence only in regions where the scale normally occurs, i.e. in dry lowland areas.

The low sugar content of scale-infested canes when harvested is well established. Brix readings from comparable clean and infested stalks showed that the insects prevent normal accumulation of sugars in the stalks during the maturation period.

A new form of rat bait, developed in Jamaica and consisting of "biscuits" made of paraffin wax, split maize, sugar, and an anticoagulant poison, promises to be most useful in cane fields. The "biscuits" have the advantages of being convenient to use, and of not deteriorating quickly in the field.

Research on the comparatively large plant-parasitic nematodes of the genera *Xiphinema* and *Longidorus* revealed five species of the former and two of the latter occurring among cane roots. The commonest species was *X. elongatum*.

CANE NUTRITION AND SOILS

Soil groups and NPK nutrition of cane crops. It has been possible, for the first time, to confront the data accumulated during the past three years on the NPK nutritional status of the sugar cane crops, as revealed by foliar diagnosis practised on the 600 permanent sampling units on sugar estates, with the corresponding soil groups to which they belong, according to the soil map published by the Institute.

As far as nitrogen status of the cane is concerned, the best nutrition occurs on Humic Latosols and Latosolic Brown Forest soils, and the worst on Low Humic Latosols and Latosolic Reddish Prairie soils, the intermediate position being held by Humic Ferruginous Latosols.

Concerning the present phosphorus status of the cane crops, the best occur on Humic Latosols, and the worst on Latosolic Reddish Prairie and Low Humic Latosols, with Latosolic Brown Forest as intermediate; while for potassium, the highest value goes to Humic Ferruginous Latosols and the Lowest to Latosolic Reddish Prairie, with Low Humic Latosols, Humic Latosols and Latosolic Brown Forest as intermediates.

These findings show how the natural original fertility of soils can be altered as a result of fertilizer practices. There exists, therefore, a danger for generalisation, under conditions prevailing in Mauritius, to follow the soil group classification as the sole basis for advice on fertilization.

Nitrogen. High levels of nitrogen are now being used by the planters of Mauritius, and with the present trend of low sugar prices and higher cost of fertilizers, studies on the efficacy of the various forms of nitrogenous fertilizer assume great importance. Moreover, with the advent of compound fertilizers containing varying levels of nitrate, and because the fertilizer application season in Mauritius may be followed by torrential rains, studies on nitrate movement through the soil profile have received attention.

The final results of field and laboratory trials comparing urea and sulphate of ammonia are presented in this report. The general conclusions which can be drawn are that although burying or watering on urea improves its efficacy, sulphate of ammonia, at present prices, and because it can be applied on the soil surface, is the best material for the sugar plantations of Mauritius.

The recovery of fertilizer-nitrogen by the cane plant is only about 50%, and therefore data are presented on the value of split applications of fertilizers and of the effect of nitrification inhibitors like 2-chloro-6 (trichloroethyl) pyridine ("N. Serve")* on fertilizer-nitrogen efficacy. Studies on nitrification and movement of nitrate have also been made, and the results obtained are discussed in terms of practical fertilizer technique. At the same time, preliminary studies on the movement of various ions through the soil profile were started, and some results obtained in 1965 are given.

Nitrogen is taken up steadily by the cane crop in the first five months, indicating that split applications of nitrogenous fertilizer could avoid the danger of leaching losses, which are greater when nitrogen is applied early in a single dose. Early application of nitrogen, however, stimulates leaf development, which is all important in terms of final yield results, whilst late nitrogen tends to accumulate uselessly in the stalks.

As the potash and phosphate status of cane lands are now generally good in Mauritius, nitrogen is becoming, as it should in any intensive agriculture, the king-pin of the fertilizer programme. The amount of nitrogen needed for maximum economic returns per unit area must therefore be assessed as accurately as possible. Field trials with new varieties were laid down in 1965 to give information on this point.

Phosphorus. One of the important changes which have occurred in the Mauritius sugar industry in the last ten years, as a result of the work

* N Serve, Trade Mark, Dow Chemical Co.

of the M.S.I.R.I., is the greatly increased consumption of phosphatic fertilizers, imports of these materials on a P_2O_5 basis having increased five fold.

Although the current fertilizer recommendations have changed radically the phosphate status of cane lands, much research work still needs to be carried out on the various aspects of the efficiency of utilization of phosphorus by the cane plant.

Some evidence exists in the literature that foliar sprays of phosphate increase the sucrose content of sugar cane. Experiments carried out late in the 1965 crushing season showed conclusively that phosphate applied as a foliar spray alters the sucrose content of canes, but that in order to have a positive effect, timing is critical. This problem will be studied further in 1966.

With the establishemnt of a radio-isotope laboratory in 1965, studies were started on the phosphate nutrition of sugar cane grown on the different soil groups of the island. In preliminary studies, the determination of exchangeable (E) and labile (L) soil phosphorus and the uptake and translocation of phosphorus by the cane plants using radio-P were carried out. The chemical fractionation of phosphorus in local soils was also studied, as were the correlations between the amounts of soil phosphorus removed by the various widely used soil extractants.

The value of soil P analyses for the guidance of fertilizer practices is discussed in the light of the results obtained.

Potassium. This is the cheapest nutrient, and with the kaolinitic soils of Mauritius, potassium is easily taken up by the plant, even when present in low levels in the soil. No deficiency of potassium should therefore occur on cane lands.

The use of molasses as a potassic fertilizer has declined in Mauritius due to the increased costs of handling and storing the molasses, and to a wider appreciation amongst cane growers that molasses are, in effect, primarily a source of potash and can be costed as such.

The application of molasses, as a source of potash, in overhead irrigation was successfully experimented with on one estate in the South.

Soil acidity. With the high levels of fertilizer N, P and K now being used, it is natural that factors other than these three major nutrients which control the nutrition of the cane itself, should receive greater attention.

Apart from a few minor areas, the trace element status of cane grown in Mauritius is adequate ; the results of several field trials and the third visible dewlap leaf analyses for Zn, Cu, and Mo are presented in this report. Moreover the large amount of sulphur added to the cane area each year as sulphate of ammonia leaves only the bases calcium and magnesium as nutrients potentially in short supply.

The addition of more than 200 Kg of sulphate of ammonia annually to sugar cane lands over many years in the past has acidified the soils and thus presented the problem of cane nutrition not as a simple base status problem, but as one in which all the facets of soil acidity are involved. To this must be added the complication that the highly laterized soils are very low in silica. Studies on the effect of soil acidity on cane composition and yields, and the interaction of the various factors involved, are underway and some of the preliminary results obtained are presented in this report.

Because of the large area under sugar cane on the highly leached humic ferruginous latosols and the latosolic brown forest, and the fact that the climate of these areas is marginal for cane production, it is felt that nutrient solution studies of the effect of Al, Fe, Mn and Si on the uptake and distribution of radio-P by sugar cane will give much needed information on the possible toxic effects of acidity, and studies on this line were initiated in 1965.

The only local sources of silica in Mauritius, should silica prove essential for good yield performances on the highly leached soils, are basalt, trachyte and, of course, factory ash; the availability to plants of the silica in these materials is being studied.

Variety corrections for Si, Ca and Mn leaf in sheaths. It has been repeatedly proved that leaf blade analysis cannot be reliably interpreted for purposes of cane nutrition without a variety correction for N, P, and K contents derived from comparative leaf sampling in variety trials. The same applies to other elements and the variety corrections are now available for sheath diagnosis dealing with silica, calcium, and manganese, concerning the recommendation of new soil amendments, whether calcareous or silicic.

Soil Survey. With the possible agricultural development of Case Noyale in relation to an irrigation reservoir at Chamarel, the soils of that area were surveyed, and a chart prepared. In this connection, close liaison was continued between the team of the U.N. Special Fund Project and the Institute concerning basic data relating to soils, climate, ground water and irrigation.

PLANT-WATER RELATIONS. IRRIGATION

Plant-soil-water relationships. Investigations were started in 1965 to determine the effect of varying soil moisture stresses on cane growth. The soil moisture conditions are more conveniently expressed as soil water potentials in units of atmospheres, a one-atmosphere potential representing a suction which equilibrates with a 76 cm column of mercury or a 1033 cm column of water.

The experiments were conducted in the greenhouse with a drought-susceptible variety, Ebène 1/37, and a presumed drought-resistant variety, M.442/51. The maximum soil water potentials allowed in the various treatments were –0.25, –0.5, –0.75, –3 and –9 atmospheres, the soil in each drum being watered to capacity when the required potentials, indicated by tensiometers and gypsum blocks, were reached.

Preliminary data showed that cane growth as measured by shoot height, leaf area and dry weight, was adversely affected by increase in soil water potential measured at 6 inches below soil level. Appreciable differences in growth were observed even between the –0.25 and the -0.5 atmosphere potentials. There is an indication that measurements of soil moisture stresses at such low values will be necessary in future work.

These results indicate that the water in the soil from field capacity to permanent wilting percentage cannot be regarded as being equally available to the plant.

It was further observed that the variety Ebène 1/37 was more affected by the different water regimes than the variety M.442/51, more particularly in the early stages of growth. This differential response might prove useful for assessing drought resistance in new cane varieties, and studies along this line are being continued.

Measurements of plant-water potential. When the supply of water from the soil is restricted, the water potential in the plant falls, and as the plant integrates all the environmental factors affecting the water balance, measurements of plant-water potentials are considered preferable to those of soil-water potentials. A suitable technique for estimating the plant-water status in the field is being investigated. This technique is based on the density column method established by Schardakow, and preliminary results indicate that it could be useful in estimating plant-water potentials in the field. Comparison of this technique with the more refined micro-osmometer method of Weatherley suitable for laboratory conditions, are being carried out in an attempt to obtaint rue estimates of plant-water potentials.

Consumptive use of water by the cane plant. Experiments on the consumptive use of water by the cane plant – using six lysimeters and three soil types – initiated in 1963 at Médine S.E. (Palmyre) are progressing satisfactorily. Data have now been recorded regularly for over two years, and will be analysed at the end of the 1966 season. A brief account of the chemical composition of leachate from the lysimeters, and seasonal fluctuations in nitrogen content of rain water is reported in another section of this report.

Present area under irrigation in Mauritius. At the end of 1965, approximately 30,000 arpents of cane land were irrigated, of which 18,700 arpents were under surface irrigation. the remainder being under overhead irrigation. A table accompanied by short notes is reproduced elsewhere in this report, showing the distribution of irrigated land by sectors and according to type of holding. These figures are compared with those obtaining in 1963, a summary of which is given below :

	1965	*1963*
	arpents	*arpents*
Area irrigated by surface	18,680	20,136
„ „ overhead	11,350	8,734
Total area irrigated	30,035	28,870
Overhead irrigation % of total irrigated ...	38%	30%

Economics of irrigation. A study of the economics of overhead and surface irrigation under Mauritius conditions was made during the year and appears in this report.

The main results obtained are given below :

	Overhead irrigation Semi-permanent unit	*Surface irrigation*
Capital cost per arpent ...	Rs. 1000	Rs. 250
Running cost per acre/inch	Rs. 9.30	Rs. 1.25

Since the efficiency of water utilisation is three times greater with overhead irrigation on Low Humic Latosols ("free" soils)*, it is necessary to express the above figures in terms of cost per round of irrigation :

	Overhead irrigation	*Surface irrigation*
Cost per round of irrigation ...	Rs. 18.60	Rs. 7.50

Assuming the value of 1 ton of cane to be Rs. 32 to the planter, and that 15 rounds of irrigation are needed during the growing season, the additional tons cane required to cover cost and interest on capital are :

Overhead irrigation	...	8.7 Tons
Surface irrigation	...	3.8 Tons

Effect of irrigation on cane yields. A comparison was established between irrigated and unirrigated fields on an estate** in the north of the island, where a new irrigation scheme (overhead, Boom-O'-Rain) was initiated in 1965 over an area of about 750 acres of latosolic reddish prairie soils.

The fields chosen were harvested in 5th ratoons in 1965 and previous cane yields had been as follows :

		A	*B*
		Area	*arpents*
		21.00	17.8
		Tons Cane	*Arpent*
Virgins	1960	20.5	21.1
1st R.	1961	22.5	24.1
2nd R.	1962	36.7	36.4
3rd R.	1963	30.1	32.6
4th R.	1964	22.3	24.4
Average	... ...	26.4	27.7

showing a slight superiority of 1.3 T.C.A. systematically in favour of field *B*.

Field *A* was irrigated in 1965, receiving 1½" of water at 13 days' interval throughout the growing season.

Cane yields in 5th ratoons in 1965 were :

A	*B*
irrigated in 1965	*not irrigated*
48.1 T.C.A.	37.8 T.C.A.

a difference of 10.3 tons per arpent, to which can be reasonably added 1.3 tons of cane representing the greater productivity of field *B*, making a total of 11.7 tons cane per arpent in favour of irrigation, and in spite of highly favourable growth conditions in that area as indicated by the higher yields obtained in 1965.

* Latosolic Reddish Prairie ("gravelly" soils) cannot be surface irrigated economically, the ratio of water used being 11 : 1 between surface and overhead irrigation

** Data published by kind permission of the Manager

WEED CONTROL

Substituted Uracils. Yield trials laid down in 1963 on the two Uracils, Isocil and Bromacil, were harvested in second ratoon in 1965. It must be recalled that these trials after they were harvested in first ratoon in 1964 were sprayed again with the same herbicide treatments that is, at 0, ½, 1, 2 and 3 lb a.i. per arpent. Of the varieties under test, M.93/48, M.202/46, Ebène 1/37 and M.147/44, only in one variety, M.93/48, was cane yield affected at the highest rate of application in some of the trials. However, no adverse effect on sugar yield was registered with both Uracils throughout the concentration range.

New herbicides. The logarithmic spraying technique was used to compare three substituted Uracils to DCMU in pre-emergence treatment of both crop and weeds. In general, the three Uracils : H.732, Bromacil, and H.767 showed the same weed control performance as DCMU, but with regard to their effect on the crop, H 767 proved safer than the two others.

The comparative effectiveness of the new herbicides, Hercules 7531 (hexahydro-methanoindanyl-dimethylurea), Hercules 7175 (chloronorbonyl-dimethyl urea) and a formulation consisting of an ester of 2,4-D and methyl substituted carbamate were also compared to DCMU. In general, DCMU gave the best weed control results, while Hercules 7175 and the ester-carbamate formulation slightly affected cane growth at the highest dosage range 5.0 -- 3.8 lb a.i.

Paederia fœtida. Experimental work this year confirmed results obtained in 1964, namely that this weed may be eradicated in stone walls by Tordon at rates of application varying from 2 to 1 lb a.i. per 60 gallon water.

Bignonia unguis-cati. Control of this noxious vine with DCMU plus an ester derivative, Bromacil, Isocil, Weedazol and Tordon 101 was best obtained with the latter chemical at 2 lb a.i. per 60 gallons of water.

Effect of herbicides on food crops. Exploratory work was carried out on the effect of Linuron (substituted urea) and Camparal (substituted triazines) on potatoes, groundnuts and maize. The herbicides were applied at rates varying from 1 to 4 lb a.i. per acre in pre-emergence treatment of these crops and sugar cane. Potatoes and maize were not affected by the two herbicides at the rates used. On the other hand, groundnut was damaged by both Linuron and Camparal at 2 and 4 lb a.i. per arpent. The phytotoxic effects were vein yellowing followed by blade chlorosis and death of plants at higher concentrations. As these chemicals gave good weed control, they might prove interesting for the eradication of weeds in plant canes interplanted with food crops, particularly with respect to potatoes and maize.

CULTURAL PRACTICE

Spacing trials. A series of ten trials were laid down in 1963 ranging over the main climatic zones of the island to compare spacings of 3′, 4′, and 6′ with the standard spacing of 5′. The best adapted varieties were planted in each climatic zone, contrasting erect and lodging types of canes.

Results obtained to date indicate that in the six trials situated in the sub-humid and humid zones, yields were significantly higher at a spacing of 4′ irrespective of growth habit of the variety. These trials are planned to continue until the 5th ratoon.

Method of planting. The usual method of planting in furrows in Mauritius is compared in a series of 5 trials to (a) planting on flat ground ; (b) planting on flat ground with drains every alternate interline ; (c) planting on ridges. Three of these trials were planted on dark magnesium clays, and two on humic ferruginous latosols. Yields will be recorded until the 5th ratoons. Results obtained to date, which include virgins and 1st ratoons indicate a slight advantage only for ridge planting on the Humic Ferruginous Latosols.

Germination experiments. The variation in the percentage and rate of germination of different cane varieties is well known, but the reasons for these differences have still to be explained. A preliminary experiment with a view to elucidating this problem was started last year with three varieties : Ebène1/37, M.93/48 and M.147/44. Results of this experiment, carried out with single-eyed cuttings, have shown that cuttings of the top half portion of the stalk of the varieties Ebène1/37 and M.93/48 germinate better than cuttings of the bottom half. This was not apparent in the variety M.147/44. The rate of germination and growth of the young shoot was comparable in all cuttings of the variety M.147/44, but there was a steep gradient in shoot height measurements of the varieties Ebène 1/37 and M.93/48, starting from the top cuttings towards the basal cuttings.

Further experiments are being pursued, including other drought-resistant and drought-susceptible varieties, in order to determine if germination capacity is an inherent varietal characteristic.

Experiments with petroleum mulch. A specially formulated water emulsion of petroleum resins, known as EAP2000 or petroleum mulch, was tested in an experiment at Belle Rive to study the effects of this mulch on soil temperature, cane germination, growth and final yield. This trial will be harvested in 1966. There was a small, but not significant, increase in soil temperature of treated plots. Germination was significantly improved by the mulch, but there was no difference in cane growth three months after germination.

FIELD EXPERIMENTATION

The usual series of experiments were continued during the year on variety testing, fertilization and amendments, cultural operations, herbicides, resistance to pests and diseases, and irrigation.

Excluding experiments on the four stations of the Institute, 168 field trials were harvested, and 46 laid down on estate land. In addition, about 50 arpents of land are made available to the Institute by three estates for irrigation experiments, breeding plots, early stages of selection, and multiplication plots of promising varieties. The assistance received from estate managers in this connection is gratefully acknowledged.

Field experimentation is also gaining favour, and four agronomists are now employed outside the Institute by sugar estates.

A list of Field Trials carried out in 1965, but excluding early stages of selection, is given below in summarized form.

	Estates	*Stations*
Variety		
Variety trials	86	2
Pre-release trials ...	15	—
Ratooning capacity ...	—	2
Observation plots on drought resistance ...	6	—
Fertilization & Amendments		
Nitrogen	18	—
Phosphate	20	—
Calcium & Phosphate ...	4	—
Variety — Nitrogen ...	3	—
Potassium, Calcium & Magnesium ...	5	—
Gypsum	—	2
Sand, Mg limestone, Muriate of potash ...	4	—
Basalt	4	—
Calcium & Basalt ...	4	—
Trace elements	8	—
Method of fertilizer application	3	—
Organic & mineral fertilization ...	5	4
Permanent fertilizer demonstration plots ...	—	4

		Estates	Stations
Cultural Practice			
Spacing	... ...	10	—
Burning	... ...	2	4
Interline cultivation	...	4	—
Method of planting	...	4	—
Selective harvesting	...	9	—
Petroleum mulch	...	—	1
Germination	... ...	—	1
Diseases	... ...		14
Herbicides	... ...		17

SUGAR MANUFACTURE

In reviewing the programme of research for 1965, the Research Advisory Committee recommended that priority should be given to two topics, namely refining quality of raw sugar and protein recovery from factory products. In consequence, the staff of the Sugar Technology Division devoted most of its time to these two problems. It was possible, however, to include several other studies in the programme of investigations, the results of which are given in the Sugar Manufacture section of this report.

Raw sugar filterability. It is most important for the economy of Mauritius that its sugars should have a good reputation in overseas market, the more so in these days of over-production when purchasers are in a position to be more selective.

Fully aware of this situation, and so as to maintain its place in a highly competitive world market, the industry, working in close collaboration with this Institute, has taken a number of steps to improve the quality of its raws. At the request of the Mauritius Sugar Syndicate, the Sugar Technologist paid a number of visits to various refiners in the U.K., Canada, and Malaya, in order to discuss with them problems of mutual interest. Mr. C. H. Allen, Chief Chemist of Tate & Lyle Refineries, London, was also invited to spend a few days in Mauritius during the 1965 crop so that the industry might benefit from his wide experience in problems related to raw sugar quality and refining. It is gratifying to note that, in Mr. Allen's own terms, he "*was very impressed by the attention and earnestness being paid by everyone (I) met on this question of improving filterability, and by the technical standard and cleanliness of the factories visited*".

Unfortunately, it is not an easy proposition for a factory to improve substantially the filterability of its raws from one crop to the next as it is not always possible, within sucht a short period, to make the necessary equipmen additions and processing changes. A further complication lies in the fact that the exact influence of various non-sugars on filterability has not been well defined yet. Several authors believe that starch is one of the major causes of poor filterability, and since many refiners claim that they encounter filtration difficulties when starch content of raws exceeds 200 ppm, it was decided to pay particular attention to this non-sugar during the crop.

The opinion is often expressed in Mauritius that one of the problems in raw sugar filterability is varietal. So far as starch is concerned, this contention does not appear to be valid. Thus analyses of juices from cane harvested in Final Variety trials show that the varieties M.147/44 and M.93/48 contained less than half as much starch in 1965 as they did in 1964, and that their starch content last crop was of the same magnitude as that of the varieties M.134/32 and Ebène 1/37, which are known to contain little starch. Further, it is a fact that those factories in Mauritius, where filterability is below average, lie mostly on the uplands where low starch varieties, such as Ebène 1/37 are still predominant.

But a juice relatively low in starch may still yield a raw with a high starch content if elimination of the non-sugar during processing has not been satisfactory. It is with the object of determining the influence of various processing techniques on starch elimination that starch balances were carried out on samples collected from a number of factories in 1965. With the limited number of results available to date, it is only possible to draw tentative conclusions from these balances which indicate that (i) very little starch, less than 2 per cent on the average, is eliminated in filter cake ; (ii) about 65 per cent of the starch present in the juice finds its way into the final molasses ; (iii) those factories where little or no molasses recycling is practised eliminate about 10 per cent more of the non-sugar in final molasses than those where a certain amount of recycling is practised.

From the point of view of the refiner, however, it is not so much the starch content of the raw, but that of the affined sugar which matters. Hence for any raw of given starch content, the higher the proportion of the non-sugar in the film of molasses, the larger will be the elimination upon affination, and the better its refining quality. Unfortunately, affination removes only part of the starch, as most of it is occluded in the crystal. Thus the analysis of a number of average 1964 crop raw sugar samples indicates that affination does not remove the larger proportion of this starch.

It is therefore most important that the sugar crystal should contain as little occluded starch as possible. One of the methods of achieving this result is to double-cure the C-sugar, which may be used then as footing for the A and B strikes, or better, remelted. A number of experiments carried out in the laboratory have shown that the starch content of the C-sugar decreases markedly with increasing purity of the sugar. Average results obtained have shown that the starch content is reduced by 45 per cent when the C-sugar purity is increased from 83 to 92 ; and these findings have been confirmed by the industrial results obtained at two factories during the 1964 and 1965 crops.

However, in factories where starch content of the juice is high, it may prove advantageous to remove as much of it as possible before the juice goes into process. One of the methods of achieving this result is by enzymatic action. Experiments carried out in the laboratory and at Mon Désert factory during the crop indicate that a large proportion of the starch may thus be destroyed without the juice undergoing much sucrose inversion. Unfortunately, only a few tests could be carried out, but the results obtained have been such that those factories with high starch content juices would be well advised to try the process, the more so that it calls for very little capital expenditure.

A number of other experiments were carried out during the crop with the object of improving raw sugar filterability. Encouraging results were obtained at Mon Désert factory where, following the experiment on enzymatic removal of starch, the Estate Chemist investigated the effect of blowing compressed air, prior to liming, into juice heated to 70-80°C. The floating scums were scraped off and sent to the vacuum filter. Filterability of the raw sugar was markedly improved, apparently as a result of better elimination of scums from the juice. These experiments were initiated at the end of the crop so that it is difficult to assess exactly the merits of the process, but the results obtained have been so encouraging that they should be repeated in several factories next crop.

Protein recovery. In October 1964 the Sugar Technologist had further discussions in Germany with Westfalia, manufacturers of continuous separators and de-sludgers, when it was decided : (i) to investigate the possibility of partly dewaxing the juice with the help of SKIG nozzle-type machines in order to increase the nutritive value of the coagulate ; (ii) to renew investigations in the laboratory, and then on a pilot plant scale, with the object of separating the protein from high Brix syrup instead of from low density juice. This decision was taken in the light of recent experience gained in Germany in the production of glucose from cane starch. In this process it is necessary to separate a mixture of fats and protein from a glucose solution of about 18° Brix. At this Brix, the difference in density between the solid and liquid phases is so small that it was not possible to obtain their separation in a continuous machine. However, when the Brix of the glucose solution was raised to 45°, efficient separation could be achieved.

Partial dewaxing with the SKIG machines was unsuccessful, as already reported in 1964.

For the purpose of carrying out the experiments mentioned in (ii) above, two small machines were received from Westfalia : one the SAOH 205 which is of the bowl type and is fitted with an automatic de-sludging device, and another, the SKOG 205, which is a nozzle separator.

After preliminary trials in the laboratory, these machines were installed at Médine factory where a complete pilot plant was erected. Trials were conducted both with syrup and with juice. The results obtained, which are reported fully in this report, were unfortunately very disappointing as it was not possible to obtain a thick sludge rich in protein. Under the circumstances, it has been decided to stop further work on this project.

Tall chutes and mill extraction. Following the erection of tall Donelly-type chutes to the last three mills of a small factory crushing a large proportion of planters' cane, it was decided to study the influence of these chutes on mill extraction, and to work out the economics of the installation. Net profit derived from the installation amounted to slightly more than the cost of building and erecting the chutes, the gain in mill extraction amounting to 0.46. Under the circumstances, there is no doubt that other factories in Mauritius would benefit from the installation of similar chutes. They are simple to make and erect, and cost little.

Continuous centrifugals for sugar curing. A continuous Allis-Chalmers Model 2750 centrifugal was used for the curing of C massecuites at Belle Vue factory in comparison with a batch fully automatic 48″ × 30″ machine running at 1800 R.P.M. Unfortunately the massecuite reheater used with the Allis-Chalmers was inadequate so that it was not possible to compare capacities. Further, only one type of screen was provided with the continuous machine. Before definite conclusions can be drawn, further tests will have to be made and careful attention paid to the design of the reheater and to the choice of the screen.

Miscellaneous. Other studies made by the Sugar Technology Division included the effect of syrup flotation on raw sugar filterability, the sampling of cane for fibre determination, the use of a modified disintegrator and trials with "pan aid" in vacuum pans.

The advice of the Sugar Technology Division was again sought on a number of problems by individual factories and corporate bodies, and reports issued accordingly.

LIBRARY AND PUBLICATIONS

The collection in the library has continued to expand, and the accessions this year have numbered 1398 new items, bringing the total to 9238 bound volumes. The catalogue of periodicals completed last year has proved of great practical value; it comprised 467 entries, including some of the rarest and oldest agricultural periodicals in the island. The current journals and reports received in the library now number 350 titles, 195 of which are received on an exchange basis or as gift.

A good opportunity to strengthen the contacts established with various libraries abroad was offered when the Librarian went on overseas leave and visited some of the leading agricultural documentation centres.

The following publications were issued during the year :

Annual Report 1964. 117, xxxii p., 24 figs, 8 pl. (includes Combined Table of Contents and Indexes for Annual Reports 1954 - 1963). French summary in *Rev. agric. sucr. Ile Maurice* **44** (2) 1965 : 72 - 97.

Occasional Papers

No. 19. George, E.F. Physiological growth attributes of *Saccharum* clones and their progenies. (Originally appeared in *Ann. Bot.*, N. S. **29**, no. 113, 1965 : 153-165.

Nos. 20 and 21. WILLIAMS, J. R. Studies on the nematode soil fauna of sugar cane fields in Mauritius.

6. *Eudorylaimus sundarus* N. Sp. (Dorylaimidae).

7. Species of *Thornenema* (Dorylaimidae). (Originally appeared in *Nematologica* **10**, 1964 : 319-322; 345-352.)

No. 22. PARISH, D. H. *and* the late S. M. FEILLAFÉ. Notes on the 1: 100,000 soil map of Mauritius. 43 p., 5 col. pl., 1 map.

Leaflet

No. 10. ROCHECOUSTE, E. *and* VAUGHAN, R. E. Weeds of Mauritius. 14 *Eleusine indica* (L) Gaertn. (Chiendent Patte de Poule, Gros Chiendent). 6p. 1 pl.

Technical Circulars (mimeographed)

No. 24. WILLIAMS, J. R. The scale insect (*Aulacaspis tegalensis*) on canes to be used for propagation. 20 p., 7 figs.

25. ROCHECOUSTE, E. Notes pratiques sur le désherbage chimique. 9 p., 4 figs.

Papers prepared for XIIth Congress, I.S.S.C.T., Puerto Rico, 1965.

ANTOINE, R. Testing the reaction of sugar cane seedlings during selection to major diseases.

ANTOINE, R. Sugar cane diseases and their world distribution.

GEORGE, E. F. An experiment to assess the effect of competition between sugar cane clones at the micro plot stage of selection.

PARISH, D. H. The efficacy of nitrogenous fertilizers.

PARISH, D. H. The amino acids of sugar cane.

PARISH, D. H. Use of protein in sugar cane as an animal feed.

ROCHECOUSTE, E. Preliminary observations on the use of substituted uracils for the control of weeds in sugar cane fields.

SAINT ANTOINE, J. D. de R. *and* VIGNES, E.C. Juice preservation during shut-down.

Article in «La Revue Agricole et Sucrière de l'Ile Maurice»

ROUILLARD, G. Histoire des domaines sucriers de l'Ile Maurice. 2. Pamplemousses et Rivière du Rempart **44** (3) 1965 : 143-176.

Articles in Foreign Journals

ANTOINE, R. Mission phytopathologique à l'Ile Maurice et à la Réunion. *Agron. trop.* **20**, 1965 : 888-892.

PARISH, D. H. The amino-acids of sugar cane. 1. The amino-acids of cane juice and the effect of nitrogenous fertilization on the levels of these substances. *J. Sci. Fd Agric.* **16**, 1965 : 240-242.

PEROMBELON, M. *and* HADLEY, G. Production of pectic enzymes by pathogenic and symbiotic *Rhizoctonia* strains. *New Phytol.* **64**, 1965 : 144-151.

ROCHECOUSTE, E. Compte-rendu d'une mission d'études sur le désherbage de la canne à sucre à Madagascar. *Agron. trop.* **20**, 1965 : 262-269.

Theses

GEORGE, E. F. The early stages of selection in a sugar cane breeding programme. Ph. D. London, 1965.

MONGELARD, C. Studies in the water relations of *Zea mays*. M. Sc. London, 1965.

PARISH, D. H. Studies on the nutrition, composition, metabolism and utilization of sugar cane, with particular reference to nitrogen and its compounds. Ph.D. Queen's University, Belfast, 1965.

RICAUD, C. Strains of *Rhizoctonia solani* resistant to chlorinated nitrobenzenes. Ph. D., London, 1965.

THE MAURITIUS HERBARIUM

(by Dr. R.E. VAUGHAN)

Accessions. During the year, nearly seven hundred specimens have been mounted, registered, and incorporated in the Herbarium. The majority of these comprise miscellaneous material collected during routine field work carried out by the Herbarium staff. Special mention may be made of the following acquisitions :

(i) A collection of about one hundred flowering plants, mostly grasses and sedges, was received from Mr. T. Cadet, Ecole Normale, St. Denis. The grasses were of special interest and included some montane species. Grasses from mountainous regions in Réunion usually fall into two groups: European adventive species which have become naturalised ; and endemic species typical of montane scrub and grassland communities. These latter species are of great significance, and knowledge of them and their ecology is still very imperfect.

(ii) A further collection of marine algae, numbering 38 species, was received from the Director, Botanic Gardens, Singapore, and a report was submitted to the Director on their determination and comparison with Mascarene species.

(iii) When visiting Mauritius as a member of the XIth Congress of the I.S.S.C.T., Mr. Gillis Een made extensive collections of mosses and hepatics in Réunion and Mauritius. A duplicate set of some of this material, comprising 43 species, named by Dr. Sigfrid Arnell, Paleobotanical Department, Swedish Museum of Natural History, was received in October.

Distribution to Institutions & Herbaria. An increasing number of specimens have been sent overseas. This material comprises either little-known or unnamed species sent out by the Herbarium for examination and determination by specialists, or duplicates donated on request to various institutions. Some of these may be recorded here : Conservatoire et Jardin Botaniques, Genève, (*Weinmannia*) ; Rijksherbarium, Leiden, (*Ipomoea*) ; Purdue University, Indiana, U.S.A. (*Securinega*) ; Museum National d'Histoire Naturelle, Paris, (ferns & ferns allies). With regard to the ferns, it is fortunate that Mme. M.L. Tardieu-Blot, the leading authority on the ferns of Madagascar and the Mascarenes, is examining material from the fern section of the Herbarium, which was badly in need of revision and bringing in line with modern taxonomy and research.

A report on a general collection recently sent to the Herbarium, Royal Botanic Gardens, Kew, revealed some species hitherto unrecorded in the Mascarene Islands. Particular mention may be made of a cane-field weed *Coronopus serratus* found last year at Phœnix. This plant was said to have been collected by Commerson at Montevideo in 1767.

Botanic Gardens, Pamplemousses. Some progress has been made during the year with the determination of plants in the Gardens, whose names have been lost or misapplied for many years. Among these may be mentioned some fine specimens of the little-known shade tree, *Cassipourea gummiflua*, native of tropical Africa. It is surprising to learn that this genus belongs to the Mangrove family *Rhizophoraceae*. Another recently named species worthy of note is *Albizia caribbaea* from the West Indies. This is one of the most imposing trees in the Gardens, with a straight unbranched bole reaching 100 ft, and topped by the feathery leaves typical of the Mimosa family. Thanks to the vigilance of the Gardens' staff, flowering and fruiting material of practically all the unknown species has now been obtained, and the process of identification should not be long delayed. This work is an essential preliminary to the construction of a new plan and census of the Gardens' plants.

Weed Flora. The next few leaflets in the *Weed Flora* series will be devoted to the grasses, and the first leaflet on *Eleusine indica* has been completed and is in the press. Concerning weeds as a whole, it is often difficult to establish the identity of some of the commonest weeds in the Mascarenes. This is partly due to the fact that the original determination of the species was at fault, and also because local strains and varieties have been evolved. The correct taxonomic status of a weed and a knowledge of its life-history is of much practical value in weed control.

At a meeting of the Royal Society of Arts and Sciences of Mauritius held in October, the Curator joined with the Botanist of M.S.I.R.I. in giving a talk on some problems posed by weeds in the Mascarene Islands.

Nature Reserves. The Curator has maintained close contact and consultation with the Forest Department and the Ancient Monuments and National Reserves Board concerning the maintenance and conservation of National Reserves, all of which have been visited and inspected in the course of the year.

In November, Ile aux Aigrettes near Mahébourg, was proclaimed a National Reserve. This low-lying islet of about 70 acres is composed mainly of compacted dune coral sand or eolianite, and still supports on its south-eastern side an indigenous vegetation of a type which has completely disappeared from the neighbouring mainland. Indeed, it is necessary to go ten or twelve miles up the coast to the rocky foreshores in the vicinity of Barachois Montagu and Trou d'Eau Douce before some small pockets of the original littoral flora can be found.

The toughness and resilience of the vegetation on Ile aux Aigrettes is evidenced by the manner it has resisted for such a long time the impact of aggressive weeds, goats, and human habitation. Though invasion by exotics has taken place to a certain extent, it is possible to build up a fairly reliable picture of its original structure. Some of the indigenous plants still to be found on the island have become extremely rare, or have disappeared from the mainland. Regular visits to the island are made to ensure that adequate material is secured for preservation in the Herbarium.

Another nature reserve, Round Island, has been the subject of an important and critical review (VINSON, 1964) in which the author, whose devoted and untiring advocacy in the cause of nature protection is well known, describes steps which should be taken for its preservation; these are now being put into effect. Round Island is not merely of parochial interest, but has an international status and reputation, and it is good to know that practical measures are at last under way for the conservation of its wild life.

Library. Some important papers and publi cations, of interest to the student of Mascarene botany, received by the Herbarium Library are given below.

ARNELL, S. (1965). Hepaticae collected by Mr. Gillis Een in Mauritius and Réunion in 1962. *Svensk bot. Tidskr.*, **59** : 65-84, figs 1-6.

BERNARDI, L. (1964). Revisio generis Weinmanniae. *Bot. Jb.*, **83** : 128-221, tab. 1-38.

CAVACO, A. (1965). Quelques considérations à propos de la répartition géographique des Monimiacées (*sensu lato*). Proc. Vth Plenary Meeting of the A.E.T.F.A.T. *Webbia*, **19** : 587-592, fig. 1.

CORNER, E. J. H. (1965). Check list of Ficus in Asia and Australia with keys to identification. *Gdns Bull., Singapore* **21** : 1-186.
(Many of the species cultivated in Mauritius are included).

KEAY, R. W. J. *et al* (1959). *Vegetation Map of Africa South of the Tropic of Cancer, with explanatory notes.* Oxford University Press.

MOHLENBROCK, R. H. (1963). A new species of «Zornia» from the Island of Mauritius. *Webbia*, **17** : 265-267, fig. 1.

RAYNAL, A. (1965). Les espèces africaines du genre *Laurembergia* Berg. *Halorrhagaceae.* Proc. Vth Plenary meeting of the A.E.T.F.A.T. *Webbia*, **19** : 683-695, figs 1-2.

VALETTE, J. (1965). L'Imerina en 1822 - 1823, d'après les journaux de Bojer et Hilsenberg. *Bull. Madagascar*, **15** : 297-341.

VINSON, J. (1964). Sur la disparition progressive de la flore et de la faune de l'Ile Ronde. *Proc. R. Soc. Arts Sci. Maurit.* **2** : 247-261, pls 6-7.

GENERAL

Meetings. The Research Advisory Committee met on the 19th January, 1965, to discuss and approve the research programme for the current year. Another meeting was held on 7th August at Pamplemousses for a visit of the Experimental Station.

Full advantage was taken of facilities available at the Institute for lectures. Thus twenty-two meetings were held at the Bonâme Hall, as follows :

15th January — Dr. F. J. SIMMONDS. (Commonwealth Institute of Biological Control). Biological control of insect pests & weeds.[1]

15th February — J. D. de R. de SAINT ANTOINE *and* J. P. LAMUSSE. Raw sugar filterability.[2]

18th February — P. O. WIEHE. A review of the work of the M.S.I.R.I. in 1964.

22nd March — R. ANTOINE. Gommose de la canne à sucre.[3]

26th April — W. de GROOT *and* J. A. LALOUETTE. Selection of cane varieties.[3]

24th May — WONG YOU CHEONG, Y. Soils and fertilizers.[3]

21st June — P. O. WIEHE *and* R. NOEL. Le XIIème Congrès du I.S.S.C.T.[4]

24th June — E. ROCHECOUSTE. Weed Control.[3]

28th June — En marge du XIIème Congrès I.S.S.C.T.[4]
(a) P. O. WIEHE. Les Iles Caraïbes.
(b) R. NOEL. Extrême Orient et Hawaii.

9th July — Dr. D. C. PEREIRA. (Agricultural Research Council of Central Africa). Effect of land use on stream flow.[5]

22nd July — En marge du XIIème Congrès I.S.S.C.T.[1]
(a) L. LINCOLN *and* R. de FROBERVILLE. Fabrication du sucre et sous-produits.
(b) P. HALAIS *and* D. H. PARISH. Highlights of agronomic research.

24th August — C. MONGELARD *and* G. MAZERY. Plant-water relationship and irrigation.[3]

17th September — C. H. ALLEN. (Tate & Lyle Refineries, London). The refining qualities of raw sugars.[2]

27th September — J. R. WILLIAMS. Entomological problems.[3]

30th September — P. O. WIEHE *and* R. ANTOINE. La gommose et le problème variétal.[3]

11th October — E. PIAT. The weighing and sampling of factory products.[3]

26th October — R. E. VAUGHAN. Some problems of weed distribution.[6]
E. ROCHECOUSTE. Les problèmes que posent les mauvaises herbes.[6]

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1 Meeting under the auspices of the *Société de Technologie Agricole et Sucrière de l'Ile Maurice.*

2 Joint meeting Mauritius Sugar Syndicate and M.S.I.R.I.

3 Talks specially prepared for the Extension Officers of the Department of Agriculture and for the Field Staff of Sugar Estates.

4 Meeting under the auspices of the Mauritius Sugar Producers' Association.

5 Meeting under the auspices of Royal Society of Arts & Sciences, Mauritius, *Société de Technologie Agricole et Sucrière de l'Ile Maurice*, and *Association des Anciens Etudiants du Collège d'Agriculture.*

6 Meeting under the auspices of the Royal Society of Arts & Sciences, Mauritius.

7 Meeting under the auspices of the Engineers' Association of Mauritius.

29th October — M. A. Gradener. (Siemens, South Africa). Electrical drives for sugar mills and centrifugals.[1]
11th November — Film : Pulse beat of our Time.[7]
22nd November — G. Rouillard. Observations agricoles à Formose.[3]
13th December — P. Halais *and* D. H. Parish. Cane nutrition.[3]
21st December — M. Ly-Tio-Fane. Stratégie commerciale en Indo-Pacifique au 18ème siècle.[6]

XIIth Congress I.S.S.C.T. The Mauritius delegation to the XIIth Congress I.S.S.C.T., held in Puerto Rico from 29th March to 6th April, comprised 10 members led by the Director who represented the Mauritius Sugar Producers' Association. Dr. Parish, Messrs. Halais and de Froberville attended on behalf of the Institute.

Seven papers were presented by members of the staff to the Congress.

While in the Caribbean area, the Director visited research stations and cane plantations in Florida, Jamaica, Guadeloupe, Barbados and Trinidad. Similarly, Mr. de Froberville spent two weeks visiting sugar factories in Mexico and Jamaica, while Dr. Parish, on his return to U.K., stopped in the U.S.A. for visits at Columbia University.

An account of the XIIth Congress and the sugar industries of Puerto Rico and the Caribbean was given in the course of lectures at the Bonâme Hall in June and July.

Comité de Collaboration Agricole The XIIth Conference of the *Comité de Collaboration Agricole Maurice-Réunion-Madagascar* was held in Mauritius from the 9th to the 16th November. There were 6 delegates from Réunion and 5 from Madagascar. The Committee spent a day visiting the Research Institute and discussing problems of special interest with members of the staff.

Mr. Antoine spent a week in Madagascar in March, visiting the East Coast in connection with Fiji Disease. He returned to Madagascar with the Director in December to attend a week's visit and conference of the Pathology sub-committee. They stopped for a few days at Réunion on the return journey.

Messrs. J.D. de Saint Antoine and E. Piat spent a week in Réunion in November for visits to sugar factories under the auspices of the *Comité*. Mr. J.R. Williams also paid a short visit to IRAT in Réunion to study methods used in the rearing of the parasite fly *Diatraeophaga*.

Staff Movements Overseas leave was granted to the following officers during the year : Dr. Parish, Messrs Rouillard, de Froberville, Béchet, de Réland, Rajabalee and Miss Ly-Tio-Fane. In conformity with the principle established since the inception of the Institute, these officers devoted part of their leave to the visit of research centres or agricultural industries. Thus, Mr. Rouillard spent four weeks in Taiwan; Mr. Béchet attended a Pest Control Course at Chesterford Park Research Station; Mr. de Réland took a special course in photography in London and Germany; and Miss Ly-Tio-Fane established useful contacts for the Library at Research Centres in the U.K., Holland and France.

Mr. F. Le Guen returned from Nottingham University after having completed an M.Sc. course in instrumentation.

Mr. M. Hardy attended a three - month Irrigation Course in Israel on a scholarship granted by the Israel Government.

I should like to take this opportunity of expressing my warmest thanks and appreciation to all the authorities concerned for the facilities granted to members of the staff and myself while on visit or mission abroad.

Miscellaneous. The Institute maintained close liaison with cane planters and sugar producers, 1,455 visits being made by the staff in 1965. Similarly, collaboration with the Department and College of Agriculture was continued at a high level.

The four field stations were used to their full potential for field experiments. Owing to the restricted area available, however, many investigations have now to be carried out at sub-stations on Estate lands. In this connection, I am greatly indebted to the Managers of Sugar Estates for facilities granted, in particular at FUEL and Mon Désert-Alma for selection work, and at Médine for irrigation experiments and breeding plots. Cane production at Stations in 1965 was at Réduit, 397 tons ; Pamplemousses, 535 tons; Belle Rive, 498; and Union Park, 312, making a total of 1,742 tons.

In concluding this report, I should like to express my gratitude to the staff for their help and for the interest shown in their duties during the year, in particular to Dr. E. Rochecouste who acted for me from 1st March to 1st June.

Director

18th February, 1966.

Left : Malformed inflorescence produced in January 1966 from a 6-month old plant cane infected with smut.

Right : Fully initiated smut whip on M.64/58 (x 75)

CANE BREEDING

P. R. HERMELIN, J. A. LALOUETTE, L. P. NOEL & M. PÉROMBELON

1. ARROWING

General

FLOWERING has been rather below normal during the year. It was possible, however, through retarded flower emergence, to utilize some of the clones of *spontaneum* in breeding work. Such retardation is attributed to late harvest the previous season, coupled with light interruption during the night to which the plants were exposed. It is interesting to note that Kassoer has never flowered in Mauritius since its introduction from Australia in 1960.

Two new breeding plots have been established during the year, one at Médine S.E. in virgin land cleared for the purpose, and the other at Pailles. The breeding plot at Médine accommodates 72 out of the 85 available noble canes, together with five other varieties including Kassoer. The plot has been heavily manured at planting time and adequate irrigation facilities are available. The breeding plot at Pailles accommodates 24 varieties which can be regarded mainly as potential males. With these two breeding plots situated where conditions are believed to be optimalfor flowering, it is hoped that a number of interesting combinations will be possible in the coming years.

Experimentation in the flowering process

A more precise control of flowering is essential in order to make a fuller utilization of the various clones of *Saccharum* species existing at present. With that object in view, several experiments were laid down exploring various techniques as a first step towards a better understanding of the mechanism of flowering in sugar cane.

The main aspects of the problem which are under study are the determination of the inductive time for flowering, the relation between number of inductive photo-periodic cycles and flowering intensity, and the duration of the inductive period in Mauritius. To that effect, experiments were conducted with rooted single stalks of the following freely flowering varieties: U.S. 48 - 34, C.P. 36 - 13, and *S. spontaneum* (Kletak.)

Studies on the detection of the presence of endogenous flowering inhibitors in sugar cane were started, using the variety U.S. 48-34. The experiment consists in a study of the antagonistic effects of inductive and non-inductive leaves on flowering intensity.

The influence of growth retardants on flowering in sugar cane is also being investigated. Cycocel* is to be used at different concentrations and at different times during normal inductive period (January-March) on varieties CP 36-13 and the type of *S. spontaneum* occurring wild in Mauritius. It is contemplated to experiment with Phosfon** at a later stage.

Furthermore, a study of the morphogenesis of the flowering apex, including a detailed anatomical comparison between the very early stages of smut whip and flower initiation is

* 2-chloro ethyl trimethylammonium chloride.
** Tributyl 2,4-dichloro benzylphosphonium chloride.

being conducted. The observed fact (Pl. I) that smutted cane plants occasionally give rise to the formation of structures bearing great similarity to a typical inflorescence, even in young cane and outside the normal flowering period, has initiated the studies.

2. CROSSING

Programme

The crossing technique was standardized in the greenhouse during the season under review. All female parents entering a cross were marcotted on the day of collection, and kept in solution until they had rooted sufficiently to be self-supporting.

A total of 1250 crosses were made, involving 293 combinations in which entered 120 different parents, of which 74 were female, 33 male, and 13 male and female.

Although fewer combinations were attempted, more crosses per combination were made in an effort to produce, where possible, a sufficient number of seedlings from the new combinations being tested. Thus, it is hoped to minimize or eliminate errors which probably occur in the recording of seedling parentage at selection time, when some of the combinations planted out in the field have yielded few seedlings.

A preliminary investigation into the causes of low fertility in some crosses was started. The method using blue light fluorescence (MARTIN, 1959) for the observation of pollen germination in stigma and style has been tried on a number of clones with satisfactory results.

A summary of crossing work is given in Table 1.

Table 1. Crossing work in 1965

Station	*No. of crosses made* Greenhouse *Bi-Parental*	Greenhouse *Polycrosses*	*Fields Bi-Parental*	*Total*
Réduit ...	934	188	19	1141
Pamplemousses	—	—	96	96
Total ...	934	188	115	1237

1965 results.

During the year, a number of new combinations involving the use of *spontaneums* and *robustums* were tried. Second nobilization of 57 N.G. 208 and 51 N.G. 140 was effected. All combinations involving *robustum* blood, some of the *spontaneum* crosses, and a few other combinations thought to be of interest on parental lines were the only crosses sown this year, apart from fuzz derived from parents showing different reactions to gumming disease, crossed in various combinations. The sowing programme was thus curtailed considerably in order to streamline the selection procedure and keep the number of seedlings at various stages of selection at a manageable level. The bulk of the fuzz obtained after ripening was stored under deep-freeze for sowing in 1966. All the seedlings obtained have been singly-potted in the greenhouse, and will be transplanted in the field by the end of March. A summary of sowing work is given in Table 2.

Table 2. Sowing in 1965*

Crosses	*No. of Combinations* *Not germinated*	*Germinated*	*No. of Seedlings obtained*
Involving *S. robustum, or* its early nobilizations	13	11	76
Involving *S. spontaneum*	2	12	3179
Others ...	2	6	6
Experimental (gummosis resistance)	—	55	1327
Total ...	17	84	4588

* Only part of the crosses made in 1965 were sown.

3. SELECTION

A summary of selection work is given in Table 3.

Table 3. Selection work in 1965

Station	Stalks planted in B.S.P.	Varieties planted in Prop. P	Varieties planted in 1st Sel. Trials	Selections made in 1st Sel. Trials
Réduit ...	7,519	—	21	5
Pamplemousses	7,557	—	117	9
Belle Rive	—	2,438	78	12
Union Park	—	127	54	11
FUEL-Union	4,561	—	—	—
Minissy ...	3,937	2,565	102	—
Total	23,574	5,130*	372**	37***

Selections from First Selection Trials were planted according to established practice for rapid multiplication. Among the 35 varieties selected from First Selection Trials and planted at Médine, the following are particularly promising :

M.124/59 (Ebène 1/37 polycross) selected at Belle Rive and Pamplemousses, yielded much better than Ebène 1/37 and M.93/48 at Belle Rive, and showed a higher sugar content than both standards. At Pamplemousses, although yield was just under that of M. 147/44, sugar content was slightly better.

M.579/59 (N: Co. 310 × M.147/44) selected at Union Park and Réduit. At Union Park, sugar content was comparable to Ebène 1/37, and better than M.93/48, but the variety outyielded both standards by a wide margin. At Réduit, both yield and sugar content were better than M. 147/44.

M.1007/59 (Ebène 1/37 × M.147/44) selected at Belle Rive where it outyielded both Ebène 1/37 and M.93/48 and showed a higher sugar content.

4. VARIETY TRIALS ON ESTATES

The new strain of the gumming disease pathogen, being more virulent, attacks a larger range of seedlings than the old one. Consequently, it is desirable to know the reactions of varieties as early as possible during selection, and in any case before they are listed for inclusion in variety trials on estates. With that end in view, it had been contemplated to test seedlings for their reaction to gummosis at the Propagation Plot stage. The project, however, had to be abandoned on account of the practical difficulties encountered in running at the same time a selection plot for agronomic performance and disease reaction. The resistance trial has therefore been established with all selections from the Propagation Plots, and includes 377 varieties. In that way, the reaction to gummosis of all varieties coming out of First Selection Trials will be known, and only those resistant to the disease will be propagated at Médine for inclusion in Variety Trials on estates.

Table 4. Distribution of trials

Year of planting	*Sub-humid*	*Humid*	*Super-humid*	*Irrigated*	*Total*
1962	5	6	2	3	16
1963	6	7	7	7	27
1964	7	6	6	8	27
1965	5	5	5	5	20
Total	23	24	20	23	90

* The number of different varieties, as they are planted in two regions, is half of the total given.

** From these, 36 varieties are planted in two regions making a total of 336 different varieties.

*** From these, 2 varieties (1959 series) were selected in two environments making a total of 35 different varieties.

During the year under review, an additional 20 trials were planted, while 12 were discarded, bringing the total to 90 trials in which 189 varieties are tested.

Table 5. Varieties tested in trials on estates

Series	*No. of varieties*
1946	1
1948	3
1949	1
1951	8
1952	2
1953	7
1954	17
1955	31
1956	37
1957	48
1958	11
Sub-total ...	166
Ebène varieties ...	10
Imported varieties	13
Total	189

The performance of the most promising varieties is given below. The varieties M423/51 and M.359/53, mentioned in previous reports, are not included because of generally inferior performance.

M.39/49 (Ebène 1/37 × M.63/39) is a rich variety well adapted to super-humid regions, but had to be abandoned on account of its high susceptibility to the new strain of the gumming disease organism.

M.409/51 (M.112/34 × D.109) is a very interesting variety. It is rich, a good yielder, germinates well, and has large, healthy, dark green leaves. The variety seems best adapted to humid regions. Stalks are semi-erect and medium to large in diameter.

M.658/51 (B34104 × M.213/40). A vigorous variety which has performed well under humid conditions. However, results were erratic for the 1965 season, but sugar content is low.

M.110/52 (Ebène 1/37 × M.63/39). Results on ratoon crops confirm its high sugar content but, on the other hand, yields are rather low.

M.13/53 (M.60/44 × M. 72/31) has again indicated that it has a high sugar content. Yield in cane is reasonably good. The variety seems more adapted to irrigated conditions; it has a tendency to split along the internodes during the period of active growth.

M.356/53 (Ebène 1/37 × Co. 290), a promising variety with a reasonable yield in cane and a high sugar content. It is being tested for its reaction to gummosis, having shown signs of susceptibility to the disease.

M.361/53 (Ebène 1/37 × Co. 290), a rich variety with medium yield which has performed well under super-humid conditions.

M.260/55 (B.34104 × M.63/39) has shown a marked preference for sub-humid conditions where it has yielded better than the standard both in cane and sugar content for two consecutive years.

M.13/56 (M.241/40 × M.147/44). A rather vigorous variety with numerous, thin stalks and good sugar content. Seems better adapted to irrigated conditions.

M.46/56 (B.34104 × M.63/39), another promising variety which has been discarded on account of its high susceptibility to gumming disease.

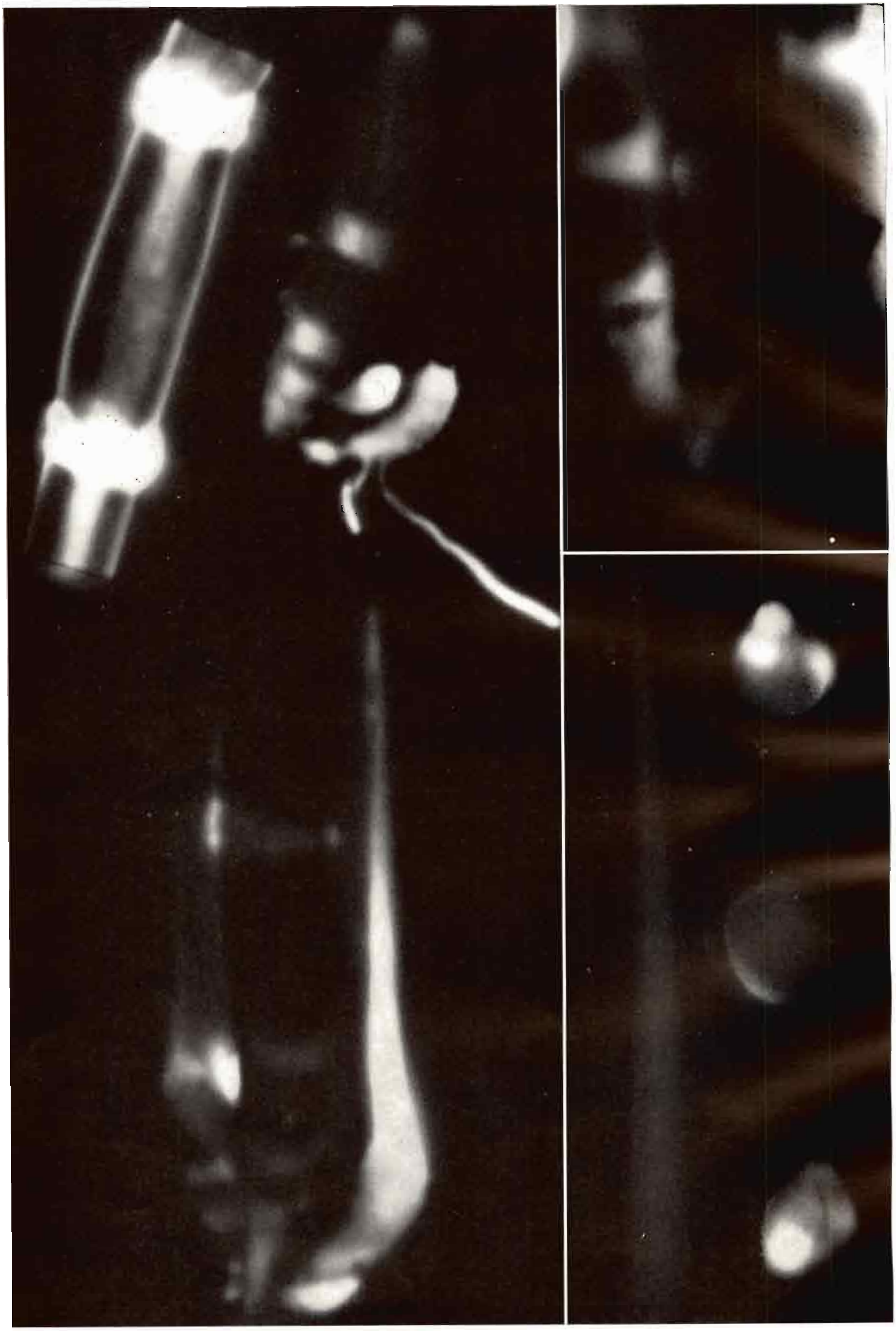
M.351/57 (N:Co. 310 × M.99/34) has performed exceedlingy well in first ratoon. Sugar content is high. The variety appears to be drought resistant.

N:Co.376 (Co.421 × Co.312) performs fairly well under super-humid conditions. The variety is rather unpopular with its numerous, thin stalks, clinging trash, and profuse flowering.

Of the Ebène 1956 series, three varieties are very promising : Ebène 74/56, Ebène 88/56, and Ebène 118/56. The last two, Ebène 88/56, a very good yielder with high sugar content, and Ebène 118/56, a rich variety with reasonable yield, would have been considered for release, had they not shown high susceptibility to leaf scald.

REFERENCE

MARTIN, W. F. (1959). Staining and observing pollen tubes in the style by means of fluorescence. *Stain Technol.* **34:** 125.



Autoradiographs showing distribution of radioactive phosphorus

Left : Accumulation of P^{32} in the nodes of injected cane and in the tips and roots of young suckers.
Top right: Movement of P^{32} between two mature stalks. *Bottom right* : Transverse section of stalk showing concentration of P^{32} in the buds; the section in the middle is internodal.

NUTRITION AND SOILS

1. NITROGEN STUDIES

D. H. PARISH, L. ROSS, C. L. FIGON & C. CAVALOT

I. EFFICACY OF AMMONIUM SULPHATE ON SUGAR CANE

THE amount of fertilizer nitrogen recovered in a crop, expressed as a percentage of the fertilizer nitrogen applied, can be taken as an indication of the efficiency of the applied nitrogen in meeting crop needs.

In the temperate zones, recoveries of fertilizer N are very low, with arable crop figures, cited by COOKE (1964), ranging from 33% with potatoes to 50% with winter wheat (grain and straw), whilst with grassland the figures cited range from about 60% with perennial ryegrass to up to almost 90% with cocksfoot.

Under tropical and sub-tropical conditions, published results range from less than 10% up to 88% (HENZELL, 1962). Wide fluctuations have been observed in almost all the nitrogen-recovery experiments which have been made, thus the data of VINCENTE-CHANDLER, SILVA and FIGARELLA (1959) from experiments carried out in Puerto Rico, show fertilizer-nitrogen recoveries from pastures ranging from 32 to 76%, with an average of around 50%.

In temperate climates, the reason for the poor performance of arable crops compared with grassland must be that the grass, occupying the whole land surface, as it does, maintains low levels of nitrate in the mass, thus reducing leaching losses, but COOKE (*loc. cit.*) suggests that the beneficial effects of grass roots on soil structure may also be important in preventing slaking and packing of the soil aggregates, which could lead to conditions suitable for denitrification during wet weather. The suppression of nitrification by perennial grasses found to occur by THERON (1951) would also contribute to higher efficiencies under pasture when ammonium salts are used as the fertilizer-nitrogen source.

The apparently lower efficiency of nitrogenous fertilizers with tropical pasture than with temperate pasture, could be simply explained by assuming that with the high temperatures and rainfall conditions of the humid tropics, losses of fertilizer nitrogen are accentuated.

So far as sugar cane is concerned, an efficiency of utilization of fertilizer nitrogen of about 50% could be assumed from the fertilizer statistics of the advanced sugar producing countries.

Studies on the recoveries by sugar cane of fertilizer nitrogen applied at varying rates have been made by BORDEN (1948), who found around 45% recovery with 100 lb of nitrogen, and up to 70% with 220 lb of nitrogen/acre, thus implying better efficiencies at the higher rate of fertilization, whilst AYRES and HAGIHARA (1963) working in Hawaii found that less than 60% of fertilizer-nitrogen was recovered by the cane crop.

As there were field trial plots in Mauritius which had received 0, 30 and 60 kg of nitrogen per acre for four years, it was felt that an estimation of the nitrogen-fertilizer efficiency of these field trials would give more accurate data than Borden's, which were obtained from large pot experiments.

Experimental and results

The complete aerial portion of canes in a ten-foot strip from the four blocks of a 0, 30 and 60 kg N/acre trial which had been running for four years, and was therefore giving a very good response to the nitrogen treatments was collected, split into its component parts, weighed and analysed for total N by the Kjeldahl method. The nitrogen had been applied in the form of ammonium sulphate buried in pockets along the cane row, and as usual, adequate K and P fertilization had been made. The treatment results which are given in Table 6 are significantly different (P = 0.01).

Table 6. The nitrogen content (Kg N/acre) of a cane crop at the time of harvest

Fertilizer Treatment Kg N/acre	*Millable cane*	*Green Tops*	*Discarded Leaves*	*Total*	*Efficiency %*
0	7.4	10.3	2.1	19.8	—
30	14.8	12.8	3.7	31.3	38
60	21.1	18.3	7.4	46.8	45

These results show the recoveries of applied fertilizer nitrogen are more than one-third at the 30 kg N treatment, and almost one half at the 60 kg treatment level. As the treatment effects are highly significant, it would seem so far as sugar cane is concerned, that the efficiency of fertilizer nitrogen may be higher at the higher levels of application, although TAKAHASHI (1964) as a result of N^{15} studies concluded that the reverse was true.

According to COOKE (*loc. cit.*), the proportions of applied fertilizer recovered by crops are greatest at low rates of dressing, but even the results presented by this author show cases of higher percentage recoveries at higher nitrogen dressings.

The reason for the higher recoveries of nitrogen at the higher levels of fertilization could be simply explained by the greater vigour and growth of the cane plant, and consequently a more rapid uptake of nitrogen, thus reducing the effects of those factors leading to nitrogen loss.

Summary

The efficiency of fertilizer nitrogen for the cane crop of Mauritius has been found to vary from 38% with a 30 kg N/acre dressing up to 45% with 60 kg N/acre.

REFERENCES

AYRES, A.S, *and* HAGIHARA, H.H, (1963). A lysimeter study of losses of nitrogen and potassium. *Hawaii. Plrs' Rec.* **56** (4) : 255-263

BORDEN, R.J. (1948). Nitrogen effects upon yields and composition of sugar cane. *Hawaii. Plrs' Rec.* **52** : 1-51.

COOKE, G.W. (1964). Nitrogen fertilisers : their place in food production, the forms which are made, and their efficiencies. *Proc. Fertil. Soc.* No.80.

HENZELL, E.F. (1962). The use of nitrogenous fertilisers on pastures in the sub-tropics and tropics. *Bull. Commonw. Bur. Past. Fld Crops.* **46** : 161-172.

TAKAHASHI, D.T. (1964). N_{15} nitrogen field studies with sugar cane. *Hawaii. Plrs' Rec.* **57** : 198-221.

THERON, J.J. (1951). The influence of plants on the mineralisation of nitrogen and the maintenance of organic matter in the soil. *J. Agric. Sci., Camb.* **41**: 289-296.

VINCENTE-CHANDLER, J., SILVA, S. *and* FIGARELLA, J. (1959). The effect of nitrogen fertilisation and frequency of cutting on the yield and composition of three tropical grasses. *Agron. J.* **51** : 202-206.

II. STUDIES ON THE NITRIFICATION OF AMMONIUM SULPHATE AND ON THE MOVEMENT OF NITRATE IN SOIL PROFILES

The zonal soils of the humid tropics are latosols or latosolic soils, and by definition these soils are being actively depleted in bases and silica by leaching; it is natural, therefore, to assume that losses of nitrogen due to leaching will be of greater consequence with these soils than with temperate zonal or azonal soils.

Ammonium sulphate has been the standard nitrogenous fertilizer used in the tropics, but fertilizers containing cheap synthetic nitrate are appearing on the market in increasing quantities, and therefore studies of the movement of nitrate in the soil profile were made to supplement the information obtained in 1962 (PARISH, FIGON & ROSS, 1963).

Experimental

The average annual dressing of sulphate of ammonia used in Mauritius for sugar cane is about 250 kg/acre and as the dressing is banded along the cane row, the actual intensity of application, taking surface area covered into account, is at least 500 kg/acre; the fertilised plots, therefore, received this level of fertilization.

The experimental sites were chosen, one site at Réduit on a Low Humic Latosol with an annual rainfall of 61″, the other at Belle Rive on a Humic Ferruginous Latosol with a mean annual rainfall of 157″. The sites were in flat fields which had just been cleared after having been under cane for several years.

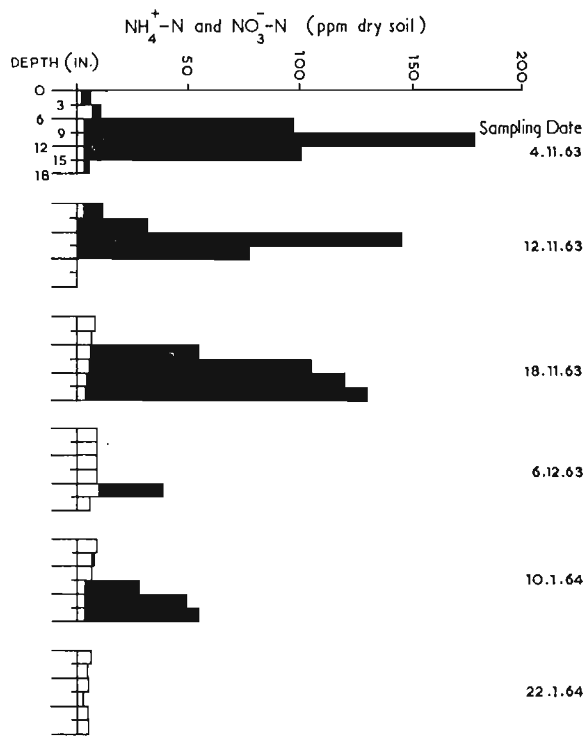
Six plots (9′ × 9′) were marked out, two receiving 500 kg of ammonium sulphate/acre, two receiving sodium nitrate at an equivalent level of nitrogen, and two were control plots. The plots were surrounded by small ditches to prevent contamination of the surfaces by soil wash, the whole area being kept free from weeds by hand weeding.

Soil sampling was carried out by digging a deep ditch at the edge of the plots and removing 3″ horizontal slices of the profile down to 18″.

Analyses were carried out for $NO_2^- + NO_3^-$—N (expressed as NO_3^-—N) and NH_4^+—N

Results

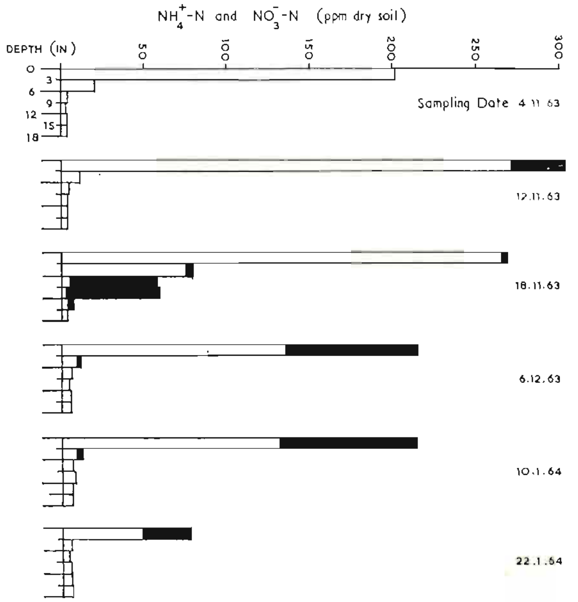
This sampling technique was considerably superior to the auger system, especially when the soil was dry, as contamination by surface soil running into the deeper layers was eliminated, and the detailed picture of the changes in nitrate and ammonium content throughout the profile obtained by the slice method, made the extra effort worth while. Analyses of the control plots showed that little or no ammonium or nitrate nitrogen was present in the profiles.



Site : Réduit   Soil : Low Humic Latosol

Rainfall from	29.10.63	to	4.11.63	=	4.81 ins.
	4.11.63		12.11.63		0.20
	12.11.63		18.11.63		6.70
	18.11.63		6.12.63		0.43
	6.12.63		10. 1.64		0.60
	10. 1.64		21. 1.64		28.83

Fig. 8. Changes in ammonium and nitrate nitrogen levels in profile of soil treated with a surface dressing of sodium nitrate.
Plain columns : ammonium nitrogen
Black columns: nitrate nitrogen



Site : Réduit Soil : Low Humic Latosol

Rainfall from	29.10.63	to	4.11.63	=	4.81 ins.
	4.11.63		12.11.63		0.20
	12.11.63		18.11.63		6.70
	18.11.63		6.12.63		0.43
	6.12.63		10. 1.64		0.60
	10. 1.64		21. 1.64		28.83

Fig. 9. Changes in ammonium and nitrate nitrogen levels in profile of soil treated with a surface dressing of ammonium sulphate.
Plain columns : ammonium nitrogen
Black columns: nitrate nitrogen

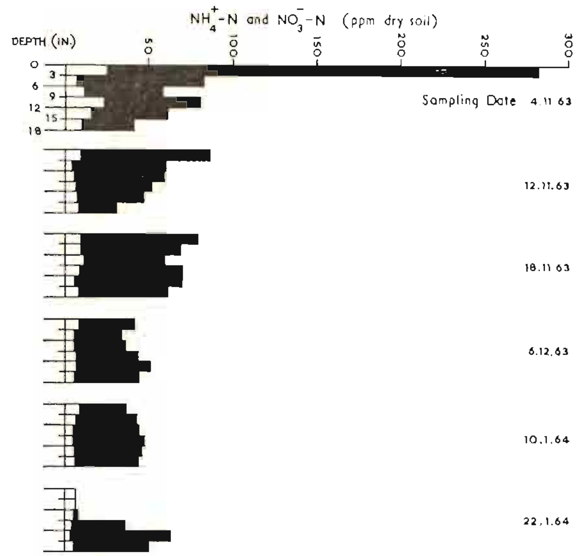
Changes in ammonium and nitrate distribution at the Réduit site. The results and rainfall data of the sodium nitrate-treated plots are given in fig. 8, and the results for the ammonium sulphate-treated plots in fig. 9.

These plots show a simple picture of elution down and from the profile. The nitrate levels in the lowest layer of the sampling dated 6/12/63 is probably a peak of deeper nitrate accumulation, as the dry conditions between the 18/11/63 and the 10/1/64 would lead to strong evaporation from the soil and consequent upward movement of nitrate, which is clearly demonstrated by the 10/1/64 sampling results.

Complete removal of the nitrate from the profile occurred with the heavy rains of the week 10/1/64 to 21/1/64, giving a complete loss of a dressing equivalent to about 100 kg N per acre in just under two months.

The ammonium sulphate-treated plot results (fig. 9) show that little or no downward movement of ammonium occurs, or if it does it is rapidly nitrified, and the nitrate formed removed from the profile by the heavy rains. About 75 p.p.m. of the fertilizer nitrogen was still present in the surface 0-3″ layer on 21/1/64, showing that, although ammonium sulphate is fairly rapidly nitrified and the nitrate leached out of the profile, on the deep free-draining Low Humic Latosols it is a more persistent form of nitrogen than sodium nitrate.

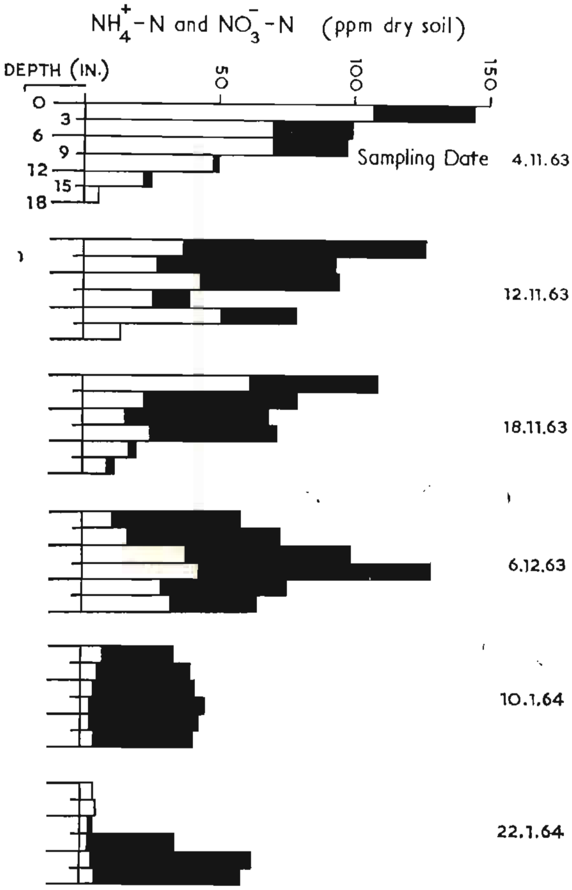
Changes in ammonium and nitrate distribution at Belle Rive. The results for the Belle Rive site (figs. 10 and 11) are entirely different from those of the Réduit site, as both the sodium nitrate and the ammonium sulphate-treated plots show almost identical changes in total nitrogen distribution.



Site : Belle Rive Soil : Humic Ferruginous Latosol

Rainfall from	30.10.63	to	4.11.63	=	7.66 ins.
	4.11.63		12.11.63		0.26
	12.11.63		18.11.63		3.31
	19.11.63		6.12.63		3.05
	7.12.63		10. 1.64		4.06
	10. 1.64		23. 1.64		40.40

Fig. 10. Changes in ammonium and nitrate levels in profile of soil treated with surface dressing of sodium nitrate.
Plain columns : ammonium nitrogen
Black columns: nitrate nitrogen



Site : Belle Rive Soil : Humic Ferrugionus Latosol

Rainfall from	30.10.63	to 4.11.63	=	7.66 ins.
	4.11.63	12.11.63		0.26
	12.11.63	18.11.63		3.31
	19.11.63	6.12.63		3.05
	7.12.63	10. 1.64		4.06
	10. 1.64	23. 1.64		40.40

Fig. 11. Changes in ammonium and nitrate levels in profile of soil treated with a surface dressing of ammonium sulphate.
Plain columns : ammonium nitrogen
Black columns: nitrate nitrogen

The 4/11/63 sampling of the ammonium plots shows that the 8″ of rain which fell in the preceding week had spread the ammonium through the profile almost as much as it had nitrate, showing that the Humic Ferruginous Latosol absorbs ammonium only weakly. SHERMAN (1955) found movement of ammonium from sulphate of ammonia through a Low Humic Latosol profile, but as in this work solutions of fertilizer were merely poured on to the soil, the results cannot be taken as proof of movenemt under field conditions.

The B horizon of the Humic Ferruginous Latosol great soil group is compact, whilst the A horizon is loose and gravelly due to the large amount of concretions. This leads to a B horizon which is almost waterlogged in periods of heavy rain, and to strong lateral drainage of the surface layer, thus accounting for the persistence of nitrate in the lower part of the profile, even after 40″ of rain fell in the fortnight 10/1/64 to 23/1/64. Under these conditions sodium nitrate is seen to be as persistent a source of nitrogen as sulphate of ammonia.

The persistence of nitrate in the profile in conditions approaching water logging supports the results presented later which show that denitrification is not a serious source of nitrogen loss in bare latosols.

Summary

The nitrification of surface-applied sulphate of ammonia and the movement of nitrate through the profile of a Low Humic and a Humic Ferruginous Latosol have been studied.

The nitrification rate of ammonia is sufficiently rapid to make this form of nitrogen only slightly more persistent in a free-draining soil than nitrate, whilst the movement of ammonium down the profile which occurs with the Humic Ferruginous Latosol, and the poor drainage of the B horizon of this great soil group eliminate any advantage of persistence which the ammonium form of nitrogen may have under more normal conditions.

Most of a dressing of fertilizer nitrogen is removed from a bare soil profile in about two months. The losses found in these experiments would, of course, have been reduced in the presence of a growing cane crop; however, heavy rains are common in November and December, and as many soils in Mauritius are very shallow and rocky, the use of heavy dressings of nitrate and even of ammonium nitrogen at this period, on these soils, is not without some risk.

REFERENCES

PARISH, D.H., FIGON, L.C. *and* ROSS, L.P. (1963). A field study of the nitrification rate of ammonium sulphate and the subsequent loss of nitrate. *Rep. Maurit. Sug. Ind. Res. Inst.* **9** : 48-55.

SHERMAN, G.D. (1955). Fertility problems of tropical soil management in the Hawaiian Islands. *Hawaii. Plrs' Rec.* **55** : 65-75.

III. STUDIES ON DENITRIFICATION LOSSES

The term denitrification is reserved to describe microbial reduction of $—NO_3^-$ to gaseous nitrogen compounds or to elemental nitrogen itself.

Attempts to determine the extent of losses of nitrogen in the field due to this process have not been particularly successful, as an accurate figure for the total soil nitrogen and of losses of nitrogen from the soil by leaching, volatilization of ammonia, and crop removal are needed.

It is not surprising therefore that ALLISON (1955) in his review should have referred to the 'enigma of soil nitrogen balance'. It has been suggested that loss of nitrogen and its gaseous oxides from the soil could be caused by non-biological mechanism, the most commonly suggested being the Van Slyke reaction of the amino group with nitrous acid, although using N^{15}, ALLISON and DOETSCH (1951) showed that under field conditions this reaction was of no significance.

The reduction of nitrates by bacterial activity was first described by GAYON and DUPETIT (1886), and since that time the denitrifying bacteria have been found to be facultative anaerobes which denitrify in conditions of low oxygen partial pressures, although MEIKLEJOHN (1940), using culture tubes, and CARTER and ALLISON (1960), and CLARK, BEARD and SMITH (1950), using soils, have recorded losses of nitrogen even under aerated conditions. Denitrification is most active in the pH range of 7—8.6, and below pH 5 is suppressed (SKYRING and CALLOW, 1962).

BREMNER and SHAW (1958) found that with low partial pressures of oxygen, maximum denitrification occurred at high temperatures (50°C) in the presence of a readily decomposable energy source, such as glucose, and in the presence of sufficient nitrate, a set of conditions which, agriculturally speaking, appears to be very artificial.

GREENLAND (1962) has studied denitrification in Ghanian soils using Bremner's and Shaw's techniques, and concluded that, although denitrification is stronger with these soils than with temperate soils under optimal conditions for this reaction, it is unlikely that in cultivated soils any serious loss of nitrogen occurs by denitrification; under grassland conditions losses were also considered to be negligible, since the nitrate levels are invariably very low.

WOLDENDORP (1963) using N^{15} has shown that the roots of living plants can stimulate denitrification by reducing oxygen tensions in the rhizosphere, through their respiration, and by excreting organic substances which serve as hydrogen donors during denitrification, and it is obvious now that the only worthwhile studies in denitrification will include N^{15} techniques.

Nevertheless, with the high soil temperatures and high levels of nitrate which occur in a recently fertilized cane field, denitrification could be significant, provided the partial pressures of oxygen were low enough.

As during cyclonic disturbances and consequent periods of heavy rainfall temporary waterlogging of recently fertilized cane soils may occur in Mauritius, an examination of the denitrifying potential of two zonal soils, using the Bremner and Shaw (*loc. cit.*) techniques, was considered to be of interest.

Experimental and results

For the first experiment, a Humic Ferruginous Latosol of the Belle Rive family was used. These soils occur in a rainfall zone with a mean annual rainfall of about 150″, and some of the profiles, particularly on flat land or in depressions, show incipient gleying; of the zonal soils, they are the ones most likely to give the low oxygen tensions associated with waterlogging. They are, however, acid, the pH of the plough layer ranging from 5.2—5.6, which is the lower end of the pH range at which denitrification can take place.

Four samples of soil were taken, the A and B horizons of a virgin site under scrub and grass, and the top and subsoil from a cane row in a field which had been under cane for fifteen years. The prepared samples were incubated at 60% and 120% M.W.H.C. (maximum waterholding capacity) with added nitrate, and analysed at intervals for total N; the whole sequence of treatments and analyses being as described by BREMNER and SHAW (*loc. cit.*).

The results, which are the means of duplicate determinations, are given in Table 7 and show that, although the reproducibility of the method leaves something to be desired, no significant changes in total N occurred.

The experiment was repeated on a Low Humic Latosol of the Réduit family, a soil which has excellent infiltration and drainage characteristics, so that low oxygen tensions will probably be more dependent on the biological oxygen demand of the rhizosphere than on the actual physical effects of waterlogging.

Because denitrification is pH-dependent, the soil taken for this study had a pH of 7.2, at which pH the denitrifying micro-organisms are quite active.

The soil was taken from a row of growing cane and prepared for analysis immediately, thus eliminating the possibility that some labile source of energy, that could act as a hydrogen donor, was being destroyed during air-drying and thus reducing the possibility of detecting denitrification. The field had been continually cropped with sugar cane for more that twenty-five years, and the soil samples were taken from the centre of the cane line where root growth is most active.

The results are given in Table 8.

These results, which are the means of triplicate determinations, show once more that denitrification of nitrate is not a source of nitrogen loss in tropical soils free of growing plants, so that if denitrification does occur in growing cane crops, it must occur as a result of the mechanism suggested by Woldendorp (*loc. cit.*).

Table 7. Changes in total soil N (p.p.m. oven-dried soil) on incubation with added nitrate and at two moisture levels

	Humic Ferruginous Latosol							
	60% M.W.H.C.				*120% M.W.H.C.*			
	Virgin Land		*Cane Land*		*Virgin Land*		*Cane Land*	
	Top Soil	*Sub Soil*	*Top Soil*	*Sub Soil*	*Top Soil*	*Sub Soil*	*Top Soil*	*Sub Soil*
Soil ...	3461	1436	3143	1438	3461	1436	3143	1438
Soil + nitrate at start ...	5032	2695	4427	2770	5032	2695	4427	2770
,, ,, after 3 days ...	5070	2790	4519	2688	4990	2774	4403	2803
,, ,, after 12 days ...	5089	2859	4574	2888	4960	2745	4374	2773

Table 8. Changes in total soil N (p.p.m.) on incubation with added nitrate and at two moisture levels

	Low Humic Latosol			
	60% M.W.H.C.		*120% M.W.H.C.*	
	Top Soil	*Sub Soil*	*Top Soil*	*Sub Soil*
Soil N at start	2685	1818	2685	1818
Soil + NO_3^- at start	3631	2830	3631	2830
,, ,, after 3 days ...	3659	2859	3716	2859
,, ,, ,, 6 days ...	3659	2887	3675	2869
,, ,, ,, 12 days ...	3688	2907	3675	2887
,, ,, ,, 18 days ...	3716	2847	3659	2830

Table 9. The effect of varying C:N ratios on the denitrification of added nitrate (1,000 p.p.m.) at 120% M.W.H.C.

	Belle Rive *Humic Ferruginous Latosol*			**Reduit** *Low Humic Latosol*		
C:N	*N at start*	*N after 20 days*	*% of added N lost*	*N at start*	*N after 20 days*	*% of added N lost*
1	3871	2954	92	4310	3258	105
2		2966			2989	
4		2932			3159	
8		3041			3448	
16		3058			3192	
32		3126			3286	
64		3029			3250	
128		3032	84		3290	102

As a check on experimental technique and on the potential of the two soil groups for denitrification, two soils were incubated for twenty days with glucose and nitrate at varying C:N ratios and a nitrate N addition of 1,000 p.p.m. The results, which are the means of triplicate determinations, are given in Table 9 and show that almost complete denitrification of the added nitrate occurred, and that unlike the soils used by Bremner and Shaw (*loc. cit.*) no indication of significant N fixation under waterlogged conditions and in the presence of large accounts of glucose occurred.

Summary

Denitrification in growing cane, if it does occur, must be due to the effects of the roots of the cane crop in reducing oxygen tension by respiration and by secreting hydrogen donors.

Only N^{15} techniques can show whether in fact, denitrification under these conditions does occur.

REFERENCES

ALLISON, F.E. (1955). The enigma of soil nitrogen balance sheets. *Adv. Agron.* 7 : 213-250.

ALLISON, F.E. *and* DOETSCH, J. (1951). Nitrogen gas production by the reaction of nitrites with amino-acids in slightly acid media. *Proc. Soil Sci. Soc. Am.* **15** : 163.

BREMNER, J.M. *and* SHAW, K. (1958). Denitrification in soil. *J. Agric. Sci., Camb.* **51** : 22-52.

CARTER, J.N. *and* ALLISON, F.E. (1960). Investigations on denitrification in well-aerated soils. *Soil Sci.* **90** : 173-177.

CLARK, F.E., BEARD, W.E. *and* SMITH, D.H. (1960). Dissimilar nitrifying capacities of soils in relation to losses of applied nitrogen. *Proc. Soil Sci. Soc. Am.* **24** : 50-54.

GAYON, U. *and* DUPETIT, G. (1886). Réduction des nitrates par les infiniment petits. *M. Soc. Bordeaux*, Ser. 3,2 : 201-214. Cited by WOLDENDORP, J.W. (1963). *Meded. LandbHoogesch. Wageningen* **63** (13): 1-100.

GREENLAND, D.J. (1962). Denitrification in some tropical soils. *J. Agric. Sci., Camb.* **58** : 227-233.

MEIKLEJOHN, Jane (1940). Aerobic denitrification. *Ann. appl. Biol.* **27** : 558-573.

SKYRING, G.W. *and* CALLOW, Barbara, J. (1962). The physiology and biochemistry of nitrification and denitrification. *Bull. Commonw. Bur. Past. Fld Crops* **46** : 56-71.

WOLDENDORP, J. W. (1963). The influence of living plants on denitrification. *Meded. LandbHoogesch. Wageningen.* **63** (13) : 1-100.

IV. COMPARISON BETWEEN UREA AND AMMONIUM SULPHATE AS NITROGEN SOURCES FOR SUGAR CANE

PARISH and FEILLAFÉ (1960) showed that surface-applied urea was inferior to surface-applied sulphate of ammonia as a nitrogen source for sugar cane and they concluded that «*in view of the intense biological activity occurring in tropical soils, it would seem reasonable to think of urea merely as a convenient way of storing and applying the unstable salt ammonium carbonate.*» This concept immediately suggests that the only way to use urea on a practical scale would be to bury it sufficiently deeply to prevent volatilization losses.

Experimental

A series of randomized block trials with urea and ammonium sulphate applied at rates equal to 0, 30 and 60 kg N/acre were laid down with two methods of placement, surface and buried. As many soils in Mauritius are extremely rocky, and burying of fertilizer is impossible for these soils, the urea and ammonium sulphate were dissolved in water and watered on, this treatment being considered as equivalent to burying.

As usual, adequate phosphatic and potassic fertilization was given.

Results

The variation in the yields from these trials was large, due no doubt to the effects of the cyclones of 1960, 1962 and 1964, and in order to obtain significant treatment effects, yields for years and sites had to be pooled.

The 30 kg N/acre level gave no significant differences between forms and placement, but the 60 kg N/acre level did (Table 10).

Table 10. Analysis of form and placement experiments. Nitrogen applied at 60 Kg/acre†

	Treatment	*(T.C.A.)*		*Treatment differences* 5	4	3	2
1.	Sulphate of ammonia (buried) ...	(31.6)	100	20.3**	8.2*	4.4*	3.2*
2.	Urea (buried)	(30.6)	96.8	17.1**	5.0*	1.2	
3.	Sulphate of ammonia (surface) ...	(30.2)	95.6	15.9**	3.8*		
4.	Urea (suface)	(29.0)	91.8	12.1**			
5.	Control	(25.2)	79.7				

† Figures are % of treatment 1; significant difference by Q-test on means of 11 trials during 3 years.

* Sig. at 5% level
** Sig. at 1% level

Discussion

The significant improvement in the efficacy of urea when it is buried, or watered on, compared with when it is applied on the surface, can be explained simply in terms of reduction of volatilization losses.

The apparent superiority of buried sulphate of ammonia to surface-applied sulphate of ammonia, and the superiority of buried sulphate of ammonia to buried urea need discussing.

It is accepted that losses of ammonia from ammonium sulphate applied on the surface of alkaline soils can be high, but the soils of the experimental sites were slightly acid to acid as the pH values in Table 11 show.

Table 11. Soil pH at trial sites

Variety	*Zone*	*No. of sites*	*Soil pH*
M.147/44	Sub-humid	4	6.6; 6.7; 6.6; 6.9
B.37172	Humid	4	5.6; 5.4; 6.1; 5.4
B.3337	Super-humid	3	5.6; 5.4; 5.8

However, even on acid soils, alternate wetting and drying of heavy surface dressings of sulphate of ammonia may cause nitrogen loss; moreover, there is the practical point that surface dressings are exposed to surface erosion, and it is felt now that every effort to bury or cover fertilizers is well worth while.

As regards the yield differences between buried ammonium sulphate and buried urea, possible explanations are that when urea is hydrolysed in the soil, the pH rises considerably above 7 and therefore free ammonia may occur and plant roots damaged (Cooke, 1962); or that toxic accumulations of nitrite occur (Court, Stephen and Waid, 1962) due to the suppression of nitrification by the high pH of the soil surrounding the zone of urea hydrolysis.

It would seem from the yield results of this last series of experiments, comparing buried and surface-applied urea and ammonium sulphate, that buried urea approaches sulphate of ammonia in efficacy.

No European field experiments have apparently been done comparing buried and surface-applied urea (Cooke, 1964), but recent American results (Meyer, Olson and Rhoades, 1961, and Jackson and Burton, 1962) show that burying urea does improve considerably its efficacy as a source of nitrogen.

REFERENCES

COOKE, I.J. (1962). Damage to plant roots caused by urea and anhydrous ammonia. *Nature, Lond.* **194** : 1262-1263.

COOKE, G.W. (1964). Nitrogen fertilisers : their place in food production, the forms which are made and their efficiencies. *Proc. Fertil. Soc.* No. 80.

COURT, M.N., STEPHEN, R.C. *and* WAID, J.S. (1962). Nitrite toxicity arising from the use of urea as a fertiliser. *Nature, Lond.* **194** : 1263-1265.

JACKSON, J.E. *and* BURTON, G.W. (1962). Influence of soil treatment and nitrogen placement on the utilisation of urea nitrogen on coastal Bermuda grass. *Agron. J.* **54** : 47-49.

MEYER, R.D., OLSON, R.A. *and* RHOADES, H.F. (1961). Ammonia losses from fertilised Nebraska soils. *Agron. J.* **53** : 241-244.

PARISH, D.H. *and* FEILLAFE, S.M. (1960). A comparison of urea with ammonium sulphate as a nitrogen source for sugar cane. *Trop. Agric. Trin.* **37** : 223-225.

V. EFFECT OF AMMONIACAL AND NITRATE NITROGEN AND TIME OF APPLICATION.

Thousands of trials must have been carried out to compare sodium nitrate with sulphate of ammonia as nitrogen sources for various crops; CAREY and ROBINSON (1953) reviewed the results of 254 experiments carried out in the British Commonwealth up to about 1943, and HODNETT (1956) extended this work up to about 1955.

One of the earliest references to comparisons between sulphate of ammonia and nitrate of soda as nitrogen sources for sugar cane must be that of BONAME (1902). Although this worker detected no difference between the two forms, he expressed a fear, which still exists in the tropics, that severe losses of nitrate might occur following heavy rain, «*de sorte qu'il n'est pas à recommander de faire de fortes fumures avec nitrate au début de la saison pluvieuse*».

The reviews of Carey and Robinson and Hodnett (*loc. cit.*) lead only to the conclusion that sodium nitrate and ammonium sulphate give similar standard responses (3.0 T.C.A. and 3.3 T.C.A. respectively, for 50 lb N/acre).

AYRES (1955) concluded for Hawaiian conditions that all forms of nitrogen are apparently equally efficacious as nitrogen sources for sugar cane, and this general statement was supported by DAVIDSON (1963) in his review of work carried out in Florida.

The failure to demonstrate a difference in yield response between two fertilizers, assuming they are compared only at levels and under conditions where a yield response could be expected, could be due to the fact that some unknown factor was limiting the yields.

When the results of leaching trials are considered, the reason that little difference has been obtained when sodium nitrate and ammonium sulphate have been compared is that ammonium sulphate itself is fairly rapidly nitrified, so that comparisons are really being made between a true nitrate source (sodium nitrate) and a mixed nitrate and ammonium source (ammonium sulphate). However, small differences between the two forms in the persistence of nitrogen did exist, and although sodium nitrate is now too expensive ever to be a commercial fertilizer for sugar cane, the increasing production and consumption of complex fertilizers, all of which contain about one-third of their nitrogen as nitrate nitrogen, make it essential that reliable data on the degree of nitrate-nitrogen losses under field conditions be obtained.

Moreover, as the complex fertilizers contain nitrate, they acidify the soil less than an equivalent amount of ammonium sulphate, a fact which is developing into a strong sales point.

Considering these points, it was felt that a new series of experiments comparing the efficacy of sodium nitrate and sulphate of ammonia as nitrogen sources for sugar cane was worth while, and the effects of the acidification of latosols by sulphate of ammonia were also examined.

The introduction by GORING (1962) of 2-chloro-6 (trichloromethyl) pyridine as a material for controlling nitrification in soils and the results of laboratory studies on the effect of this material on nitrification rates (PARISH, 1964) made field trials with this material also worth while.

Experimental and results

(*a*) *Sulphate of ammonia, sodium nitrate trials*

Four 5×5 latin square trials were laid down in 1961, two in the super-humid zone on Humic Ferruginous Latosols, and two in the humid zone in Low Humic Latosols. No results were obtained in 1962 because of cyclonic damage, but in 1963 the four trials were harvested.

Only two of the experiments gave significant yield increases with nitrogen, one at Beau Plan showing that nitrate and ammoniacal forms are equivalent, whilst the other at Bar le Duc, although showing little difference in final yields, gave vegetative indices which strongly suggest a marked loss of efficiency of applied N at the 60 kg level as sodium nitrate (Table 12).

Table 12. Comparison of sulphate of ammonia and sodium nitrate (5 × 5 latin square)

Site		Control	Sulphate of ammonia 30 kg N/acre	Sulphate of ammonia 60 kg N/acre	Nitrate of soda 30 kg N/acre	Nitrate of soda 60kg N/acre
Beau Plan	T.C.A.	19.4	35.4	44.2	33.5	42.4
	V.I.	100	139	155	134	147
	Mn p.p.m. D.M. (TVD)	21.6	26.8	42.6	24.6	22.6
Bar le Duc	T.C.A.	24.1	28.5	32.4	26.7	29.0
	V.I.	100	106	112	106	104

One interesting point, in view of the current work on the possibility of manganese toxicity and induced molybdenum deficiency, was the effect of ammonium sulphate, through its acidification of the soil, on manganese uptake which in the case of the 60 kg N level was almost doubled.

(b) The effect of 2-chloro-6 (trichloromethyl) pyridine (N-Serve) on cane responses to sulphate of ammonia

In view of the fact that N-Serve decreased significantly the nitrification rate of sulphate of ammonia buried in the soil, six field trials covering the full range of soils met with in Mauritius, were laid down in 1963 to test this material on a field scale.

The design used was a split plot (N-Serve, no N-Serve) 4 × 4 latin square with 0, 15, 30 and 45 kg N/acre treatments.

The N-Serve was dissolved in methylene chloride and added to crystalline sulphate of ammonia to give a concentration of 2% of N-Serve on a nitrogen-content basis, the whole mass being tumbled in a drum until dry. In the field, both the treated and untreated fertilizers were placed in small holes about 6 inches deep around the cane stools and then covered immediately with soil. Detailed studies of cane yields, N% D.M. of the T.V.D. leaf laminae and the V.I., showed that no significant effects of the N-Serve treatment could be detected. The growing season 1963-64 was not a good one, but 1964-65 was, and yet again no effects of N-Serve were detected.

Many chemicals are known which retard nitrification when added to the soil, and moreover some both retard nitrification and increase the mineralization of soil nitrogen (Gasser and Peachey, 1964). There is, therefore, a great possibility that a material which could be used on a commercial scale to prevent nitrification of the ammonium ion and increase the mineralization of soil nitrogen, will become available for use on an agricultural scale eventually.

(c) The uptake of nitrogen by sugar cane and the effect of split doses of nitrogenous fertilizer

Cane is harvested in Mauritius from July to December, and the heavy rains and hot weather occur in January, February, March and April. Fertilizer practice, based on past experimental evidence, is to apply all the nitrogen in a single dressing as soon as possible after harvesting. This means that late-harvested cane is fertilized in, or just before, the period of heavy rains, when, as was seen from the nitrification and leaching studies, rapid removal of fertilizer nitrogen from the soil profile takes place, implying that much loss of nitrogen must occur before strong assimilation by the cane starts.

Taking into consideration the foregoing facts, it is felt that further studies on the effect of split applications on nitrogenous fertilizer efficiency, on the degree of nitrogen tolerance of a 'nitrogen tolerant' variety, and on the uptake and distribution of nitrogen by the cane crop are needed if any improvement in the efficacy of fertilizer-nitrogen use by the sugar cane is to be obtained.

Two field experiments were laid down on a uniform area of the variety M.93/48 which had been harvested at the end of November 1963.

The first trial was to assess the effect of single and split doses of nitrogen applied at rates of 0, 15, 30 and 45 kg of nitrogen/acre on final cane yields.

The design was on 4 × 4 split plot. The single dose of nitrogen was applied at the beginning of December, and five equal split doses were applied at the beginning of December, the beginning of January, the end of January, the middle of March and the middle of April. The second trial was designed to check the degree of nitrogen tolerance of the variety used by applying a fairly heavy dressing of nitrogen late in the season.

The experiment was laid down at the end of April 1964 in the same field, on an area which had been fertilized by the estate with 50 kg of N/acre in early January 1964.

The design used was six blocks split into two plots, to one of which 30 kg N/acre (as sulphate of ammonia) was added. Cane yields and sucrose percentage were determined at the time of harvest.

A trial was designed to study the uptake of nitrogen from plots which had received no nitrogen, and 45 kg of nitrogen, in a single early dressing and in split dressings fractionized as above; treatments were carried out in triplicate.

From these plots, the total aerial portion of cane growth from 5 ft of cane row was harvested at approximately monthly intervals. Care was taken when harvesting to avoid any gaps from previously harvested strips so that the border effects of light and competition were avoided. Initially the growth consisted only of green tops, and was weighed and analysed as such, but later sub-division into green tops, cane and trash was made. To avoid losses due to falling leaves the total number of nodes in each harvest sample was counted and the trash figure corrected for fallen leaves.

Growing conditions during 1964 were not good, and the canes in this series of experiments were affected to some extent by an early drought and an exceptionally cold winter period (July, August and September).

(*d*) *Dry matter production and uptake of nitrogen*

Studies of the uptake and distribution of nitrogen with a heavy crop like sugar cane are extremely difficult, as is the interpretation of the results. BORDEN (1948) following his detailed studies of growth and nitrogen uptake under Hawaiian conditions stated, «*As is usually found in studies where small samples of cane are taken from field plots, the experimental errors are often quite large and many real differences may not be reliably established as treatment effects; however, if their existence can be rationalized, they may be tentatively accepted*».

This difficulty of carrying out a discussion on fertilizer effects on sugar cane yields, using arguments based on the classical concept of statistics, is again illustrated in a recent paper by STANFORD and AYRES (1964) who present an interesting discussion on the 'internal nitrogen requirement' of sugar cane without any statistical assessment of fiducial limits.

There is little difficulty in establishing statistically the significance of the effect of nitrogen fertilization on the nitrogenous composition of sugar cane, but it is often difficult to detect differences in yield of less than 5% by the usual field trial techniques, and yet commercially, differences of this order are of vital interest.

The results of the 'uptake of nitrogen' trial illustrate the difficulty of detecting treatment effects on the yield of dry matter, but once nitrogen composition effects are examined, several significant treatment effects are found.

(*e*) *Dry matter production*

Examination of the yields of dry matter obtained in the uptake of nitrogen studies, *viz.*: no nitrogen, 45 kg of nitrogen in a single early dose, and 45 kg in split doses, showed that there were no statistically significant differences between treatments, although at the late harvest dates an increase in yield following nitrogenous fertilization was apparent.

Fig. 12 which presents the dry matter yields of the bulked split and single dose nitrogen treatments, shows the typical logarithmic growth pattern associated with a young crop with a rapidly increasing canopy, or in effect leaf-area index. The most rapid rate of production of dry matter for this late harvested crop

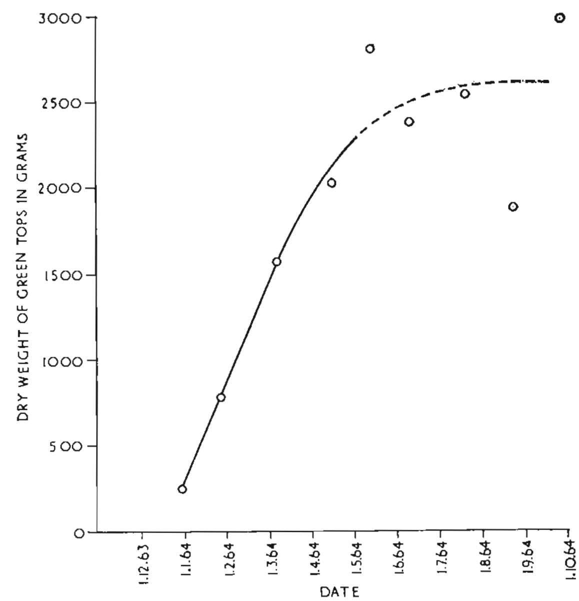


Fig. 12. Dry weight of green tops/unit area.
Points are mean of 45 kg N split and single applications.

occurred in the period March-April-May; thereafter the rate of development fell, and the yield curve must become a sigmoid, as indicated by the broken line, and statiscal analysis of the data confirmed this. This inflection of the curve which starts at the beginning of June, shows that the rate of accumulation of dry matter is falling off, but that even so, about one third of the total dry matter production of this crop was synthesized after this date.

The decline in dry matter production from June onwards could be due directly to the reduction in leaf area, or indirectly as a result of a reduction in assimilation due to a lowering of temperatures and of incident sunlight, or a combination of both.

When the quantity of total dry matter contained in the green cane tops is plotted against time (fig. 13) it is seen that the weight increases rapidly up to the beginning of May, and that thereafter no significant changes can be detected.

If the weight of green cane tops is taken as an indication of leaf area and therefore of photosynthetic potential, much of the decline in the net assimilation rate must be due to the fact that the L.A.I. of the cane crop at this time is falling off, and that in effect the L.A.I. of the cane crop is a factor limiting dry matter production.

The work of EVANS (1935) implies that after the first four months, the weight of green tops/acre is constant, but an increase in L.A.I., and then a decline with the onset of maturity, appear to give a more rational picture.

In this connection the work of THORNE and WATSON (1955), and THORNE (1962) is of interest. These authors found that the leaf area of field crops of winter wheat reaches a maximum in July, shortly before ear emergence, and subsequently falls rapidly. As the dry matter that fills the grain is all produced by photosynthesis after ear emergence, there was the possibility that yields of grain could be increased if the decline of leaf area from its maximum could be delayed. As senescence and death of leaves are associated with loss of nitrogen to other parts of the plant, these authors studied the effect of applying additional nitrogen at the time of maximum leaf area, and found, in fact, that increases in grain yield could be obtained.

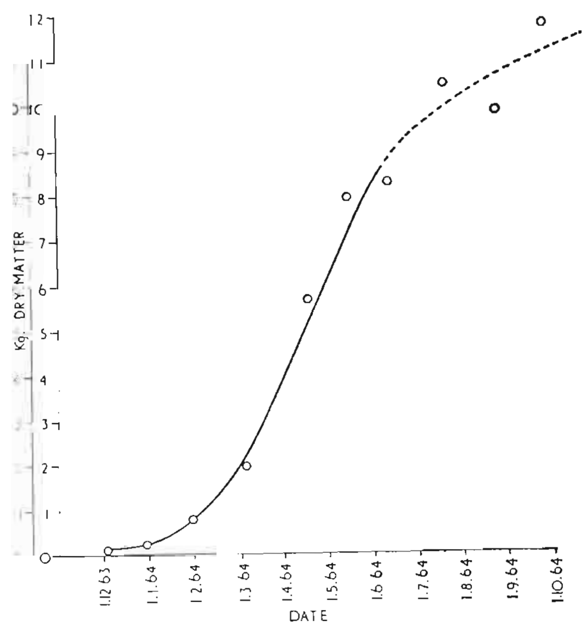


Fig. 13. Dry matter production/unit area with 45 kg N/acre.

One point which the work of Thorne (*loc. cit.*) stresses, is the danger of extending the results of pot experiments to field conditions, as, quite naturally, when the yields of materials such as grain or sugar are being studied, the effects of competition for light and water determine the pattern of growth and, hence the final vegetative composition of the crop. The differences in environmental conditions between cane grown in pots, or single stools plots, are so different from plantation conditions that results obtained from experiments based on small scale growth should probably be rejected, particularly as regards long term nitrogen studies.

As the months of January, February, and March are the hottest and wettest, conditions are ideal for growth, but because of the low L.A.I. of a late-harvested cane crop at this stage, dry matter production is low.

Nitrogen applied late in the season has been shown to increase dry matter production, and therefore in terms of practical agriculture, the opportunities which remain for increasing the yield of cane are the boosting of the initial canopy production and/or the L.A.I. in the months of March and April, when dry matter production is at its highest rate.

The initial canopy could be increased by leaving as much green tissue, in the form of young shoots, in the field as possible after harvest, and encouraging early growth by irrigation and fertilization, but there are practical limits to which this effort can be pushed.

In the months of March and April, however, labour is available, and growth is not normally limited by climatic conditions so that the forcing of nitrogen assimilation with resultant increases in leaf area could possibly be practised; the use of foliar application of some nitrogen source suggests itself, and work on this subject is needed.

(*f*) *Uptake and distribution of nitrogen*

Van Dillewijn (1952) has reviewed the voluminous literature on the uptake and distribution of nitrogen by the cane crop.

Much of the information available on the subject is of little general interest, as no original physiological principles are involved, the work being generally confined to studies on the relationships between the amount of nitrogen removed by the cane crop, its distribution in the major vegetative components, and the sensitivity of various selected tissues in reflecting the intensity of nitrogenous fertilization.

Studies on the effect of split applications of nitrogen on yield and nitrogen recovery have also been made, particularly by the Hawaiian workers (Borden, 1948), but none has compared the effects of a single dose of nitrogenous fertilizer applied just before the rainy season with the same dose split into smaller amounts, but all applied during the time the cane was rapidly assimilating nitrogen.

The results of the periodic harvests in terms of dry matter yield have been discussed, but when considering the efficacy of a nitrogen fertilizer treatment, yields of nitrogen/acre are needed.

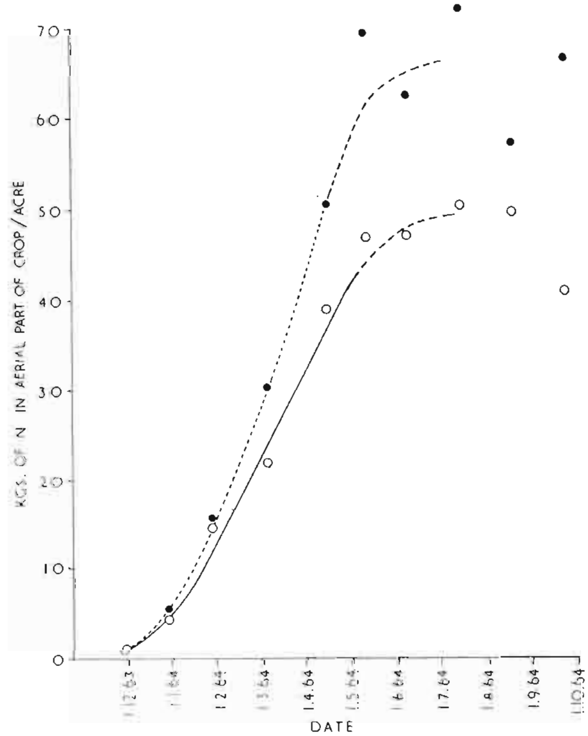


Fig. 14. The effect of nitrogen fertilization and time on the uptake of nitrogen by sugar cane.

o———o ON
• - - - - - • 45 kg N/acre

This information, which is given in fig. 14 confirms that nitrogen uptake is most rapid in the first few months of growth; it also demonstrates clearly, however, that the recovery of the fertilizer nitrogen applied increases with time, although even at five months, the last really reliable sampling, no more than 20 kg of nitrogen had been recovered from the 45 kg applied. If nitrification and leaching are active in the early months of the year, it would seem that the fertilizer nitrogen recovered later in the year must have been stored.

The effect of the split applications was not significant in terms of yield of nitrogen, possibly because of the very large errors associated with this type of harvesting experiment; however, when the various tissues collected were analysed significant effects were obtained.

Fig. 15 shows the changes with time of the average nitrogen content (% D.M.) of the aerial growth of cane under the three treatments.

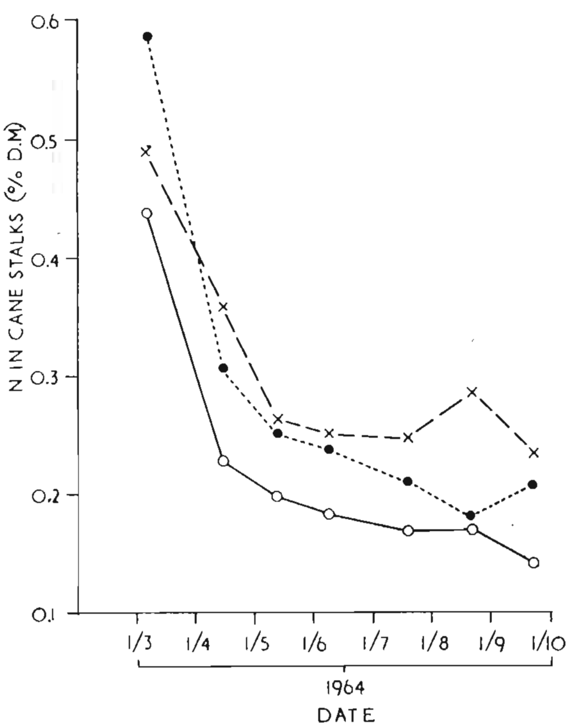


Fig. 15. The effect of age and nitrogen treatment onthe nitrogen content of cane stalks (N% D.M.)

o——o ON
•------• 45 kg. N single dose
×— —× 45 kg. N. split doses

The general picture is that the nitrogen content of the dry matter falls rapidly with time until the May harvest, after which date the curve becomes asymptotic.

The effects of the different treatments are not noticeable until the May harvest, when the split nitrogen treatment leads to a significantly higher nitrogen content of the dry matter.

The increase in nitrogen content of the dry matter at the later harvest dates is due primarily to the increase in the nitrogen content of the cane stalk, particularly with the split doses, as can be seen from fig. 16.

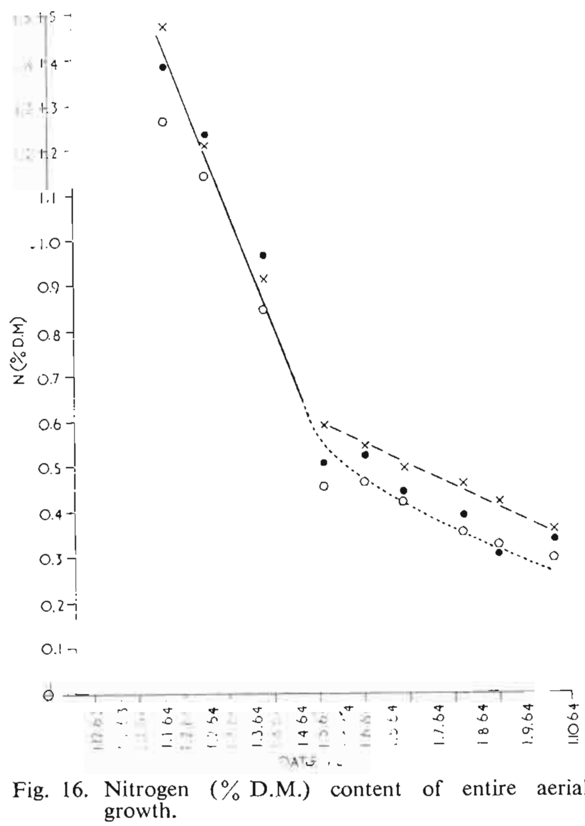


Fig. 16. Nitrogen (% D.M.) content of entire aerial growth.

o o ON
•--• 45 kg. N single dose
× × 45 kg. N split doses

The conclusions to be drawn from this work are that small quantities of late applied nitrogen tend to be stored in the cane stalk and are without significant effect on the L.A.I. It would thus seem once more that the most likely way of getting nitrogen into the green tissues in the critical first five months is by foliar application.

Summary

Field trials have shown that surface-applied urea is inferior to surface-applied sulphate of ammonia as a nitrogen source for sugar cane.

Burying of urea improves its performance considerably by reduction of volatilization losses.

Burying of sulphate of ammonia also improves its efficacy, even though the soils of the experimental sites were slightly acid to acid.

No difference in efficacy could be detected between sulphate of ammonia and nitrate of soda as nitrogen sources.

No improvement in the efficacy of sulphate of ammonia in terms of cane yield or nitrogen uptake followed the use of 2-chloro-6 (trichloromethyl) pyridine.

No beneficial effect of split applications of nitrogenous fertilizers on cane yields has been detected.

The problem of improving the efficacy of nitrogen fertilization is discussed.

REFERENCES

AYRES, A.S. (1955). Forms of fertiliser material in relation to efficiency of utilisation. *Hawaii. Plrs' Rec.* **55** : 65-75.

BONAME, P. (1902). Nitrate de soude et sulphate d'ammoniaque. *Rep. Stn Agron. Maurice* **10** : 38-53.

BORDEN, R.J. (1948). Nitrogen effects upon fields and composition of sugar cane. *Hawaii. Plrs' Rec.* **52** : 1-51.

CAREY, T.M. *and* ROBINSON, P. (1953). The manuring of sugar cane. *Emp. J. expt. Agric.* **23** : 99-115.

DAVIDSON, L.G. (1963). Sources of nitrogen for sugar cane in Louisiana. *Proc. int. Soc. Sug. Cane Technol.* **11** : 87-91.

EVANS, H. (1935). Investigations on the course of growth in a virgin, or plant crop, of sugar cane. *Sug. Cane. Res. Stn Maurit.* Bull. 7, pp. 36.

GASSER, J. K.R. *and* PEACHEY, J.E. (1964). A note on the effects of some soil sterilants on the mineralisation and nitrification of soil nitrogen. *J. Sci. Fd Agric.* **15** : 142-146.

GORING, C.A.I. (1962). Control of nitrification by 2-chloro-6(trichloromethyl) pyridine. *Soil Sci.* **93** : 211-218.

HODNETT, G.E. (1956). The responses of sugar cane to fertilisers. *Emp. J. exp. Agric.* **24** : 1-19.

PARISH, D.H. (1964). Chemical fertilisation. *Rep. Maurit. Sug. Ind. Res. Inst.* **10** : 53.

STANFORD, G. *and* AYRES, A.S. (1964). The internal nitrogen requirement of sugar cane. *Soil. Sci.* **98** : 338-344.

THORNE, Gillian N. (1962). Effect of applying nitrogen to cereals in the spring or at ear emergence. *J. agric. Sci., Camb.* **58** : 89-96.

THORNE, Gillian N. *and* WATSON, D. J. (1955). The effect of yield and leaf area of wheat of applying nitrogen as a top dressing in April, or in sprays at ear emergence. *J. agric. Sci., Camb.* **46** : 449-456.

VAN DILLEWIJN, C. (1952). The botany of sugar cane. Chronica Botanica Co., Waltham, U.S.A.

2. THE PHOSPHORUS STATUS OF MAURITIUS SOILS AS DETERMINED BY CHEMICAL EXTRACTANTS AND FOLIAR DIAGNOSIS

D. H. PARISH, Y. WONG YOU CHEONG, & L. ROSS

The most important factor limiting plant growth in Mauritian soils ten years ago was phosphorus deficiency; since then, with liberal phosphate fertilisation, the soil reserves have been built up and the phosphate status is now generally good.

The use of soil analysis for forecasting phosphate fertilisation needs has been used widely in Hawaii, South Africa, and Australia. The most common extractant used is dilute sulphuric acid of various strengths, but many alternative extractants are also used. A recent F.A.O. study showed that the most popular extractant is Olsen's sodium bicarbonate solution.

As the various extractants remove different chemical forms of phosphate, the distribution of phosphate in local soils was studied, and various extractants were compared.

The standard extractant used in Mauritius is the modified Truog which has given very good results in forecasting soils in which phosphate limits the growth of the plant crop. The problem of deciding phosphate fertilizer needs for the ratoon crop has not been considered, as foliar diagnosis is completely adequate ; it still remains, however, of interest to study the problems of phosphate nutrition of ratoon crops.

The phosphorus status of the Mauritian sugar cane crop is followed by foliar diagnosis of canes from Permanent Sampling Units. To avoid any fluctuations due to other conditions three-year means of twice-yearly leaf samplings are taken as far as possible. The leaf P levels have been correlated with available phosphorus as determined by soil analysis for these sampling units.

Experimental

About 450 soil samples, covering a wide range of neutral and acidic latosolic soils and latosols, with a few alkaline soils, were analysed for available phosphorus using the following extractants :- 0.02 N H_2OS_4 + 3 g $(NH_4)_2$ SO_4 (TRUOG, as modified by PEECH, 1944, and AYRES, 1952), 0.5 M $NaHCO_3$ (OLSEN, 1954) 0.03 N NH_4F in 0.025 N HCl (BRAY'S No. 1, 1945) and 0.1 N NaOH (SAUNDER, 1956).

Correlation coefficients were calculated for those soils considered to be deficient by the levels of available P (Truog) and between the different extractants and the foliar P levels (Tables 13 and 14).

Leaf P was determined colorimetrically after dry ashing according to the molybdo-vanadate method, corrections being made for the age and the variety of the canes. Leaf samples were taken at the boom stage of vegetative growth according to the method now currently in use in Mauritius, and the data used were the mean of at least two years' samplings.

For the comparison between the different extractants, all the soils were grouped together, but for the comparison between the extractants and foliar diagnosis, each soil group was considered on its own.

Results

Table 13 shows that there is correlation between all the extractants, but the highest correlation is obtained between the mild extractants.

Table 13. Correlation of the phosphorus removed by different extractants

		Correlation coefficients		
		Olsen	*Bray's No. 1*	*Saunder*
Deficient Zonal Soils	Truog	0.691***	0.379***	0.221*
Deficient Zonal & Intrazonal Soils	Truog	0.448***	0.451***	0.273**
,,	Saunder	0.339**	0.462**	—
,,	Bray	0.309**	—	—

Table 14. Correlation of foliar levels of P with P removed by different extractants

		Correlation coefficients			
	Type of Soil	*Truog*	*Olsen*	*Bray's No. 1*	*Saunder*
Foliar Diagnosis P	Latosolic Reddish Prairie	N.S.	N.S.	0.358*	0.519**
	Latosolic Brown Forest	0.495**	0.893**	0.435**	0.469**
	Low Humic Latosol	N.S.	N.S.	N.S.	0.524**

*** Significant at 0.1% level
** ,, ,, 1% ,,
* ,, ,, 5% ,,
N.S. Not significant

Of the latosols, only the Low Humic Latosols give any significant correlation between foliar levels of P and soil P (Saunder); no correlation is obtained for the Humic Latosols and the Humic Ferruginous Latosols.

The correlation coefficient for the Latosolic Reddish Prairie Soils between foliar P and Truog and Olsen, although not significant, however approaches significance at 5% probability level.

Discussion

A typical CHANG and JACKSON (1957) fractionation of representative soils from the soil families of Mauritius is given in Table 15.

Table 15. Fractionation of Mauritius Soil Families*

	p.p.m. P						
	Loose bound P	*Al-P*	*Fe-P*	*Ca-P*	*Reductant soluble P*	*Occluded Al-P*	*Occluded Al-P and Fe-P*
Latosolic Reddish Prairie ...	0	36	275	62	380	20	16
Latosolic Brown Forest ...	0	16	158	21	411	4	12
Low Humic Latosol ...	0	12	161	26	220	12	27
Humic Ferruginous Latosol	0	62	160	25	208	13	20

* Chang and Jackson method.

As the soils get older and the degree of laterisation increases, there is a shift of phosphorus from calcium phosphate towards aluminium phosphate and iron phosphate. In latosols, added phosphate is held in the form of iron phosphate (CHANG and CHU, 1961) and as Table 15 shows, it may represent over 70% of available phosphorus in Mauritian latosols.

There would be decreasing correlation between Truog and the other extractants as the strength of these extractants increases; Bray's No. 1 and Saunder, which are selective for Al-P and Fe-P, would extract more of these fractions and would reflect the quantity or capacity factor of the phosphorus status of the soils, whereas Truog and Olsen would be more related to the intensity factor (easily available phosphate).

This is in fact borne out by the results. The correlation between Truog (range 0-20ppm P) and Olsen is highly significant ($r = 0.691^{***}$, 0.1% probability level); that between Truog and Bray is smaller (r 0.379***, 0.1% level) although still highly significant, whereas between Truog and Saunder, the significance is only at 5% level. Essentially the same results are obtained for a greater range of Truog values (0-40 ppm P).

Sugar cane has a long growing season. WILLIAMS and KNIGHT (1963) stated that for crops with long growing seasons, quantity measurements were of more significance than intensity measurements. The correlation cœfficient between soil analysis and crop figures did not exceed 0.70 even for the carefully controlled pot experiments.

SUSUKI *et al.* (1963) found that a test which gave a measure of aluminium phosphate was a better indicator of long-term availability of soil phosphorus, whilst Truog only gave a measure of immediate availability. This would hold true for a test for Fe-P, as this is by far the most important fraction in latosols.

Therefore, the extractants that would be expected to give any correlation at all between soil analysis and leaf phosphorus (an indication of long-term phosphorus availability) would be those that reflect the quantity factor, i.e. Saunder.

In fact, only Saunder gave a correlation (at 1% level) with leaf analysis on latosolic soils and Low Humic Latosols.

No correlation was obtained on Humic Latosols and Humic Ferruginous Latosols. This fact is not surprising. A correlation between soil analysis and plant analysis can only be obtained at low leaf levels. However, the latosols of the humid zones have the best phosphorus status of the soils of Mauritius; the leaf levels are near the optimum and tend to lie between 0.200 and 0.210 (P % dry matter) whereas the Saunder soil values show much greater variation.

On Mauritius latosols, Saunder values above 300 p.p.m. P seem to indicate adequate phosphorus nutrition.

Summary

Various phosphorus extractants have been compared : Truog, Olsen, Bray's no. 1 and Saunder's extractants are all correlated.

Distribution of phosphate in Mauritius soils shows that Fe and Al phosphates are the dominant forms.

Saunder's extractant correlates with foliar diagnosis of sugar cane, showing that aluminium and iron phosphates are active sources of phosphorus for ratoon crops.

REFERENCES

AYRES, A.S. *and* HAGIHARA, H.H. (1952). Available phosphorus in Hawaiian soil profiles. *Hawaii. Plrs' Rec.* **54** : 81-99.

BRAY, R.H. *and* KURTZ, L.T. (1945). Determination of total, organic and available forms of phosphorus in soils. *Soil Sci.* **59** : 39-45.

CHANG, S.C. *and* CHU, W.K. (1961). Fate of soluble phosphate applied to soils. *J. Soil Sci.* **12**: 286-293.

CHANG, S.C. *and* JACKSON, M.L. (1957). Fractionation of soil phosphorus. *Soil Sci.* **84** : 133-144.

OLSEN, S.R., COLE, C.V., WATANABE, F., *and* DEAN, L.A. (1954). U.S.D.A. Circular 939.

PEECH, M., ALEXANDER, L.T., DEAN, L.A. *and* REED, J.F. (1947). Methods of soil analysis for soil fertility investigations. U.S.D.A. Circular 757.

SAUNDER, D.H. (1956). Determination of available phosphorus in tropical soils by extraction with sodium hydroxide. *Soil Sci.* **82** : 457-463.

SUSUKI, A., LAWTON, K. *and* DOLL, E.C. (1963). Phosphorus uptake and soil as related to forms of phosphorus in some Michigan soils. *Proc. Soil Sci. Soc. Am.* **27** : 401-403.

WILLIAMS, E.G. *and* KNIGHT, A.H. (1963)). Evaluation of soil phosphate status by pot experiments, conventional extraction methods, and labile phosphate values estimated with the aid of phosphorus-32. *J. Sci. Fd Agric.* **14** : 555-563.

3. INTERSTALK MOVEMENT OF PHOSPHATE IN SUGAR CANE BY MEANS OF RADIO-ACTIVE PHOSPHORUS

Y. WONG YOU CHEONG & C. L. FIGON

The method of application of phosphate to the soil is important, but in a stooling crop like the sugar cane, it is equally important to know if interstalk movement of phosphate is possible. In principle, if there is interstalk movement, a single root may feed the whole stool in phosphate.

SCHROO (1953) stated that soon after stooling the stalks become separated, each of them fed by its own root system and without any intercommunication, whereas BURR (1953) was of the opinion that movement occurred between all parts of a sugar cane stool. Later work carried out at H.S.P.A Experiment Station in 1956 confirmed Burr's findings.

Whilst it is relatively easy to ascertain whether there is any physical connection between the stalks, the use of a radiotracer and autoradiographs will afford definite proof of actual movement between the stalks.

Experimental

A small hole about 2 mm. deep was bored in an internode about half-way up the stalk. One end of a wetted wick 5 cm. long was pushed into the hole, ensuring close contact, while the other end dipped into a small glass vial containing 25μc P^{32} in 1 ml. of water.

After a week, the stool was carefully dug up and those stalks with no obvious connections with the injected cane, discarded. Radio-activity was determined by a portable ratemeter; plane sections were made and left in contact with no-screen X-ray films (Kodirex) in a deep-freeze chamber for a fortnight.

Results

Movement of radio-active phosphorus within the injected cane was very rapid. Phosphorus accumulated mainly at the nodes, in the young meristematic tissues, in the veins and in the buds (Pl. II).

Although there was translocation of P^{32} to other mature stalks, this movement was more pronounced in the case of suckers, specially to the leaf tips and the roots. This fact is of agronomic importance because «babas» which have been feeding off the mother stalk thus receive an early start in phosphorus nutrition compared to cuttings whose root systems are not yet sufficiently well developed.

Our work has shown that there is interstalk movement even between mature stalks each with its own root system, but in some cases the "bridges" rot away and the stalks become independent of each other.

REFERENCES

BURR, G. O. (1953). Basic problems of sugar cane nutrition. 1. Absorption and distribution of tagged elements by sugar cane. *Proc. int. Soc. Sug. Cane Technol.* **8** : 45-51.

H.S.P.A. Expt. Station Committee (1956). *Rep. Hawaiian Sug. Plrs' Ass. Exp. Stn*, 1956 : 13.

SCHROO, H. (1953). The fertility of sugar cane soils with special regard to phosphate. *Proc. int. Soc. Sug. Cane Technol.* **8** : 116-124.

4. TRACE-ELEMENT STATUS OF SUGAR CANE IN MAURITIUS

D. H. PARISH, E. C. VIGNES, C. CAVALOT & M. ABEL

Although certain trace element deficiencies were known to exist on sugar cane in Mauritius, they were associated only with peculiar sites, such as soils with very high pH, or cold, waterlogged conditions; on the zonal or intra-zonal soils no deficiencies had been recorded.

Experiments with maize and cauliflower have shown that large areas exist with low reserves of zinc, copper and molybdenum, and it was thought worthwhile to study the zinc, copper and molybdenum status of cane from typical areas of Mauritius.

Accordingly, ten confounded randomized block trials were laid down in 1963 to study the nutritional status of cane in copper, zinc, and molybdenum, and the effects, if any, of soil treatment with these trace elements on cane yields.

Zinc was determined by the method of WESTOO (1963), and copper as given in *The Analyst* (1963). Molybdenum was determined following dry ashing of the plant material by a modified thiocyanate stannous chloride method (BARSHAD, 1949).

The results of the trace element analyses carried out are given in Table 16. The Cu content of the T.V.D. leaf laminae of cane grown in areas typical of Mauritian cane land is about 8 p.p.m. on a dry matter basis, which is higher than the accepted minimum level of $<$ 5 p.p.m.; the Zn levels are on the average 15 ppm, and the critical level for cane is accepted

Table 16. Trace Element levels (p.p.m. D.M.) of Cu. Zn & Mo in cane T.V.D. leaf laminae at boom stage of vegetative growth.

No.	*Site*	*Soil Group*	*Cu.*	*Zn.*	*Mo.*
23/63	Sans Souci	H.F.L.	8	15	0.05
24/63	Metheline	H.F.L.	8	14	0.05
25/63	New Grove	L.B.F.	8	15	0.06
27/63	Bénarès	L.H.L. (pH 6.5)	8	19	0.03
28/63	Bonne Mère	L.H.L. (pH 5.2)	7	12	0.03
29/63	Mon Désert	H.L.	7	13	0.10
30/63	Beau Songe	L.H.L. (pH 7+)	6	14	0.11
31/63	Solitude	L.H.L. (pH 7+)	7	14	0.17

as $<$ 10 p.p.m. These results imply that Cu or Zn deficiencies are unlikely to be limiting yields on the normal soil of Mauritius, although the actual levels occurring do imply that soil reserves are not high; a careful watch of the copper and zinc status of sugar cane, particularly in areas of high pH must therefore be initiated.

Yield increases in this series of trials were negative, so far as effects of Cu and Zn were concerned.

The molybdenum levels of the foliage of sugar cane are extremely low, and obviously the analytical difficulties in determining accurately such low levels are great.

The critical level for molybdenum in the T.V.D. leaf lamina of sugar cane is accepted to be less than 0.05 p.p.m., so the acid Low Humic Latosols of site 27/63 Bénarès and 28/63 Bonne Mère may be genuinely deficient.

Yield results gave no effect of molybdenum treatment at Bénarès, but the 1965 harvest results given in Table 17 gave a significant response (5% level) at Bonne Mère to the molybdemum treatment.

Table 17. Effect of trace elements treatments on cane yields at Bonne Mère, 1965 harvest (1st Ratoons)

Treatment	*Yield T.C.A.*	*S% Cane*
0. Control	33.4	13.7
1. Cu (25 kg Copper Sulphate/arp.)	36.2	13.4
2. Zn (25 kg Zinc Sulphate/arp.)	35.3	13.5
3. Mo (5 kg Sodium Molybdate/arp.)	40.8	13.8
1 + 3 Cu Mo	41.4	13.9
1 + 2 Cu Zn	36.4	13.2
2 + 3 Mo Zn	37.0	13.7
1 + 2 + 3 Cu Zn Mo	39.5	14.0

Sucrose % cane was not significantly affected. The acid Low Humic Latosols, being highly manganiferous, give cane with very high manganese levels, and therefore, the possibility of a molybdenum deficiency induced by manganese antagonism must be considered, and further work on this line becomes essential.

REFERENCES

SOCIETY FOR ANALYTICAL CHEMISTRY (1963). The determination of small amounts of Cu in organic matter. *Analyst, Lond.* **88** : 253-258.

BARSHAD, E. (1949). Mo determination in plant material. *Analyt. Chem.* **21** : 1148

D'HOTMAN DE VILLIERS, O. (1947). Sur des résultats d'études relatives à la réjuvénation de nos sols épuisés des régions humides par incorporation de poussière basaltique. *Rev. agric. Ile Maurice* **26** : 160-175.

FEILLAFÉ, S.M. (1954). Preliminary results of liming soils of the super-humid zone. *Rep. Maurit. Sug. Ind. Res. Inst.* **1** : 33-37.

PARISH, D.H. (1963). Chemical fertilization : Phosphate. *Rep. Maurit. Sug. Ind. Res. Inst.* **10** : 55-65.

WESTOO, G. (1963). A dithizone method for determining Zn in organic material. *Analyst, Lond.* **88** : 287-291.

5. YIELD RESPONSES OF SUGAR CANE TO POTASSIUM, CALCIUM, MAGNESIUM, PHOSPHORUS AND SILICON

D. H. PARISH

1. Potassium, Calcium, Magnesium trials

A series of factorial experiments with K, Ca and Mg at two levels each, were laid down in 1963.

K was applied at 0 and 200 kg of muriate /arpent annually, Ca as coral sand at 0 and 2 tons/arpent once only, and Mg as Epsom salt at 0 and 100 kg/arpent annually. Basic phosphatic fertilizer was 200 kg of ammonium phosphate/arpent, and the nitrogen was supplemented as ammonium sulphate to give 45 kgN /arpent annually.

Virgin and 1st ratoon harvests were taken and the yield results are given in Table 18.

Sheath samples collected in 1965 were analysed for Ca and Mn, and the mean results of the O Ca and +Ca treatments are given at the foot of Table 18.

As can be seen, yield data were extremely variable; significant yield responses were obtained only from the potassium treatments. The analytical data show, however, that even as little as two tons of coarse coral sand/arpent, when mixed with the soil, can increase sheath calcium and lower sheath manganese levels significantly, thus demonstrating the sensitivity of sheath composition to slight changes in soil acidity.

Table 18. The effect of potassium, calcium, magnesium, and their interaction on yields of cane

	Virgins T.C.A. Site					*1st Ratoons T.C.A. Site*				
	3	4	5	6	7	3	4	5	6	7
Control ...	28.6	25.5	33.2	12.2	—	13.8	—	31.7	25.3	36.5
K ...	35.2	22.4	32.9	16.8	—	16.8	—	38.2	30.3	40.0
K Ca ...	33.7	26.0	36.4	15.6	—	14.0	—	39.8	27.9	37.8
K Mg ...	35.1	26.8	29.3	16.6	—	12.6	—	40.4	33.7	39.9
K Ca Mg	35.5	21.9	32.8	16.2	—	16.9	—	38.7	31.1	37.3
Ca ...	32.6	20.2	32.1	14.3	—	16.8	—	34.6	24.5	36.7
Ca Mg ...	31.3	25.1	30.5	12.0	—	16.0	—	33.7	23.1	35.7
Mg ...	34.1	20.2	28.2	13.4	—	16.9	—	34.7	23.5	26.3

Ca% D.M. & Mn p.p.m (in brakets) of leaf sheaths

Treatment	*Site* 3	4	5	6	7
O Ca ...	0.179(120)	0.218(66)	0.210(125)	0.171(145)	0.153(94)
+ Ca ...	0.193(105)	0.220(49)	0.232(92)	0.193(126)	0.165(86)

Table 19. Effect of phosphate and coral sand applied at planting on the yields, and calcium and manganese status of 3rd ratoon cane

	T.C.A. Site			*Ca% Site*			*Mn p.p.m. Site*		
Treatment	*13/61*	*15/61*	*17/61*	*13/61*	*15/61*	*17/61*	*13/61*	*15/61*	*17/61*
1. Guano phosp.	38.2	32.2	38.4	0.122	0.156	0.148	133	116	89
2. Ammonium phosp.	38.1	32.7	37.9	0.116	0.139	0.144	182	138	93
3. 1 + Sand	40.5*	36.2	37.4	0.134	0.164	0.162	138	102	71
4. 2 + Sand	42.4**	35.0	41.3	0.144	0.167	0.175	169	109	76
5. Control	35.6	33.8	39.1	0.109	0.122	0.164	160	138	107

* Treatment effects significant at 5% level
** ,, ,, ,, at 1% level

2. Phosphorus and Calcium trials

In 1961 a series of 6 × 6 latin squares were laid down, in which guano-phosphaté (local rock phosphate) and ammonium phosphate, used at 125 kg P_2O_5/acre, were compared with and without coral sand applied at a rate of 3 tons/acre.

In the first year, there was a strong response to the phosphate treatment, particularly the ammonium phosphate treatment (PARISH, 1963) but in the first ratoon crop, no treatment effects were apparent; in second ratoons, there was a slight, though still non-significant, response to sand + phosphate, whilst in the third ratoons harvested in 1965, an effect of sand application in the presence of phosphate became apparent.

Results of the yields (TCA) and of the dried sheath analyses for Ca% and manganese p.p.m., are given in Table 19. Although yields were only significantly increased at one site, in all cases the calcium content of the sheaths was markedly increased, whilst the manganese levels tended to fall with the sand treatment.

Yields of canes, when the results of the three trials were bulked, were significantly higher (5%) in the coral sand plus phosphate treatments, than in the straight phosphate treatments.

The soil at site 13/61 was a Humic Ferruginous Latosol, whilst the other two sites were Latosolic Brown Forest soils. The soil pHs at site 13/61 were in water 4.9 and 5.3, and in KCl 4.4 and 4.9 without sand and with sand, respectively.

FEILLAFÉ (1955) had already demonstrated that yield responses to applications of lime at 2 tons/acre occur on the Latosolic Brown Forest soils, but the results presented here are the first to demonstrate a yield response to low levels of liming in a Humic Ferruginous Latosol; D'HOTMAN (1947) showed that massive doses of coral sand (15 tons/acre) increased cane yields on the Humic Ferruginous Latosols. It can be concluded, therefore, that all the highly leached soils of Mauritius are limiting plant growth, probably by a combination of low calcium status, high available manganese, and low silica contents.

Current recommendations are to add coarse coral sand at 3—5 tons/acre to bring the pH, in water, of the Humic Ferruginous Latosols above 5.3, and the Latosolic Brown Forests above 5.5.

3. Siliceous amendments

Field trials in which the effect on yields of basalt dust, factory ash, and sodium silicate were studied, have proved disappointing in that no significant treatment effects have been recorded.

This point draws attention to the difficulty of carrying out field experiments in the superhumid zone where climatic conditions for cane growth are often marginal, particularly with the cyclones of 1960, 1962, 1964, and the small but late cyclone of 1965 aggravating the whole problem.

Many experiments on the use of calcareous and siliceous amendments are now underway, which, it is hoped, will pin-point accurately the reasons for the increase in yields of cane. However, the principal point to remember when the results of these trials are considered is that work of this nature must be concerned with long-term effects; therefore, experiments must run for at least three years.

Laboratory and pot experiments on the inter-relationships between P, Si, Mn, Fe and Al have been initiated in the belief that this work will give more rapid results than the laborious one of long-term field experimentation under what, in the last few years at any rate, can be considered as very adverse conditions.

REFERENCES

PARISH, D.H. (1964). Chemical fertilisation. *Rep. Maurit. Sug. Ind. Res. Inst.* 10 : 60.

FEILLAFÉ, S.M. (1955). Preliminary results of liming soils of the super-humid zone. *Rep. Maurit. Sug. Ind. Res. Inst.* **1** : 33-37

D'HOTMAN de VILLIERS, O. (1947). Sur des résultats d'études relatives à la réjuvénation de nos sols épuisés des régions humides par incorporation de poussière basaltique. *Rev. agric. Ile Maurice* **26** : 160-175.

6. PRELIMINARY NOTES ON LEACHING OF NITROGEN IN LYSIMETER STUDIES

D. H. PARISH & M. HARDY

Though the leaching of nitrogen from bare Mauritius soils has been studied by PARISH, FIGON and ROSS (1962), a study of this nutrient movement in soils with a cover of sugar cane would yield a more accurate picture for practical purposes. Changes in soil flora, soil atmosphere, rate of nitrification, drainage and root effects, among other factors, may alter the rate of leaching of nitrogen.

Experimental

In Research project 33(5) started in 1963 three soil types are studied in 6 lysimeters as follows :

(a) Lysimeters I, III, V : "free" soils from Palmyre (Low Humic Latosol of the "Richelieu" family). In lysimeter I, however, the rocks were replaced in the same position as found in the soil profile during digging (29% rocks by volume).

(b) Lysimeter II. : "gravelly" soil from Palmyre (Latosolic Reddish Prairie of the "Médine" family).

(c) Lysimeter IV and VI : free soils from Savannah (Low Humic Latosol of the "Réduit" family).

Rain water, irrigation water, and leachates were analysed for nitrogen and the totals worked out for the crop. The nitrogen was added as sulphate of ammonia.

Changes in soil nitrogen or nitrogen removed by the crop were not taken into consideration.

Results

Table 20. gives the amounts of nitrogen added to the soil and removed from it. Fig. 17 shows the total nitrate leached with time.

Leaching losses of nitrogen from lysimeters I and II are high, owing to the rocky and gravelly nature of the soil. On "free" soils, the leaching losses are much smaller and are of little importance, thus implying a fairly high efficacy of nitrogen in these dry areas if losses by other means are ignored. The soils are slightly acid to neutral; therefore, losses by volatilization of ammonia occur mainly by wetting and drying and are probably small.

From fig. 17, it may be seen that the leaching of nitrate has not reached a maximum after eleven months and seems to be proceeding at much the same rate as before. PARISH *et al* (*loc. cit.*), however had obtained complete

Fig. 17. Cumulative leaching of N in lysimiters I to VI, 1965.

Table 20. Percentage of N leached in each lysimeter by 1965 crop

$NO_3^- + NO_2^-$ N *in grams*

Lysimeters	I	II	III	IV	V	VI
Fertilizers	63.0	63.0	63.0	63.0	63.0	63.0
Irrigation	12.9	14.9	10.9	11.6	13.9	12.6
Rain	2.1	2.1	2.1	2.1	2.1	2.1
Total N added ...	78.0	80.0	76.0	76.7	79.0	77.7
Total N leached ...	30.5	16.8	4.6	3.1	3.1	2.0
% N leached ...	*39.0*	*21.0*	*6.0*	*4.0*	*3.9*	*2.6*

nitrification of ammonium sulphate and leaching of nitrate from a bare soil profile after three months; they concluded that losses of nitrate by leaching on a practical scale could possibly be unimportant.

The high figures of nitrogen content of irrigation water are explained by the fact that the water has previously been used to irrigate sugar cane in other fields, thereby leaching away the fertilizer nitrogen in the furrows.

REFERENCE

PARISH, D.H., FIGON, C.L., *and* ROSS, L.P. (1962). A field study of the nitrification rate of ammonium sulphate and the subsequent loss of nitrate. *Rep. Maurit. Sug. Ind. Res. Inst.* **9** : 48-55.

7. NOTES ON THE CHEMICAL COMPOSITION OF RAIN AND IRRIGATION WATER

MICHEL HARDY

In 1963, Research Project 33(5) was implemented by the M.S.I.R.I. to study evapotranspiration of sugar cane, and a secondary aim of the project was to determine the nutrition balance of sugar cane plants growing in each lysimeter. The amount and quality of water, both rain and irrigation, were therefore carefully controlled. Some of the results obtained are presented in this note.

Rain Water

Summer rains are richer in N-content than winter rains as shown in Table 21. Of the 25 inches rainfall registered in 1964-65, 8.98 inches fell in winter (May to October) bringing 0.496 kg. N to the soil, while 16.33 inches fell in summer (November to April) and brought 2.358 kg. N. The total N thus supplied to the soil per arpent for that particular year amounted to 2.854 kg., or the equivalent of 14 kg. ammonium sulphate, and although important from an experimental angle, this amount is not expected to influence cane growth to a marked extent.

The amount of solutes contained in rain water may be high in a maritime climate where winds blowing from over the ocean bring sea spray in contact with rain. This applies more particularly to chlorides, as may be seen from Table 22 which gives the results of chemical analysis carried out on samples collected in 1964 and 1965.

Irrigation water

Irrigation water is of varying composition. This is not only due to its origin, but also to whether or not leachates from tail ditches are returned to the main or distributing canal. Table 23 shows the results of 12 analyses made on samples collected at each irrigation in 1964-65.

Table 21. N content of rain water

Period	*Amount of rain inches*	*$NO_2^- + NO_3$-N p.p.m.*	*Total N received Kg. per arpent*
May 19th to June 6th	0.37	0.6	0.022
June 7th to August 1st	2.09	0.8	0.167
August 2nd to September 1st ...	2.32	0.4	0.093
September 2nd to October 4th ...	3.82	0.5	0.191
October 5th to October 27th ...	0.38	0.6	0.023
Winter totals & mean	*8.98*	*0.6*	0.496
October 28th to November 11th ...	0.10	1.5	0.015
November 12th to November 29th ...	1.13	1.2	0.136
November 30th to December 15th ...	0.39	1.9	0.074
December 16th to January 5th ...	1.22	2.0	0.244
January 6th to March 23rd ...	5.31	1.0	0.531
March 24th to April 7th	6.27	1.8	1.129
April 8th to May 18th	1.91	1.2	0.229
Summer totals & mean	*16.33*	*1.4*	*2.358*
Year totals & mean	*25.31*	*1.1*	*2.854*

Table 22. Cl, $SO_4^=$ & K content of rain water

Period	*Amount of rain inches*	*pH*	*Cl*	*So_4 p.p.m.*	*K*
May 19th to June 6th	0.37	7.6	21.3	4.0	13.0
June 7th to August 1st	2.09	7.5	20.6	4.0	1.8
August 2nd to September 1st ...	2.32	7.9	17.8	2.0	6.3
September 2nd to October 4th ...	3.82	7.8	17.8	2.0	6.0
October 5th to October 27th ...	0.38	7.6	18.8	3.1	2.9
October 28th to November 11th ...	0.10	7.9	32.0	4.0	1.0
November 12th to November 29th ...	1.13	7.9	17.8	1.8	1.5
November 30th to December 15th ...	0.39	7.6	28.4	3.6	4.5
December 16th to January 5th ...	1.22	8.3	24.9	1.8	7.8
January 6th to March 23rd ...	5.31	7.4	14.2	4.1	7.2
March 24th to April 7th	6.27	7.2	35.5	4.0	1.0
April 8th to May 18th	1.91	7.2	17.8	8.6	6.3
Totals & means	*25.31*	*7.4*	*22.2*	*3.6*	*4.1*

Table 23. Results of 12 irrigation water samples analysis expressed in p.p.m.

Samples	*pH*	*$NO_2^- + NO_3$-N*	*K*	*SO_4*	*Cl*
1 ...	8.6	1.3	2.0	6.3	28.4
2 ...	8.3	5.8	4.0	20.0	28.4
3 ...	8.4	1.6	2.0	3.5	29.1
4 ...	8.5	2.2	3.0	7.0	29.8
5 ...	8.4	1.6	4.0	7.0	28.4
6 ...	8.3	1.5	2.0	14.0	29.8
7 ...	—	—	—	—	—
8 ...	—	—	—	—	—
9 ...	9.0	1.5	23.6	—	—
10 ...	8.4	2.3	5.0	13.0	28.4
11 ...	7.1	1.2	3.0	8.0	24.7
12 ...	7.5	0.8	13.0	4.0	20.6
Mean ...	*8.2*	*1.98*	*6.0*	*9.2*	*28.3*

Consumptive use of sugar cane for that particular year was 59 inches, of which 34 inches were supplied by rain, or the equivalent of 34×10^5 litres/arp. The mean N-content being 1.98 p.p.m., the total amount entering the soil per arpent per year was $34 \times 10^5 \times 1.98$ roughly 6.8 kg., or more than twice the amount brought in by rain.

It is a common belief among cane growers that rainfall is more profitable to cane growth than irrigation, and one of the hypotheses put forward is that rain water has a high N-content during the growth period. This case was worth studying experimentally, and although it is true that summer rains are richer in N than winter rains (1.4 p.p.m. as compared to 0.5) yet, the N-content of irrigation water is still higher (1.98 p.p.m.). Other causes must be sought, therefore, to explain the beneficial effect of rain water as compared to irrigation, one of which is possibly the higher content of oxygen in rain water.

8. THE INTERPRETATION OF THREE YEARS' FOLIAR DIAGNOSIS ON THE PERMANENT SAMPLING UNITS

PIERRE HALAIS

Arrangements were made, at the end of 1962, for the selection of permanent leaf-sampling units on millers' plantations for the control of the nutritional status of the sugar cane crops by means of foliar diagnosis run on a follow-up basis.

The permanant sampling units are regular cane fields, more than 10 arpents in size, which are as representative as possible of larger sectors of sugar estates, judged for soil type and climate by specialists of the Institute and, for cultural and fertilizer treatments, by the field managers. The selected permanent sampling units do not get special treatment outside those in regular use for the sectors of the estate to which they belong.

The work has been carried out through the following stages :

(i) Representative leaf sampling is made, twice every year, on the permanent sampling units on ratoon crops between the ages of 3 to 8 months, during the peak of the growing season (boom stage, the leaf surface area being at its maximum), provided favourable meteorological conditions have prevailed. Special care is taken to remove the midrib of the central portion of the leaf before the blades are dried, on the spot, according to the instructions given by the Institute.

(ii) The two leaf samples are bulked on their arrival at the Institute, and the NPK contents % dry matter are determined by means of standard analytical techniques, free from systematic errors.

(iii) Appropriate corrections are made when the average age of the two samples differs from the standard age of 5 months. The desired variety corrections are also made, from previous results available at the Institute, in order to bring the NPK contents in line with those of sugar cane in general.

(iv) In order to rule out the dangers of hasty conclusions, interpretation of the nutritional status is made only when the results of three years' analyses are available. Such a precaution will be permanently observed so as to enable technicians to follow the evolution of the nutritional status as time goes on.

The choice of optimum values for NPK, allowing for sound jugdment on the nutritional status observed on the permanent sampling units, constitutes the key of interpretation of foliar diagnosis. For the carefully standardised leaf sampling technique operative in Mauritius, the bulk of information which has gradually accumulated on this subject during the last thirty years brings out the following optimum levels which are now adopted:

Sugar response to nitrogen fertilization for the variety		*Optimum levels on dry matter basis*		
		N	P	K
High	...	1.95	0.190	1.30
Medium	...	1.90	0.190	1.30
Low	...	1.80	0.190	1.30

The results obtained, presented in a condensed form, on the last series of field trials with fertilizers are given below. They refer to the series Agro '60, comprising ten widely located trials conducted in 2nd and 3rd ratoons in 1963 and 1964 respectively, with six different cane varieties. The vegetative response is given in terms of grams of green weight per leaf sampled at the peak of the growing season.

Foliar diagnosis of control plots		*Response to N,P, or K fertilization*	
		Vegetative Green Wt per leaf (g)	*Sugar Tons per arpent*
K % d m 1.32	...	+ 0.3	0.11
P % ,, ,, 0.198	...	+ 0.3	- 0.03
P % ,, ,, 0.178	...	0.4	0.21
K % ,, ,, 1.12	...	0.7	0.32
N % ,, ,, 1.85	...	1.3	0.42
N % ,, ,, 1.49	...	3.2	1.06

It is therefore clearly seen that the optimum NPK levels adopted agree very well with actual results obtained from regular fertilizer trials when properly interpreted. The agreement between the vegetative and the sugar responses is worth stressing. It allows for the formulation of the useful rule that a response of 1 gram per green leaf, collected at the boom stage, corresponds later to a response of 0.33 ton of sugar per arpent (0.82 per ha.) for ratoon canes harvested at 12 months.

The following rules have been adopted for the interpretation of foliar diagnosis collected on a three-year basis.

(i) The NPK nutritional status is considered to be *high* when the data obtained for leaf analysis have been higher than the optimum NPK level during three years.

(ii) Similarly, the nutritional status is deemed to be *low* when there have been no cases in the three years studied in which foliar diagnosis has been higher than the optimum NPK level.

(iii) The nutritional status of permanent sampling units are considered doubtfully *high* or *low* when higher than optimum figures have been obtained for two and one year respectively.

Thus the bulk of the data obtained on the sampling units can be grouped for each of the three major nutrients NPK into one of the following four classes :

N P K nutritional status			*Higher than optimum N P K levels*
	High	...	for the 3 years
Doubtful	High	...	for only 2 years
Doubtful	Low	...	for only 1 year
	Low	...	for no year

From the purely statistical point of view, the two extreme classes, *high* and *low*, are significant when judging the nutritional status of sugar cane in commercial plantations.

An attempt has been made for the first time to group the results for the 421 permanent sampling units, for which the data for three years foliar diagnosis are now available, according to the great soil groups (typical) to which they belong.

The percentage distribution of the four nutritional classes in each great soil group is shown in Tables 24 to 26.

Some interesting points are revealed in the above comparisons :

(i) The present nitrogen nutritional status is often high with Humic Latosols, Humic Ferruginous Latosols and Latosolic Brown Forest soils; and rather low with Low Humic Latosols and Latosolic Reddish Prairie soils.

(2) The present phosphorus nutritional status is often high with Humic Latosols, Latosolic Brown Forest soils, and Humic Ferruginous Latosols; and rather low with Low Humic Latosols and Latosolic Reddish Prairie soils.

(3) The present potassium status is often very high with Humic Ferruginous Latosols, and high with Humic Latosols, Low Humic Latosols soils; and sometimes low with Latosolic Brown Forest and Latosolic Reddish Prairie soils.

It should be stressed that the actual nutritional status observed on each permanent sampling unit represents the basis on which advice is given on the best fertilizer programme to be adopted for a given sector of the estate concerned. Nevertheless, better understanding of the debatable question of the relationship between soil classification and cane nutrition may be derived from the present study.

Table 24. Nitrogen nutritional status in relation to soil groups (%)

Great Soil Groups	*High*	*Doubtful High*	*Doubtful Low*	*Low*	*No. of permanent units*
Humic Latosols ...	70	23	7	0	40
Humic Ferruginous Latosols	50	35	13	2	46
Latosolic Brown Forest ...	65	16	11	8	62
Low Humic Latosols ...	32	31	24	13	119
Latosolic Reddish Prairie ...	32	25	27	17	99
Other soils ...	50	24	7	16	55
All soils	*45*	*26*	*18*	*11*	*421*

Table 25. Phosphorus nutritional status in relation to soil groups (%)

Great Soil groups	*High*	*Doubtful High*	*Doubtful Low*	*Low*	*No. of permanent units*
Humic Latosols ...	66	22	5	7	40
Latosolic Brown Forest ...	52	30	15	3	62
Humic Ferruginous Latosols	61	17	20	2	46
Low Humic Latosols ...	23	29	30	18	119
Latosolic Reddish Prairie ...	26	23	22	29	99
Other soils	53	33	8	6	55
All soils	*40*	*26*	*20*	*14*	*421*

Table 26. Potassium nutritional status in relation to soil groups (%)

Great Soil Groups	*High*	*Doubtful High*	*Doubtful Low*	*Low*	*No. of permanent units*
Humic Ferruginous Latosols	89	8	3	0	46
Humic Latosols ...	55	32	8	5	40
Low Humic Latosols ...	60	27	8	5	119
Latosolic Brown Forest ...	52	26	16	6	62
Latosolic Reddish Prairie ...	40	33	20	7	99
Other soils	38	35	14	13	55
All soils	*54*	*28*	*13*	*5*	*421*

9. VARIETY CORRECTIONS FOR Si, Ca, Mn LEAF-SHEATH DIAGNOSIS

PIERRE HALAIS

Tissue testing, as the regular means of studying the nutritional status of sugar cane crops, has been extended recently to the 3rd—6th leaf sheaths to obtain further information on the necessity of soil amendments. Our knowledge on the subject, which is being built up gradually, does not attain, at the present time, the precision and usefulness of that derived from foliar analysis dealing with the major untrients N, P, and K.

Nevertheless, tentative optimum levels are already available (Table 27) for Si, Ca and Mn in leaf sheath of ratoon canes, sampled at the same time and with similar precautions as the 3rd leaf blade normally used for foliar diagnosis.

Table 27. Tentative optimum levels 3rd - 6th leaf sheaths

SiO_2 % d m	Ca % d m	Mn p.p.m.
above 1.25	above 0.15	below 125

Use of liming amendment is indicated for improving conditions when the Mn content exceeds the limit of 125 p.p.m., and when the SiO_2 content is at the same time normal. Such conditions arise only when the acidity factor is involved. On the other hand, when the SiO_2 content of the leaf sheath is under the limit of 1.25% d.m., a low level known to occur in Mauritius on old soils having undergone a high stage of laterisation, the use of silicic amendments carrying simultaneously silica and lime in an available form is most probably necessary. Two amendments are found locally in considerable abundance; they are:

(1) Coral sand which contains over 95% of calcium carbonate.

(2) Bagasse furnace ash which contains about 75% SiO_2

Field trials will be initiated to test the practical value of both amendments as soon as crushing facilities for bagasse furnace ash is available.

For the time being, a survey of the Si, Ca and Mn contents of leaf sheaths is being carried out on the permanent sampling units already selected for foliar diagnosis.

Experience has shown that accurate interpretation of cane tissue cannot be made unless variety corrections are available. Such corrections already exist for N.P.K. foliar diagnosis.

Opportunity was taken to evaluate the variety corrections for six commercial varieties from Final Variety Trials (Series '60) which were in 4th ratoons in 1965.

Since there is no variety/location interaction, data in Tables 28 to 30 have been arranged in order to show at a glance the validity of the correction.

The variety correction for SiO_2 and Mn are given as correction factors, and that for Ca as simple differences.

Table 28. SiO_2 % d.m. of 3rd-6th leaf sheaths

Trial No. and Location	*M*253/48	*Eb.*50/47	*M*93/48	*Eb.*1/37	*M*202/46	*M*147/44	*Location means*
7/60 Rivière des Créoles ...	1.80	1.80	1.72	2.52	1.84	1.86	1.92
11/60 Beau Bois ...	1.78	1.73	1.92	2.34	2.20	1.95	1.99
12/60 Valetta ...	2.00	1.87	2.17	2.18	2.17	2.55	2.16
10/60 Unité	2.73	3.10	3.26	3.29	3.36	3.24	3.16
5/60 Bènarès	4.00	4.14	4.58	4.41	4.20	4.65	4.33
6/60 & 13/60 St. Antoine ...	3.52	4.85	4.39	4.71	5.25	5.44	4.77
14/60 Mon Désir ...	4.93	4.95	4.64	4.88	5.63	5.40	5.07
Variety means	*2.97*	*3.21*	*3.24*	*3.48*	*3.52*	*3.58*	*3.33*
Correction factors ...	*1.12*	*1.04*	*1.03*	*0.96*	*0.95*	*0.90*	

Table 29. Ca % d.m. of 3rd-6th leaf sheaths

Trial No. and Location	*M*93/48	*M*147/44	*M*202/46	*Eb.*1/37	*Eb.*50/47	*M*253/48	*Location means*
11/60 Beau Bois ...	0.110	0.140	0.123	0.130	0.139	0.133	0.129
7/60 Rivière des Créoles ...	0.106	0.137	0.144	0.146	0.124	0.129	0.131
14/60 Mon Désir ...	0.122	0.106	0.139	0.138	0.147	0.150	0.134
10/60 Unité	0.128	0.156	0.140	0.144	0.158	0.143	0.145
5/60 Bénarès	0.115	0.141	0.139	0.154	0.155	0.167	0.145
12/60 Valetta	0.147	0.158	0.156	0.142	0.158	0.172	0.156
6/60 & 13/60 St. Antoine ...	0.145	0.148	0.162	0.178	0.155	0.181	0.162
Variety means	*0.125*	*0.141*	*0.143*	*0.147*	*0.148*	*0.154*	*0.143*
Variety correction ...	*+ 0.018*	*+ 0.002*	*0.000*	*— 0.004*	*— 0.005*	*— 0.011*	

Table 30. Mn p.p.m. of 3rd-6th leaf sheaths

Trial No. and Location	*M*253/48	*M*147/44	*M*202/46	*M*93/48	*Eb.*1/37	*Eb.*50/47	*Location means*
14/60 Mon Désir ...	32	35	42	43	53	63	45
6/60 & 13/60 St. Antoine ...	77	64	75	86	95	125	87
12/60 Valetta	85	98	83	101	105	127	100
5/60 Bénarès	84	96	116	81	147	132	109
11/60 Beau Bois ...	107	120	115	122	145	132	123
10/60 Unité	107	125	116	132	135	186	134
7/60 Rivière des Créoles ...	146	152	147	182	168	213	168
Variety means	*91*	*99*	*99*	*107*	*121*	*140*	*110*
Correction factors ...	*1.21*	*1.11*	*1.11*	*1.03*	*0.91*	*0.79*	

M.147/44 stool inoculated with new strain of *Xanthomonas vasculorum* through cut made with a contaminated knife above growing point. Note chlorotic tillers (left) developing from rhizome.

New strain of *Xanthomonas albilineans* on M.202/46, showing (*left*) typical wilting and incurved leaves, and (*right*) acropetal development of side shoots.

CANE DISEASES

R. ANTOINE & C. RICAUD

1. GENERAL CONSIDERATIONS

CANE diseases were, generally speaking, markedly affected by the abnormal conditions which prevailed during winter this year. The extremely wet weather favoured diseases such as chlorotic streak, eye spot, *Fusarium* stem rot and yellow spot, and supra-normal temperatures, coupled with the excess rainfall, by extending the growing season and retarding maturity, increased the tolerance of susceptible varieties to gumming disease.

Yellow spot was severe on B.3337 in super-humid areas with the first symptoms appearing in March, one month earlier than in 1964. The intense leaf spotting leading to a considerable reduction in assimilating area and premature defoliation, coupled with an early outbreak of the disease in the uplands where the growing season is already short, may cause severe reductions in yields. However, B. 3337 is being replaced by M.99/48, a variety which has so far proved much less susceptible and in which onset of infection, as in Ebène 50/47, has been seen to occur later in the year.

Rust has again been observed in several young plantations of M. 147/44, M. 202/46 and M. 442/51. In general, under local conditions, the fungus attacks the oldest leaves of the plant, and as the canes usually recover early in the growing season, the disease does not seem to affect yields.

Smut has been observed on several varieties in observation plots, as well as on a few seedlings in propagation plots and variety trials established in the sub-humid zone. Some of the susceptible varieties were of foreign origin.

Eye spot was spectacular, with heavy leaf striping, during the winter months, particularly in fields of B.37172.

2. GUMMING DISEASE

General

The epidemic of gumming disease caused by a new strain of *Xanthomonas vasculorum* is now widespread over the island. Conditions at the beginning of the year were ideal for the dissemination of the bacterium, and severe leaf striping was observed in many fields of susceptible varieties. However, with the abnormal climatic conditions which prevailed during winter and extended considerably the growing season, the disease was much less severe than in 1964, particularly in a vigorous cane such as M.147/44. The variety showed a lower incidence of systemic infection as indicated by leaf chlorosis.

It has been observed that the disease can be damaging under very different environmental conditions. Thus, cases of severe systemic infection with abundant gum pockets in stalks and oozing of gum from cut stems, were found in B.3337 in the super-humid zone, as well as in M. 147/44 in the sub-humid zone. Similar observations were made on a few seedlings in variety trials in different localities.

It is encouraging to record the efforts made to replace the varieties susceptible to the disease.

Thus the area of new plantations of M. 147/44 established in 1965 on estates represents only 4% of the total area planted, as compared to 22% in 1964. No new plantations have been established with B. 3337 and B. 34104.

Resistance trials

Immediately after the outbreak of the epidemic in 1964, measures were adopted to replace the susceptible varieties under cultivation. This necessitated the testing of all commercial varieties, as well as promising seedlings during selection, for their reaction to the new strain of the pathogen. A large trial was established with 267 varieties in a locality where the disease was severe. Inoculated rows of M.147/44, the infection cane, flanked the varieties under test on one side. Each variety was represented by a 10′ row separated from the next variety, along a furrow, by 5′ of M.147/44, which was also inoculated. The following varieties were used as controls :

Highly susceptible	:	M.147/44
Moderately resistant	:	M.442/51
Highly resistant	:	M. 31/45

There were seven replicates of each control in the trial.

The method for inoculating the infection cane described in the 1964 report proved very practical and was highly successful. However, with the prevailing climatic conditions during the maturing season, the ratings of varieties were on the low side. This was evident from the behaviour of M.147/44 which, although showing high susceptibility to infection in some of the replicates as shown by foliar symptoms, gave only few cases of systemic infection. The proportion of susceptible varieties obtained in the trial is shown in Table 31.

Thus 25% of the varieties tested were susceptible. These included 7 varieties which had shown promise during selection; four of them, rated as highly susceptible, will have to be discarded. The other three will be re-tested together with other promising varieties which have shown resistance. The proportion of susceptible varieties is high compared to that usually obtained in resistance trials before the occurrence of the new strain. Thus, from 1954 to 1964, the number of susceptible varieties recorded each year was 4, on an average, representing less than 9% of the total number then tested yearly.

Table 31. Reaction of varieties to the new strain of the gumming disease pathogen in resistance trial

*Rating**		*No. of varieties*	*% of** total tested*
Resistant	1 ...	63	23.6
	2 ...	128	48.0
Susceptible	3 ...	51	19.1
Highly Susceptible	4 ...	14	5.2
	5 ...	3	1.1
	6 ...	0	0

* Numbers correspond to the following ratings :

1 Absence of leaf stripes.
2—Few short stripes on old leaves.
3 Long stripes old leaves, short stripes young leaves.
4 Heavy striping old and young leaves.
5 Heavy striping and chlorosis.
6 Death of stalks.

** Eight varieties (3%) were not given final rating due to bad germination, death of stools or rat damage.

Of the 267 varieties in the trial, 145 had previously been tested to the old strain. A comparison between the reactions to the old and new strains is presented in Table 32.

Table 32. Comparison of reaction of 145 varieties to old and new strains of the gumming disease organism

Reaction to new strain as compared to old		*No. of varieties*	*%*
Same reaction	Resistant ...	36	24.8
	Susceptible ...	8	5.5
Slightly more susceptible	...	24	16.6
More susceptible ...	...	47	32.4
Much more susceptible	...	30	20.7

The results confirm previous evidence that the difference between the two strains lies in virulence rather than in varietal specificity.

The routine testing of varieties coming out of First Selection Trials is being continued, and this year 42 such varieties were included in two trials in different localities in order to test their reaction to both old and new strains. The trial with the old strain is carried out at Réduit Experiment Station where the new strain is not yet established. The noble variety 55-1182 is still used as contaminant for the old strain of the bacterium, while B. 34104 has been used to replace M.147/44 for the new strain, owing to the tendency of the latter variety to lodge as a result of its vigour, thus rendering surveys difficult.

The project of testing seedlings at the Propagation Plot stage had to be abandoned on account of the practical difficulties encountered in running a selection plot for the purpose of assessing both agronomic performance and disease reaction at the same time. It has therefore been decided to test for reaction to gummosis in an independent trial run in parallel with First Selection Trials, the number of varieties under test being reduced to a tenth. Such a trial was established during the year with 377 varieties coming out of Propagation Plots to assess their reaction to the new strain of the pathogen.

Studies on systemic infection

Heavy leaf striping in itself does not reflect the extent of damage caused by the disease, which depends on the number of stalks in which systemic infection develops and the degree of deterioration inside such stalks. Observations have shown that very few canes develop systemic infection in M. 147/44 when the plant is actively growing, and that such infection takes place when the cool season sets in and growth slows down. Similarly, systemic infection is more severe in canes growing under adverse environmental conditions. Furthermore, flowering stalks have been observed to develop systemic infection more easily, a result which appears to be correlated to the reduced infection path in the much shorter laminae of the uppermost leaves. The severity of the disease in M.147/44 could be favoured by a late cyclone, providing ideal dissemination of the pathogen, followed by an early start of the cool season, with low temperatures and dry conditions prevailing, whereby the tolerance of the variety would be lowered, and sufficient time would elapse between the onset of systemic infection and crop harvest.

One of the characteristic features of the new strain of the pathogen is the production of leaf chlorosis as a result of systemic infection. However, it has been observed so far that, in general, canes which develop leaf chlorosis appear to recover after some time, if subsequent production of green leaves is to be taken as a sign of recovery. Attention during the year was therefore focussed on the significance of the chlorotic symptom, its development and ultimate disappearance. To that effect, several naturally infected fields were kept under observation and, in addition, specific experiments were set up using artificial inoculation.

The preliminary results obtained may be summarized as follows : all cases of characteristic leaf chlorosis are the result of systemic infection in the stalk. However, not all cases of systemic infection necessarily result in leaf chlorosis. Thus, systemic infection in a field is more widespread than what would be inferred from the number of stools showing leaf chlorosis.

The onset of the reaction leading to the production of chlorosis occurs in leaves which are still enclosed within the spindle, and in which chlorophyll has not yet been formed. Thus, for the plant to develop such symptoms, it is essential that, while growth is taking place, there is a certain amount of bacterial activity inside the stalk. Sections through chlorotic leaves have revealed that the plastids in the cells of the bundle sheath are still present, suggesting that chlorosis is due to an interference in the mechanism of chlorophyll synthesis, probably through the agency of toxins produced by the bacterium. The change is irreversible and, once induced in the leaf, chlorosis is permanent. In plants showing partial chlorosis of the leaves, a common pattern is present : from the older to the younger leaves, the presence of the chlorotic band gradually passes from the base of the lamina to the upper portion of the blade, to be observed finally at the tip, on the last leaf showing chlorosis. The factors involved are under study, and interesting conclusions are being derived.

The number of stalks which develop leaf chlorosis in mature canes before harvest is relatively low. Most cases of chlorosis occur in young canes after harvest, and are due to inoculation by knives contaminated when cutting stalks with systemic infection, especially in young shoots cut above the growing point. An experiment was designed to study the extent of such infection by knives. Young shoots of M. 147/44 were cut above the growing point with a knife dipped in a dilute suspension of the bacterium. For comparison, shoots were also cut in the same way and inoculated by pouring 1 c.c. of the same bacterial suspension over the cut ends. Each treatment was performed on 2 replicate rows of 100 ft and there were 2 control rows similarly cut but not inoculated. The average number of cases of chlorosis which developed in each row is shown in Table 33.

Table 33. Development of chlorosis in young shoots inoculated with knife, compared to inoculation with bacterial suspension

Method of Inoculation	*Average no. of stools inoculated/row*	*% shoots dead*	*% developing chlorosis*	*No. of chlorotic secondary tillers/row*
Knife ...	186	12.9	48.9	10
Bacterial suspension	212	13.0	27.3	21
Control ...	193	7.0	0	0

Knife inoculation at harvest is an important way by which stools may develop systemic infection. The bacterium may subsequently develop in the rhizome, and secondary tillers produced show chlorosis (Pl. III).

Two fields of M.147/44 showing leaf chlorosis after harvest were kept under observation in order to study the rate of disappearance of the chlorotic symptom. In one case — an irrigated field in the sub-humid area — several stalks with chlorotic leaves exhibiting different degrees of chlorosis were tagged and the leaves numbered. The stalks were grouped in three categories according to the intensity of chlorosis: (i) heavy chlorosis, with more than 75% of the leaves affected ; (ii) medium, with 50-75% of the leaves chlorotic ; and (iii) light, with less than 50%. Even the slightest leaf chlorosis was taken as a positive case. The canes were examined at fortnightly intervals. In 53% of the cases, the intensity of chlorosis increased and the stalks finally died, some faster than others, and were soon replaced in the stools by more rapidly growing green tillers. The others gradually lost their chlorotic appearance through the production of new green leaves and, on an average, appeared to have recovered completely about 32 weeks after harvest. The percentage of dead and recovered stalks in each category is presented in Table 34.

Table 34. Fate of stalks showing chlorosis as a result of systemic infection by gumming disease

Degree of chlorosis	*No. observed*	*Dead*		*Recovered*	
		No.	*%*	*No.*	*%*
Heavy ...	12	10	83.3	2	16.7
Medium ...	12	7	58.3	5	41.7
Light ...	8	0	0	8	100
Total ...	32	17	53.1	15	46.9

It should be noted that usually, stalks which have apparently recovered, still harbour the bacterium in gum pockets in the stalk. The site of the pockets corresponds more or less to the internodes where the chlorotic leaves were originally attached. In an experiment to study the fate of the bacterium in recovered stalks, isolations from the infected tissues of the stem, 9 months after the leaves had lost the chlorotic symptoms, showed that the bacterium was still alive. Thus, such stalks provide an ideal source of inoculum for dissemination when the canes are cut, the site of the gum pockets being usually in the basal portion of the mature stalk. This explains partly why certain fields show abundant chlorosis year after year, while others nearby, under the same environmental conditions, may not. Furthermore, in young ratoons, canes with systemic infection can be the starting point for a build-up of secondary infection in neighbouring stools. Thus, it has been observed in a young ratoon field that stools showing abundant leaf striping were concentrated around chlorotic plants.

Growth rate measurements have shown that stalks with chlorotic leaves, although they may recover, grow appreciably more slowly than healthy stalks.

The extent of chlorosis in young ratoon fields may at times be considerable, and some stalks may not recover until harvest. In these circumstances, it is evident that the disease may affect yields. It follows that the systemic infection of young ratoons by knife inoculation is an important aspect of the disease to which due attention should be paid.

Comparison between old and new strains

There are appreciable differences between the new strain of the pathogen and the old one. In 1964, cultural differences between them were reported; this year, attention has been focussed mainly on differences in their pathogenic activity. Such investigations form part of a general study on strain variation in *X. vasculorum*.

Although the new strain of the bacterium seems to be more infectious than the old one, it would appear, so far, that the extent of damage resulting from systemic infection with the old strain in noble canes and other susceptible varieties cultivated in the past, is more severe than that caused by the new strain in the more vigorous hybrids at present under cultivation. Gumming disease on the old varieties in the cane collection invariably gives abundant systemic infection which starts well before the beginning of winter. Eventually, as the cool season sets in, the condition aggravates, plenty of gum pockets are produced in the stalk, the leaves turn yellow, and wilting occurs, followed by death of the stalk in severe attacks. Wilting has never been observed with the new strain in commercial varieties grown at present, but chlorosis develops instead, and this is a symptom essentially produced in a cane which continues to grow despite bacterial activity inside the stalk. The old strain very rarely produces chlorosis in noble canes and, when it does, this is restricted to new shoots which develop in summer from the rhizome of heavily infected stools.

An experiment was designed to compare the virulence of old and new strains in M.147/44, and to see whether the old strain could cause chlorosis in that variety. Young shoots were cut above the growing point and inoculated with bacterial suspensions. Three concentrations were used for each bacterium, and each treatment consisted of two replicate rows of 100′. In the control rows, shoots were cut but not inoculated. The results are presented in Table 35.

Table 35. Effect of new and old strain of bacterium inoculated in M. 147/44

Inoculum	*Dilution**	*Average no. of shoots inoculated/row*	*% shoots dead*	*% developing chlorosis*	*No. of chlorotic secondary tillers/row*
	I	206	13.1	38.8	28
New Strain ...	II	219	13.7	25.7	17
	III	212	12.3	26.4	19
	I	212	7.8	8.8	0
Old Strain ...	II	205	10.3	18.9	0
	III	177	11.2	15.5	0
Control ...	—	193	7.0	0	0

* Dilutions I, II, III are in decreasing order of concentration

Both strains caused chlorosis when inoculated in M.147/44, but the new strain proved to be more virulent, judging from the number of affected shoots and the intensity of symptoms. With the new strain, systemic infection developed in the rhizome, in several cases, giving rise to chlorotic secondary tillers, a condition which was not observed with the old strain. Furthermore, the intensity of leaf chlorosis was much lower with the old strain, and all canes with chlorotic leaves apparently recovered much more quickly than those inoculated with the new strain. These results confirm that the new strain has a greater physiological activity, and probably produces more toxin within the plant.

Attempts were also made to isolate bacteriophages specific to each strain. Isolations from diseased leaves, as well as from soil in the immediate vicinity of diseased stools, have so far been unsuccessful.

Comparison between isolates from Réunion, Madagascar and Mauritius

Towards the end of 1964, isolates of the bacterium from Réunion, Madagascar, and Mauritius (both strains) were inoculated in stools of M.147/44 and M.202/46 to compare their reaction, in an attempt to ascertain the origin of the new strain of the organism discovered during that year in Mauritius. The work was conducted in England, in the glass-houses of the Plant Pathology Department of the Imperial College of Science and Technology, with kind permission from the Ministry of Agriculture of the United Kingdom and the co-operation of the Commonwealth Mycological Institute. The assistance and co-operation received from the authorities concerned are gratefully acknowledged.

Three stools of each variety, growing in 12-inch pots, were inoculated with each strain. The inoculation was performed by pricking into the spindle, just below the first visible leaf triangle, with a bunch of needles which had previously been dipped in a concentrated suspension of the bacterium.

The Madagascar, Réunion, and Mauritius (new) strains all gave severe infection with heavy striping, becoming systemic, and producing small gum pockets inside the stalks. There were some qualitative differences between the strains, and M. 147/44 always proved to be more susceptible than M.202/46. The Mauritius (old) strain was less infective, systemic infection developing in three cases only, two in M.147/44 and one in M.202/46, with few isolated red streaks running down the stem.

The symptoms produced by the Madagascar strain were appreciably different from those of Réunion and Mauritius (new). The leaf streaks were deep yellow, with red stripes here and there, and caused a pronounced necrosis at the tip of leaves. This strain proved slightly more virulent than the Réunion and Mauritius (new) ones, and the characteristic red stripes it produces were never encountered with the latter two strains. There was little difference between symptoms produced by the latter two strains, except that the isolate from Mauritius (new strain) appeared slightly more virulent than the Réunion one.

3. LEAF SCALD

The outbreak of leaf scald, probably caused by a new strain of the bacterium, which was reported last year in M.202/46 and M.147/44, has been spreading gradually all over the island with increasing intensity. On two occasions the acute phase of the disease was observed on M.147/44 and on a seedling in a multiplication plot. In both cases, the diseased plants wilted and died suddenly without showing the characteristic symptoms usually associated with the disease. Leaf scald proved to be more severe in humid and super-humid areas.

Apart from M.202/46 and M.147/44 which are susceptible, a few seedlings under selection were also found infected. The unreleased variety Ebène 88/56, which was showing high promise and was under observation on a field scale on several estates, has shown susceptibility. In several fields, a high level of infection was observed, and in one case up to 350 diseased stools per arpent were detected.

Very little is known about the natural methods of transmission of the disease. It is mainly spread by knives at harvest and in the preparation of cuttings, and also by infected cuttings at planting time. Surveys in fields after harvest have revealed that the characteristic leaf symptoms are found mainly on young shoots which have been cut above the growing point. It has been recommended that fields of M.202/46 should be surveyed after harvest, and diseased stools rogued to reduce the spread of the disease at the next harvest. Owing to the relatively low rate of spread of the disease by knives, if all necessary steps are taken, infection in M.202/46 can be kept at a low level.

Such recommendations have been followed on several estates, and surveys and rogueings are carried out regularly in young fields of M.202/46. Valuable data have thus been obtained on the distribution of the disease, and on the control work generally. On one estate, a maximum incidence of 24 diseased stools per arpent was observed, with an avarage of 2 to 3 infected stools per arpent. On another estate, the maximum number of infected stools rogued per arpent was 68, with an average of 5 stools per arpent. In general, subsequent surveys and rogueings brought down the number of diseased stools to an insignificant level. At times, however, there is an apparent build-up of infection in a field.

These facts are illustrated in Table 36 which gives a few figures for rogueings made at approximately 5-6 weeks intervals in 12 fields of an estate. The figures were kindly supplied by the Agronomist of the estate concerned.

Table 36. Number of leaf scald infected stools rogued in 12 fields of M.202/46 for three surveys at 5-6 weeks intervals

Field	*Category*	*Acreage (Arpents)*	*No. of stools rogued at each survey*		
			1st	*2nd*	*3rd*
A	1st Ratoon	5.62	39	5	—*
B	,,	4.00	2	2	24
C	,,	8.50	38	17	34
D	2nd Ratoon	4.05	23	4	4
E	,,	9.30	217	37	9
F	,,	10.43	21	28	87
G	3rd Ratoon	4.83	138	15	—
H	,,	7.93	128	87	7
I	,,	2.00	23	14	25
J	4th Ratoon	10.86	153	13	—
K	,,	7.36	47	43	9
L	,,	5.56	71	123	—

* — No survey made.

The increase in the number of diseased stools detected in later surveys may be due to two factors. Stools inoculated by the cutting knife at first show only leaf streaks, the thin white pencil line, and may easily escape the attention of rogueing gangs. Some time elapses, during which there is a build-up of the bacterium within the plant, before the conspicuous symptoms of leaf chlorosis appear. Also, the disease is known to remain latent in the plant without showing any symptoms for some time. These, however, may suddenly develop when there is a change in environmental conditions. For these reasons, young fields should not be surveyed too early, and at least two rogueings should be conducted before the cane canopy closes in. It is not recommended to rogue tall canes. If the level of infection is still high after the early rogueings, it is best to plough out the field after harvest.

Particular attention should be paid to nurseries. Fortunately, so far, surveys carried out at the Central Nursery, as well as in several B nurseries on estates in the variety M.202/46, have not revealed the presence of the disease.

Knives should be sterilized during the preparation of cuttings, and a fresh knife used for each cane. For this purpose, the detergent-iodine compound Iosan may be used at a concentration of not less than 75 ppm. available iodine. This compound is a potent germicide against gram-negative bacteria, and should be preferred to quarternary ammonium compounds which have been recommended for knife sterilization in the control of ratoon stunting disease. However, the substance is corrosive and is rapidly decomposed when in contact with certain metals. An experiment was carried out in order to determine the most economic way of using the chemical. Two methods were compared. In one case, two knives were used, one being left in the disinfectant, while the other was being used for cutting, the knives being interchanged after cutting each cane. The other method involved scrubbing the knives with a damp cloth after cutting each cane to remove plant debris, and then dipping it for 10 seconds in the disinfectant. Seven litres of prepared disinfectant were used in each case. The rates of decomposition of the disinfectant in the two methods, starting with an original concentration of about 240 ppm. available iodine, are shown in Fig. 18.

It is, therefore, not recommended to leave a set of knives in the disinfectant for long periods, or to use metallic containers not coated with a proper paint. Furthermore, it is important that organic matter be removed from the knife surface before sterilization, a recommendation already made. Starting with an original concentration of approximately 250 ppm. available iodine, the disinfectant solution should last for a normal day's work, each man being allotted about 7 litres of solution for preparing 3,500 cuttings. Changes in volume or original concentration can be made if fewer cuttings are to be prepared, but any disinfectant left over at the end of the day's work should be discarded.

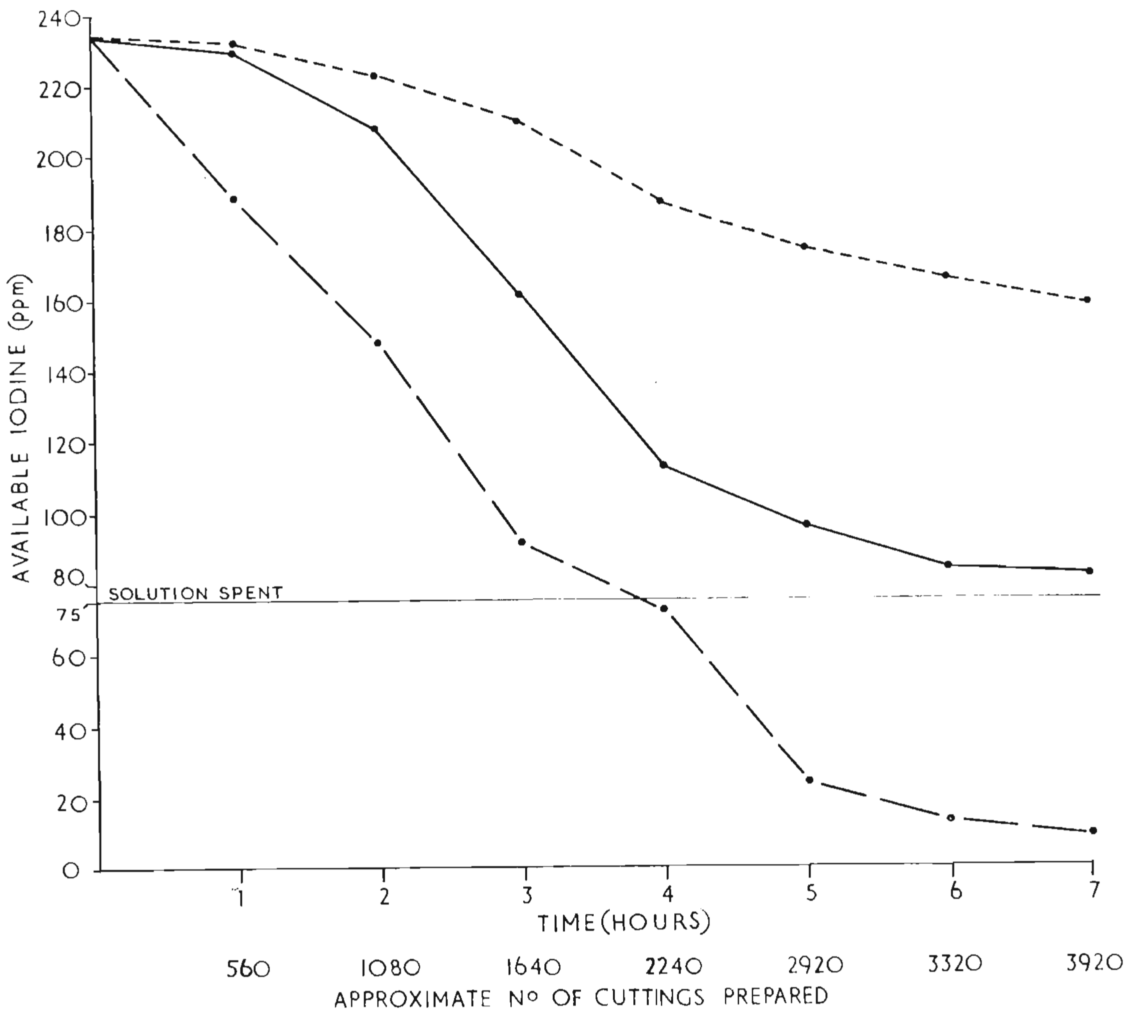


Fig. 18. Deterioration of Iosan solution used for disinfecting knives during preparation of cuttings. Broken line (- - -) : control ; plain line : knife scrubbed, then dipped in disinfectant ; broken line (— —) : one knife permanently in disinfectant.

4. RATOON STUNTING

The various trials, which had run for several years, were concluded in 1964. No experiments were laid down in 1965, as it was necessary to obtain results from the gumming disease trials before the selection of promising gummosis-resistant varieties for inclusion in the R.S.D. trials.

The supply of planting material to estates from the Central Nursery amounted to nearly 3,000 tons. Compared to 1964 (3,400 tons) and 1963 (1,900 tons), and considering the set-back caused by the outbreak of gumming disease which led to a reshuffle of the planting programme and the loss of planting material from gummosis-susceptible varieties, a very creditable effort was made in 1965 by the management of the Central Nursery.

Just over 200 tons of cuttings were treated at the Central Hot-Water Treatment Station to plant 42 arpents of land at the Central Nursery, or 4.8 tons/arpent. Germination of treated setts varied from 54% to 96% with an average of 62%. A total of approximately 150 arpents were under "A" and "B" nurseries for supply of planting material in 1966.

The increased yields obtained from heat-treated planting material had been outlined in the annual reports of the Institute during the last years when discussing results of experimental work. In 1965, the beneficial effect of using R.S.D.-free cuttings at planting time was further illustrated, this time on a plantation scale on one estate in the south, where comparisons were made between cane yields obtained in fields of M.147/44 planted with cuttings derived from nurseries, and with untreated cuttings (Table 37).

Table 37. Yields of cane obtained with treated and untreated cuttings in 3rd, 4th, and 5th ratoons on one estate

	Yield in Ratoon (Tons/Arpent)		
	3rd	*4th*	*5th*
Treated ...	39.5 (18)*	38.3 (8)	41.9 (4)
Untreated ...	29.2 (8)	28.6 (12)	31.2 (35)

* Figures in brackets indicate the number of fields.

The comparison was based on 85 fields representing an area of 651 arpents in 3rd, 4th, and 5th ratoons. Fields in early ratoons having all been planted with material derived from nurseries, no comparisons could be established for that part of the cycle. The average difference in cane yield was 9.5 tons per arpent in favour of treated canes.

5. CHLOROTIC STREAK

As a consequence of the exceptionally wet conditions during the cool season, chlorotic streak was severe in badly drained areas in the super-humid zone, causing death of young tillers or of entire stools particularly in the variety Ebène 1/37. Thus, the ratoons of highly susceptible canes in such areas may be considerably affected, and it is recommended that in severe cases, fields still in early ratoon, should be recruited with hot-water treated cuttings. Although such recruitings may seem too late for the crop under way, they will serve for the years to come. Heavily infected fields in higher ratoons should be replanted.

Most of the varieties at present under cultivation in Mauritius are susceptible, or highly susceptible, to the disease; an exception is M.93/48, a variety adapted to the humid to super-humid zone, which has so far shown moderate susceptibility. M.442/51 is highly susceptible, but this variety is recommended for the sub-humid and humid regions where chlorotic streak is less important.

The testing of new or modified hot-water treatment installations on estates continued during the year, and recommendations were made for improving the efficacy of the curative treatment.

Studies on disease transmission

Owing to the concentration of efforts on the problem set up by gumming disease, studies on transmission of chlorotic streak have slowed down during the year.

In 1964, transmission of the disease was successful when healthy plants were exposed to infection by growing them in culture solution in which diseased plants had previously grown. The search for chytrid fungi in roots of plants which had contracted infection continued this year. The object of such investigations is to assess the role of such an organism in disease transmission, or even as the actual causal agent.

Critical examinations of squashed preparations of roots revealed the frequent occurrence of a species of the order Chytridiales in the epidermal cells. The fungus (Pl. V) is characterized by an unbranched vegetative thallus, with a well-defined cell wall and numerous globules in the cytoplasm. There is usually one unit per epidermal cell. The sporangia are sausage-shaped, and have a conspicuous terminal discharge tube. The occurrence of a resting spore in its life cycle has not yet been observed, and the organism has not been identified so far.

Preliminary examinations of roots of plants which contracted infection in transmission experiments in soil, as well as those of plants showing severe infection in the field, have so far failed to reveal the presence of the chytrid fungus.

Concurrently with the experiment on transmission in water culture mentioned above, and described in the 1964 report, another experiment was performed to study transmission in soil in comparison with that in water culture. Hot-water-treated cuttings and untreated diseased cuttings of M.442/51 were grown side by side in soil in 9-inch pots. One healthy and one diseased plant were established in each pot, and there were 15 replicates. These were watered heavily throughout the experiment to provide ideal conditions for transmission. The diseased plants developed abundant symptoms which persisted throughout the duration of the experiment which was concluded this year. After 12 months, healthy plants contracted the disease in 3 plots. The remaining twelve were ratooned and transplanted to fresh sterilized soil without the diseased plants, after their roots had been washed in running water. Three more exhibited disease symptoms. This shows that once infection has occurred, there appears to be a build-up of the causal agent inside the plant before symptom expression.

The results on transmission in soil and in water culture brought additional evidence that transmission in soil is much slower than in water culture. Thus, in water culture, 82% infection was obtained after only 7 months' exposure, while 40% infection was obtained in soil after more than 12 months.

6. FUSARIUM STEM ROT OR WILT

Several cases of dying canes, near harvest time, in fields in the humid and super-humid zones, were investigated during the year. The disease manifests itself in patches where the canes show symptoms which could be attributed to drought effect, nutritional deficiency, attack of *Clemora smithi*, or root disease. However, grub counts in such patches were well below the deleterious level, and the affected canes had an extensive root system. Further investigations revealed that the disorder was due to *Fusarium* stem rot or wilt disease.

Diseased canes show a pronounced yellowing of the leaves which starts in the midrib, and in the later stages, a purple discoloration as well. Leaves die prematurely in a V-shaped pattern, from the tip pointing down towards the midrib. In certain canes, adventitious roots develop profusely on the stem. This symptom, as well as the purple discoloration of the leaves, is most pronounced in the variety M.134/32. Growth is stopped and the canes die gradually, being invaded finally by *Melanconium sacchari*. Internally, the diseased stalks are hollow and pithy at the centre, the condition aggravating in the later stages; in certain cases, there is a red discoloration at the nodes, which sometimes extends in the internodes as well. In the early stages of infection, however, the interior of the canes appears healthy, infection being restricted to the very base of the stalk, near the point of attachment to a stalk of lower order, where wind damage has occurred (Pl. VI, *left & centre*). From such diseased tissues at the base of the stalk, the following fungi were isolated :

Fusarium moniliforme
Fusarium solani
Thielaviopsis paradoxa
Trichoderma sp.

Cases of *Fusarium* top rot are numerous on the younger shoots in the diseased patches. The cane stalks are also covered with discoloured spots due to infection by spores of the causal organism *F. moniliforme* (Pl. VI, *right*). Such infections remain quite superficial, except if wounds are present or through leaf scars, whereby the internal discoloration already mentioned ensues. By such wind-borne infection by spores, the diseased patches enlarge with time in a field, and in some cases, infection has been per epidermal cell. The sporangia are sausage-shaped, and have a conspicuous terminal discharge tube. The occurrence of a resting spore in its life cycle has not yet been observed, and the organism has not been identified so far.

Preliminary examinations of roots of plants which contracted infection in transmission experiments in soil, as well as those of plants showing severe infection in the field, have so far failed to reveal the presence of the chytrid fungus.

Concurrently with the experiment on transmission in water culture mentioned above, and described in the 1964 report, another experiment was performed to study transmission in soil in comparison with that in water culture. Hot-water-treated cuttings and untreated diseased cuttings of M.442/51 were grown side by side in soil in 9-inch pots. One healthy and one diseased plant were established in each pot, and there were 15 replicates. These were watered heavily throughout the experiment to provide ideal conditions for transmission. The diseased plants developed abundant symptoms which persisted throughout the duration of the experiment which was concluded this year. After 12 months, healthy plants contracted the disease in 3 plots. The remaining twelve were ratooned and transplanted to fresh sterilized soil without the diseased plants, after their roots had been washed in running water. Three more exhibited disease symptoms. This shows that once infection has occurred, there appears to be a build-up of the causal agent inside the plant before symptom expression.

The results on transmission in soil and in water culture brought additional evidence that transmission in soil is much slower than in water culture. Thus, in water culture, 82% infection was obtained after only 7 months' exposure, while 40% infection was obtained in soil after more than 12 months.

6. FUSARIUM STEM ROT OR WILT

Several cases of dying canes, near harvest time, in fields in the humid and super-humid zones, were investigated during the year. The disease manifests itself in patches where the canes show symptoms which could be attributed to drought effect, nutritional deficiency, attack of *Clemora smithi*, or root disease. However, grub counts in such patches were well below the deleterious level, and the affected canes had an extensive root system. Further investigations revealed that the disorder was due to *Fusarium* stem rot or wilt disease.

Diseased canes show a pronounced yellowing of the leaves which starts in the midrib, and in the later stages, a purple discoloration as well. Leaves die prematurely in a V-shaped pattern, from the tip pointing down towards the midrib. In certain canes, adventitious roots develop profusely on the stem. This symptom, as well as the purple discoloration of the leaves, is most pronounced in the variety M.134/32. Growth is stopped and the canes die gradually, being invaded finally by *Melanconium sacchari*. Internally, the diseased stalks are hollow and pithy at the centre, the condition aggravating in the later stages; in certain cases, there is a red discoloration at the nodes, which sometimes extends in the internodes as well. In the early stages of infection, however, the interior of the canes appears healthy, infection being restricted to the very base of the stalk, near the point of attachment to a stalk of lower order, where wind damage has occurred (Pl. VI, *left & centre*). From such diseased tissues at the base of the stalk, the following fungi were isolated :

Fusarium moniliforme
Fusarium solani
Thielaviopsis paradoxa
Trichoderma sp.

Cases of *Fusarium* top rot are numerous on the younger shoots in the diseased patches. The cane stalks are also covered with discoloured spots due to infection by spores of the causal organism *F. moniliforme* (Pl. VI, *right*). Such infections remain quite superficial, except if wounds are present or through leaf scars, whereby the internal discoloration already mentioned ensues. By such wind-borne infection by spores, the diseased patches enlarge with time in a field, and in some cases, infection has been found to spread to an adjacent field across a path.

The causal organism produced only microspores typical of *Cephalosporium* in cultures on Wilbrink medium. The microspores measured 7.7μ ± 0.4 (range 4.5 — 13.8) by 3.4μ ± 0.1 (range 2.5 — 4.5).

Young canes of M.202/46 were inoculated with a suspension of mycelium and spores of the organism grown in liquid culture. Some of the canes were inoculated at the base of the stalk, using a cork borer, and others in the spindle, using a hypodermic syringe. Although the inoculations were successful, no wilting symptoms were reproduced. However, a few canes inoculated in the spindle developed typical symptoms of *Fusarium* top rot as well as pokkah boeng.

Conclusions and practical considerations

The disease is of minor importance, as it is restricted to isolated cases in areas where the soil is heavy and badly drained. Heavy gusts of wind on tall canes due to the late cyclone *Rose* in May, and also the excessively wet winter, have been responsible for the various outbreaks during the year. Infection sets in through the damaged base of twisted stalks, and failure of the adventitious roots above the infected tissues to establish themselves quickly in the waterlogged soil, causes a water stress in the plant leading to gradual deterioration of the stalk. A build-up of fungal inoculum in the diseased patch increases aerial infection of the upper part of the stalks by spores, thereby aggravating the deterioration of the canes, and also spreading the disease beyond the focus of infection.

The variety M.202/46 was observed as the most susceptible, but outbreaks also occurred in other varieties, namely in M.134/32, Ebène 1/37, M.93/48 and B.37172.

Infected patches should be harvested early owing to the rapid deterioration of the stalks. The removal of diseased stalks also reduces the fungal inoculum, thereby limiting the extension of the diseased patches and reducing the risks of a carry-over to the ratoon crop. In one case, such carry-over was observed with increasing intensity. In severe cases, the affected areas should be recruited to avoid gappy stands in the ratoon crop.

7. MICROFLORA OF THE SUGAR CANE RHIZOSPHERE

Since 1960, whenever time has permitted, attention has been given to studies on the microflora of the sugar cane rhizosphere. The preliminary object of these investigations was to detect any possible quantitative differences between the total fungal populations in the rhizosphere of plants receiving organic fertilization in the form of factory residues, such as scums and molasses, as opposed to inorganic fertilization alone. Although benefit to be derived from the practice of adding organic amendments at planting time is still a debated point in Mauritius, such practice is conducted on a large scale. The investigations aimed at studying this problem from the microbiological angle, special considerations being given to thc influence of changes in the microbial balance of the rhizosphere on certain soil-borne diseases such as root rot. While these quantitative investigations were being conducted, the fungal species most frequently isolated were identified, and a collection of type cultures kept for future work. The help received from the Commonwealth Mycological Institute for the final identification of the fungi is gratefully acknowledged.

Fungal isolations and counts were made from two permanent field trials in which the relative merits of organic and inorganic fertilisations are being studied. Blocks of soil containing cane roots were removed by means of a soil auger within, or around, cane stools and sampled from various plots, at a depth of 2 to 6 inches. Several random samples were taken from each plot. Isolations and plate counts were made from the soil layer in contact with the surface of roots within the soil blocks sampled (the rhizosphere), as well as from soil slightly away from the surface of the roots.

Table 38. Preliminary list of fungi isolated from sugar cane rhizosphere in Mauritius

PHYCOMYCETES

Mucorales

Absidia corymbifer (Cohn) Sacc. & Trott.
Gongronella butleri (Lendner) Peyr. & dal Vesco
Mucor hiemalis Wehmer

ASCOMYCETES

Sphaeriales

Ceratocystis paradoxa (Dade) Moreau
Chaetomium funicolum Cooke

FUNGI IMPERFECTI

Shaeropsidales

Sphaerioidaceae

Phaeocytostroma ambigua (Mont.) Pet.
Phoma sp. (not fully determined)

Melanconiales

Melanconiaceae

Pestalotiopsis sp. (not fully determined)

Moniliales

Moniliaceae

Aspergillus chevalieri (Mang.) Thom & Church
A. flavipes (Bain. & Start.) Thom & Church
A. nidulans (non-ascosporic)
A. terreus Thom
A. ustus Bain.
Gliocladium roseum Bain.
Paecilomyces marquandii (Massee)
Paecilomyces sp. (not fully determined)
Penicillium funiculosum Thom
P. lilacinum Thom
P. raistrickii Smith
P. vermiculatum Dang.
Trichoderma koningii Oud.
T. viride Pers. ex Fr.
Trichoderma sp. (not fully determined)

Dematiaceae

Cladosporium cladosporioides (Fresen) de Vries
C. sphaerospermum Perz.
Humicola fuscoatra Traaen
Humicola sp. (not fully determined)
Trichobotrys sp. (not fully determined)

Tuberculariaceae

Fusarium oxysporum Schlecht. ex Fr.

The soil dilution and plate count method of TIMONIN (1940) was adopted. A peptone-dextrose agar medium supplemented with rose bengal and aureomycin was used for isolations (MARTIN, 1950) (JOHNSON, 1957).

No consistent differences were found between the total number of fungal isolates, whether from the rhizosphere, or from the soil, in plots receiving organic and inorganic fertilisation. The nature of the rhizosphere is so complex that investigations should be conducted under strictly controlled conditions if any differences are to be detected.

A preliminary list of fungi isolated from sugar cane rhizosphere is given in Table 38.

In relation to the above investigations, fungi were also isolated on several occasions from roots of plants appearing to suffer from root rot, in different fields of the island. The following fungi were most frequently isolated :

Pythium arrhenomanes Drechsler
Fusarium oxysporum Schlecht. ex Fr.
Trichoderma sp.

The readiness with which *Trichoderma* is isolated from diseased cane roots, and its very common occurrence in the sugar cane rhizosphere, suggest that it may be an important antagonist in relation to root rot.

REFERENCES

JOHNSON, L.F. (1957). Effect of antibiotics on the numbers of bacteria and fungi isolated from soil by the dilution-plate method. *Phytopathology*, **47** : 630-631.

MARTIN, J.P. (1950). Use of acid, rose bengal and streptomycin in the plate method for estimating soil fungi. *Soil Sci.* **69** : 215-233.

TIMONIN, M.I. (1940). The interaction of higher plants and soil micro-organisms. I. Microbial population of rhizosphere of seedlings of certain cultivated plants. *Canad. Jour. Res.* **18**(c) : 307-317.

8. FIJI DISEASE IN MADAGASCAR

As mentioned in the 1964 report, it had been contemplated to finish the uprootings in the whole province of Tamatave by the end of February 1965, and to complete the surveys and rogueings, if necessary, in all new plantations by December 1965, date on which the official campaign against Fiji disease was to come to an end. As from January 1966, the provincial sections of the Plant Protection Service of the Agricultural Service were expected to take over from the Fiji Section, a separate unit which was established immediately after the discovery of the disease in 1954, and to which due credit should be paid for the good work performed against tremendous odds during the last ten years.

However, an unexpected rat invasion on a considerable scale in 1965 brought the activities in the Fiji campaign to a standstill, all efforts of the Fiji Section being diverted until September to face the new problem. As a result of this setback, and although no new cases of Fiji disease were discovered during surveys, the Malagasy authorities have decided to extend the life of the Fiji Section by another year.

The control organization which was set up in Tamatave in order to prevent the entry of any part of the sugar cane plant into the port area continued to operate satisfactorily. Furthermore, control measures to ensure that no unauthorized varieties are sold in the markets of Tamatave were maintained. It is interesting to note that sugar cane cultivation around the town of Tamatave has been declining steadily, being gradually replaced almost exclusively by bananas which are rapidly becoming a major export crop of the province.

In the resistance trials, the environment provided by the highly susceptible M.134/32 had been gradually becoming less infective, a major cause for concern. Indeed, stools with severe infection had gradually died and disappeared, and a large number of the remaining diseased plants were considerably dwarfed, bearing witches' brooms or coarse leaves most probably unattractive and unpalatable to the leafhopper vector. A plan devised to build up again the infective environment, including the breeding of vectors on diseased plants and their release in the trials was put under way. Latest reports indicate that the position has improved considerably, with a fair number of M.134/32 stools showing large galls on leaves of apparently normal plants. Results obtained in first ratoons in the trial planted in 1963 are as follows :

Highly susceptible :	B.42231, B.45151, B.4744 & N:Co. 376
Susceptible :	H.39-3633, H. 44-3098, P.O.J. 3067

The following varieties did not show any disease symptom :

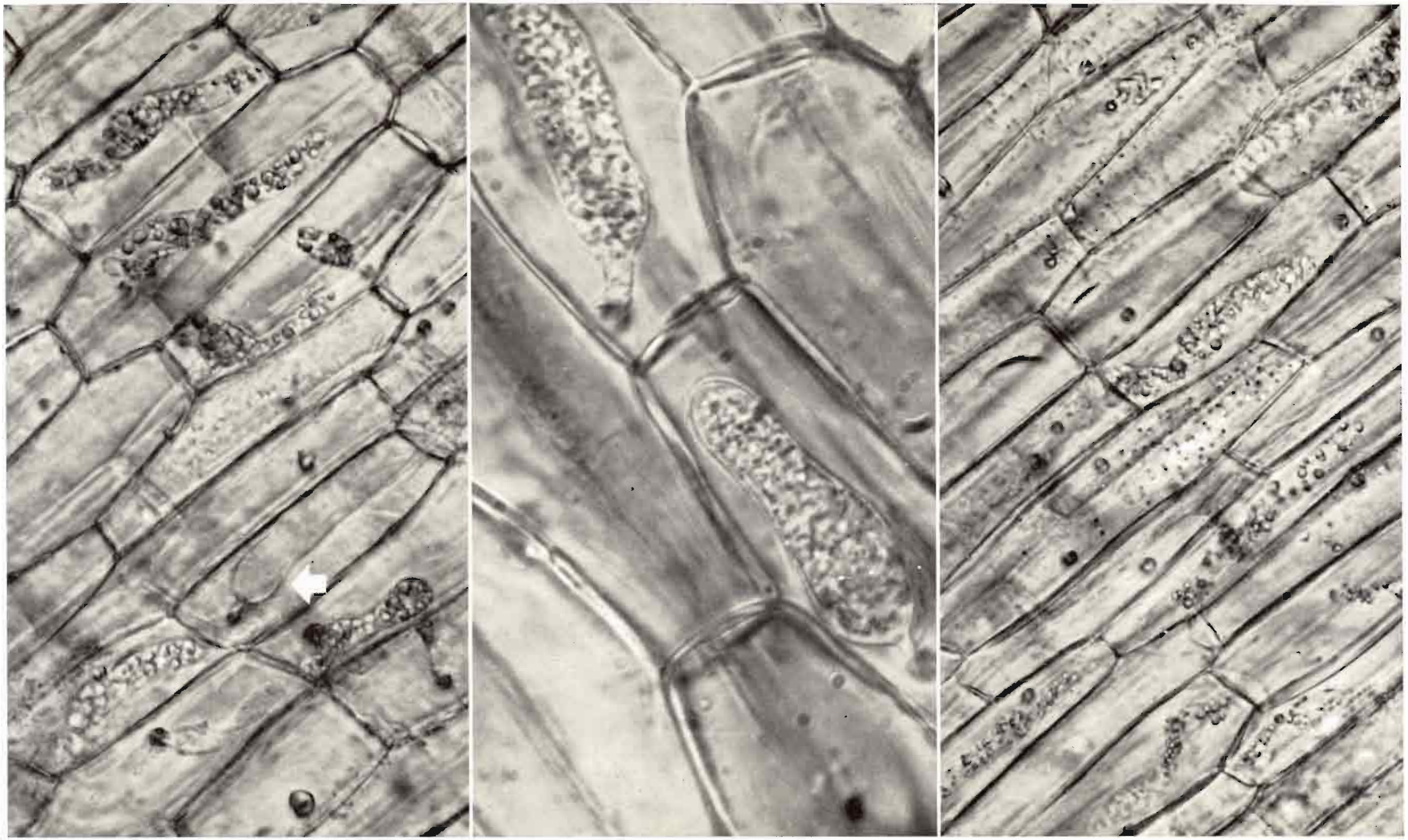
B.46364, B.49119, C.L. 41/223, Q.58

However, as disease incidence was low in the infective environment and in the susceptible control plots, the trial is to stand for another year.

In the trial planted in 1964 , the following varieties have contracted infection in virgins : H. 32-8560, M.442/51, R.445 and R.447. The other canes under test are : Ebène 50/47, M.99/48, M.423/51, P.R. 1013, Q.50, R.430, R.511, R.512, R. 514, R. 519, R.520.

The following varieties were planted in October in the 1965 trial : B.51129, B.55362, Co. 449, C.P. 48/103, Ebène 88/56, N:Co.293, R. 519, Saccharine, Salvo, Samson and Saraband.

Three canes of special interest to Mauritius are : M.409/51, under multiplication, and M.13/53 and Ebène 74/56, in their second year of quarantine.



Commonly encountered Chytrid in epidermal cells of roots of M.442/51 which have contracted chlorotic streak infection.
Note : *left*, empty sporangium (<—); *centre*, sausage-shaped sporangia with well-defined cylindrical discharge tube; *right*, discharged zoospores.

Fusarium stem rot in M.202/46

Left : Beginning of infection at base of secondary stalk; *middle* : advanced stage showing internal discoloration and hollow central portion; *right* : spots on stalks due to aerial infection by spores (note lesions due to internal spread through leaf scar ⟨—).

CANE PESTS

J. R. WILLIAMS

1. THE STALK MOTH-BORER

DATA on the incidence of damage to millable stalks by the moth-borer, *Proceras sacchariphagus*, were collected by sampling in fields during harvest on six estates representative of the different climatic zones of the island. From each of the 186 fields visited, 50 canes were taken at random, weighed, and the number of internodes and bored internodes per cane counted. Similar sampling had been done in 205 fields in 1964, and the considerable amount of data now acquired needs further analysis before conclusio-s may be drawn from it.

Proceras injury affects sugar cane at all stages of growth, beginning with the planted setts if these are bored, and cane quality as well as yield is reduced. Assessment of loss is consequently difficult, and in general terms for the island as a whole involves so many variables that accuracy is impossible. However, the insect leaves a convenient record of its activity in a crop in the form of holed internodes and, within limits, it should be possible to relate this with field populations and loss.

Two items of interest were obtained from the data and may be mentioned without prejudice to its fuller treatment at a later date.

(*a*) *Severity of damage to millable cane in 1964 and 1965.*

The average figures for intensity of stalk and internode damage were very different for the two years, as shown below, and the lower figures for 1965 were borne out by general field observations :

	No. fields sampled	*Average % stalks bored per field*	*Average % internodes bored per field*
1964	205	38	4.7
1965	186	26	2.3

Fig 19 shows the frequency of fields with different levels of borer injury. It is seen that in 1965 fields with 0-20% stalks bored preponderate.

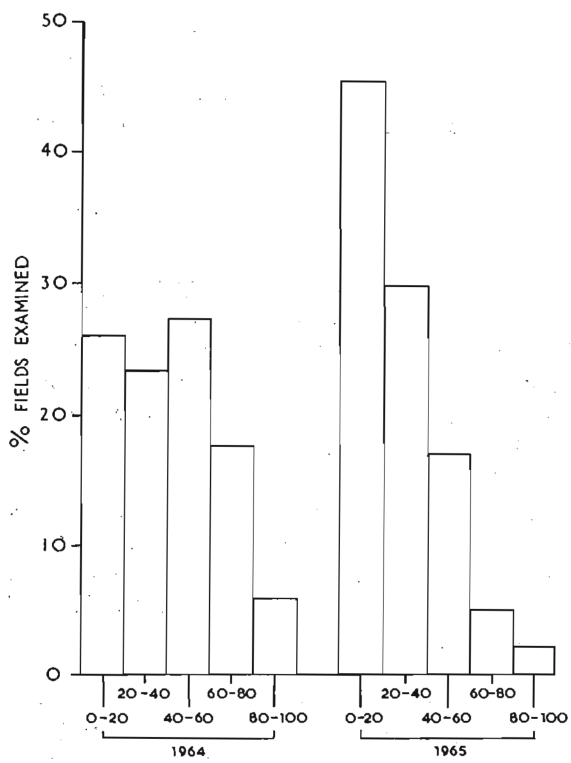


Fig. 19. Frequency of bored canes in fields examined in 1964 and 1965. Fields grouped into five categories according to % stalks bored.

(b) Relationship between frequency of injury to stalks and to internodes.

Fig. 20 is based on 1964 data and shows the percentage of stalks and of internodes bored, and the relationship between these statistics, in 205 fields. Many readings were identical, and are therefore not visible in the figure. The relationship between the percentage of stalks and of internodes bored is evidently curvilinear, and a reasonably good fit to the plotted points is given by the regression

$$Y = 0.00204\ x^2 + 0.43,$$

where Y = % internodes bored, and X = % stalks bored. The correlation coefficient is + 0.525 with $P < 0.001$. Using this regression, an estimate of the amount of internodal injury may be obtained from counts of canes bored.

Diatraeophaga striatalis, the Javanese tachinid parasite released in 1961 and 1964, has not been recovered in the field and has apparantly failed to establish itself. A further final effort to establish this parasite is planned.

During discussions with Dr. F. J. Simmonds, Director of the Commonwealth Institute of Biological Control, who visited Mauritius in January, it was concluded that exploratory work in the Far East, particularly in Indonesia, was highly desirable in connection with biological control of cane pests originating from that region. A plan to that end was drawn up, to be implemented when possible.

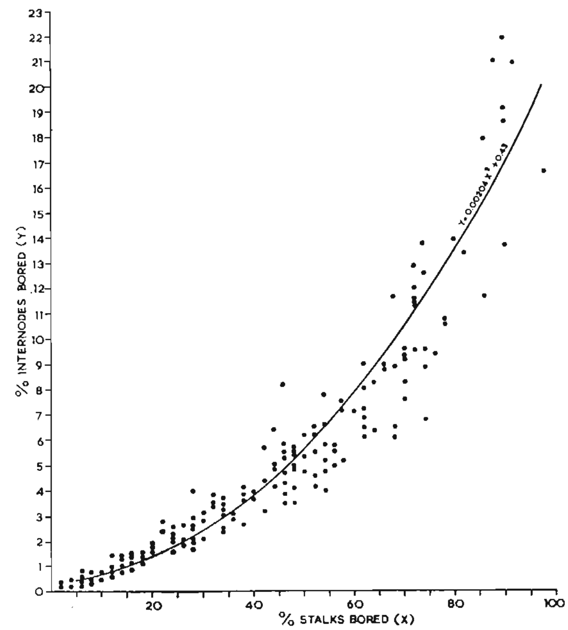


Fig. 20. Relationship between % stalks bored and % internodes bored by *Proceras sacchariphagus* in 205 fields at harvest, 1964.

2. THE SCALE INSECT

The scale insect (*Aulacaspis tegalensis*) continued to be troublesome at the Central Cane Nursery where the piecemeal cropping and planting of the area involved, which is concomitant with the function of the nursery, and suitable climatic conditions, favour the development of infestations.

A simple apparatus was devised for the injection of insecticide into the piped irrigation water shortly before it reaches the sprinklers for overhead dispersion. The application of malathion at fortnightly intervals by this method is under trial.

Further experiments on the germination and early growth of scale-infested setts, and on remedial treatments which might be applied to such setts, were made.

Experiment 1. The following treatments were applied to 32 three-budded infested and uninfested setts, respectively, from 10-month-old M.93/48 cane before dipping in aretan and planting in trays of soil in the open at Réduit :

(a) No treatment
(b) Washed
(c) Dipped in a emulsion of albolineum (2%) and malathion (0.1%).
(d) HWT at 52°C for 15 minutes

The results obtaines eight weeks later are given in Table 39.

Experiment 2. A similar experiment using infested 11-month-old M.202/46 cane, comparable uninfested material being unavailable, gave the results shown in Table 40.

Table 39. **The effect of scale-infested setts and treatment of setts on early growth**

	UNTREATED		WASHED		INSECTICIDE		HWT		LSD	
	Uninfested	*Infested*	*Uninfested*	*Infested*	*Uninfested*	*Infested*	*Uninfested*	*Infested*	*5%*	*1%*
Germination (%)	79	44	80	77	48	73	76	69	16	21
Av. shoot length (cm)	61	42	63	55	68	51	65	55	9	12
Growth index* ...	100	40	104	86	66	78	101	79	19	25

* Total lengths of all shoots as a percentage of such data for uninfested, untreated setts

Table 40. **Early growth from scale-infested setts with and without treatment**

	Untreated	*Washed*	*Insecticide*	*HWT*	*LSD* 5%	1%
Germination (%)	18	39	29	63	12	16
Average shoot length (cm)	40	57	49	47	NS	NS
Growth index*	100	305	177	297	86	112

* Total lengths all shoots as a percentage of such data for untreated setts

Table 41. **Early growth from healthy setts after insecticidal treatment**

Variety	*M.253/48*		*E. 1/37*		*M.31/45*		*M.442/51*		*M.99/48*		*M.202/46*		*M.50/47*		*M.93/48*	
Age (months)	7		8		8		11		9		13		13		8	
	U*	T†	U	T	U	T	U	T	U	T	U	T	U	T	U	T
Germination (%) ...	57	47	51	64	74	82	61	60	60	57	68	54	44	42	58	71
Av. shoot length (cm) ...	28	35	32	31	24	24	30	39	33	30	49	44	17	18	30	30
Growth index ‡ ...	100	104	100	116	100	118	100	123	100	91	100	71	100	100	100	125

* Untreated
† Treated
‡ Total lengths of all shoots as percentage; untreated setts = 100%

Table 42. **Effect of scale-infested setts and treatment of setts on early growth and yield of cane**

(*a*) *Pointe aux Sables*	UNTREATED		INSECTICIDE		HWT		LSD		Age
	Uninfested	*Infested*	*Uninfested*	*Infested*	*Uninfested*	*Infested*	*5%*	*1%*	*(weeks)*
Germination (%) ...	80	62	79	67	84	73	8	11	6
Av. shoot length (cm) ...	52	41	52	42	58	48	7	9	6
Growth index* ...	100	74	99	74	103	96	19	26	11
Yield (TCA)	54.7	45.7	56.5	45.0	53.6	52.7	8.0	11.0	54
(*b*) *Belle Vue*									
Germination (%) ...	41	33	43	38	52	48	8	11	4
Av. shoot length (cm) ...	62	54	70	65	66	56	NS	NS	7
Growth index* ...	100	66	101	71	110	70	28	38	7
Yield (TCA)	39.7	39.4	43.2	44.3	44.6	43.4	NS	NS	64

* Total lengths of all shoots per unit length of row as a percentage of such data for untreated, uninfested setts

Experiment 3. Uninfested three-budded setts from eight varieties were dipped in the above-mentioned insecticide mixture and their germination compared with simliar untreated setts. Twenty four treated and untreated setts of each variety dipped in aretan and planted in trays of soil in the open at Réduit, gave after seven weeks the results shown in Table 41.

The tabulated results serve to confirm conclusions drawn from earlier experiments, as described in the previous report, and especially in Technical Circular No. 24. The scale depresses germination and young growth when it is abundant on the planted setts, but their removal or destruction diminish considerably this adverse effect of the scale. The destruction of the scales with HWT is complete, and this is preferable to the insecticide dip which is not highly efficacious. The dip in Table 39 would seem to have reduced germination of uninfested setts but a similar effect is not evident in Table 41, where there are no significant differences, or in other experiments carried out.

Two field experiments were concluded. These were designed to indicate the effect of scale-infested setts, and of treatment of setts, on yield of cane as well as on early growth. The survival of the insects on the planted setts and their ability to originate infestation in the virgin growth were also studied in these experiments. The two experiments were identical, but laid down in different localities, and were randomised blocks with five replications and plots of 1 row × 4 gaulettes (approx. 40 ft.), each plot being planted with 50 three-budded setts of 14-month-old M.202/46. Treatments were (i) nil; (ii) HWT at 50°C for 10 min.; (iii) insecticide dip as above, for both infested and uninfested setts, giving six rows (plots) per block. It should be noted that no effort was made to prevent scales being dislodged from infested material during preliminaries, i.e. cutting, loading, transport, chopping into setts, etc., and many were in fact removed as would happen in normal field practice. The experiments were well watered by overhead irrigation. Results are given in Table 42 (a) and (b); in (a) yields from infested setts are less than from clean setts, except when HWT had been applied; in (b) yields do not differ much.

The observations made in these field experiments on survival of scales underground on the infested setts have already been described.* The persistence of the scales is remarkable, and the progeny of those on the setts at planting may be found months later on both setts and underground parts of the new shoots. Later, scales appear above ground when internodes have formed suitably, and there seems little doubt that they are derived from those originally on the setts. As previously emphasized, this factor can be important in originating infestations only in areas where the insect thrives, namely, the dry coastal districts.

The maturation of infested and clean canes in a field of M.93/48 was studied by taking readings of internodal brix at intervals from April to November. In figure 21, each point represents the mean brix value from all the internodes of five complete canes. It is seen that the brix of infested canes remained low: the increase in September-October coincided with the death of most scales on the stalks, as usually happens later in the crop season, largely from the action of natural enemies.

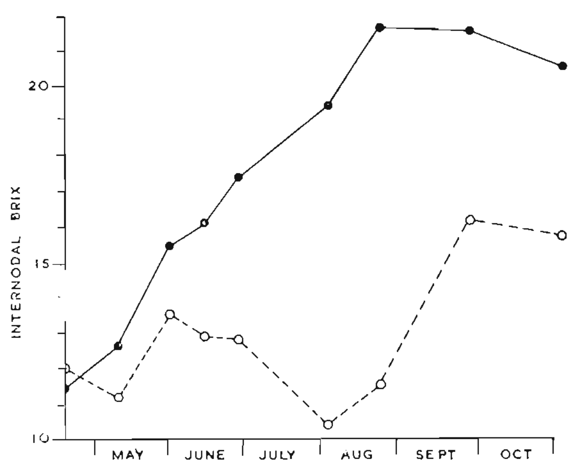


Fig. 21. Brix of scale-infested and clean stalks of M. 93/48. Each point represents the mean value of internodal brix in five canes.

●——● clean canes

o--------o infested canes

* *Rep. Maurit. Sug. Ind. Res. Inst.* **11** (1964) : 68-71 ; *and Technical Circular* no 24, 1965.

3. GENERAL

(i) Over 50 soil samples were taken from around cane roots in different localities and examined for nematodes of the genera *Xiphinema* and *Longidorus*. Five species of the former, the commonest being *X.elongatum*, and two of the latter were found.

(ii) A few localized attacks by aggregates of red locust hoppers occurred in December and were suppressed by spraying with dieldrin. The largest was over about 20 arpents in the north.

(iii) Armyworms (*Leucania loreyi*) attacked young ratoon cane on several occasions, invariably in fields which had been burnt at harvest a few weeks previously. Insecticidal treatment was recommended as necessary.

(iv) A new form of rat bait, originally devised for use in coconut groves in Jamaica, is a mixture of anti-coagulant rodenticide (0.5%), crushed maize, sugar and paraffin wax in the proportions 1 : 11 : 2 : 7 by weight, respectively. The wax is melted, the other ingredients stirred in, and the mixture poured into moulds and then, when hard, cut into blocks, or biscuits. The biscuits are convenient to use and, because of the wax, do not deteriorate rapidly in the field. Laboratory tests showed them to be both palatable to the brown rat and highly efficacious. They have been recommended for use in cane fields.

WEED CONTROL

E. ROCHECOUSTE

1. FURTHER INVESTIGATIONS ON THE USE OF SUBSTITUTED URACILS

THE nine trials initiated in 1963 to determine the effect of Bromacil (5-bromo-3 *sec.* butyl-6-methyl uracil) and Isocil (5-bromo-3 isopropyl-6-methyl uracil) on cane yield and sugar content were harvested in 2nd ratoon in 1965. It must be recalled that these trials were distributed in humid and super-humid areas, and the herbicides were applied a fortnight after harvest. The experimental design consisted of 5 × 5 latin square with plots 1/80th of an arpent. After the 1964 harvest, the experimental plots received again the same herbicide treatment as in 1963, that is, the Uracils were sprayed at dosages 0, ½, 1, 2 and 3 lb a.i. per arpent.

Results. From the results obtained and presented in Table 43 it will be observed that no increased phytotoxic effects on cane growth were registered after a second application of the Uracils. In fact, it is only at the highest rate of application (3 lb a.i.) that Bromacil and Isocil affected cane growth in the variety M.93/48 in 3 out of the 8 trials. No adverse effect on sugar yield was recorded with both Uracils at all rates of application experimented. These data indicate that the rates of application between ½ lb to 1 lb a.i. per acre may be safely used in ratoon crop.

Table 43. Effect of Bromacil and Isocil on cane yield (Tons/arpent).

BROMACIL

TREATMENTS	*M.93/48*					*M.202/46*		*Ebène 1/37*		*M.147/44*
lb a.i. per arpent	*Belle Rive Beau Champ*	*Henrietta*	*Riche en Eau*	*Bonne Veine*	*Alma*	*Gros Bois*	*New Grove*	*Mon Désert St. Pierre*	*Bois Sec*	*St. Aubin*
CONTROL ...	32.8	31.6	29.1	42.7	31.0	34.1	28.1	25.7	36.4	38.6
1/2 lb ...	31.2	31.1	28.0	42.4	34.3	32.4	28.8	31.1	35.2	42.2
1 lb ...	30.2	30.0	27.7	40.9	28.7	33.5	30.8	28.3	35.6	41.5
2 lb ...	29.6	30.4	33.6	41.1	29.3	30.0	30.3	26.2	33.6	41.9
3 lb ...	28.0	26.8	28.6	29.2*	25.5	30.1	31.1	22.9	32.0	37.0

ISOCIL

TREATMENTS	*M.93/48*					*M.202/46*		*Ebène 1/37*		*M.147/44*
lb a.i. per arpent	*Belle Rive Beau Champ*	*Henrietta*	*Riche en Eau*	*Bonne Veine*	*Alma*	*Gros Bois*	*New Grove*	*Mon Desert St. Pierre*	*Bois Sec*	*St. Aubin*
CONTROL ...	27.3	33.3	32.5	36.9	28.7	31.7	29.9	28.2	32.9	44.7
1/2 lb ...	30.2	33.9	32.2	38.1	34.0	34.5	28.6	29.7	34.2	44.7
1 lb ...	29.7	31.9	31.6	34.3	29.2	31.7	29.2	30.2	34.7	43.0
2 lb ...	28.4	29.6	26.2	29.5	29.8	33.7	31.7	27.6	32.7	45.7
3 lb ...	22.6*	26.3*	27.8	30.6	32.6	32.2	29.9	26.8	34.9	49.1

* Significant at 5% level.

2. EVALUATION OF NEW HERBICIDES

Two logarithmic trials were laid down at the Belle Rive Sugar Experiment Station. The log-plots were 45 ft long and each treatment was duplicated. Weed assessment was made by the frequency-abundance technique. In one trial the new herbicides Hercules 7531 (hexa-hydro-methanoindanyl-dimethyl urea), Hercules 7175 (chloronorbonyl dimethyl urea) and UCP-40-1 (2,4-D ester plus methyl substituted carbamate) and compared to DCMU. In the other trial, the effectiveness of the substituted Uracils, Bromacil (5-bromo-3 *sec.* butyl-6-methyluracil), H-732 (5-chloro-3 *tert.* butyl-6-methyluracil) and H-767 in comparison to DCMU was investigated. In both trials the herbicides were applied in pre-emergence treatment of both crop and weeds.

Results. *Trial No. 1.* DCMU was the most effective herbicide throughout the concentration range tested. Both Hercules weed-killers showed better weed control performance than UCP-40-1. Hercules 7175 and UCP-40-1 slightly affected cane growth at the dosage range 5.0—3.8 lb a.i. per acre. In general, DCMU was more effective than these herbicides on the following weed species *Digitaria timorensis, Setaria pallidefusca* and *Ageratum conyzoides.*

Trial No. 2. The substituted Uracils, Bromacil, H-732 and H-767 gave comparatively similar weed control results as DCMU. Of the three Uracils, Bromacil proved more toxic to cane growth at the concentration range 5.0—2.8 lb a.i. per acre than H-732 and H-767, and there are indications that H-732 might be slightly more toxic than H-767 at the highest dosage range.

Trial No. I Effects of new herbicides on weed infestation and cane growth, 12 weeks after planting

	WEED INFESTATION % CONTROL					MEAN SHOOT LENGTH % CONTROL				
	Dosage range per acre (lb active) per 3 yd. logarithmic strip					*Dosage range per acre (lb active) per 3 yd. logarithmic strip*				
TREATMENTS ...	*5.0-3.8*	*3.8-2.8*	*2.8-2.1*	*2.1-1.6*	*1.6-1.2*	*5.0-3.8*	*3.8-2.8*	*2.8-2.1*	*2.1-1.6*	*1.6-1.2*
DCMU 5 lb ...	20.6	16.2	17.6	25.7	22.8	105.3	95.5	89.6	98.6	94.6
Hercule 7175 5lb ...	36.0	30.9	33.8	49.3	55.9	75.5	82.5	86.7	89.3	98.6
Hercule 7531 5lb ...	29.4	33.1	36.8	40.4	57.0	84.9	108.7	110.7	94.6	101.4
UCP 40-1 5lb ...	47.1	50.0	51.5	63.2	67.6	73.5	94.0	98.8	94.2	91.3

Duration of experiment = 86 days
Total Rainfall = 24.03 in.
No. of rainy days = 59
Rainfall during 1st fortnight = 7.71 in.

Trial No. II Effects of new herbicides on weed infestation and cane growth, 18 weeks after planting

	WEED INFESTATION % CONTROL					MEAN SHOOT LENGTH % CONTROL				
	Dosage range per acre (lb active) per 3 yd. logarithmic strip					*Dosage range per acre (lb active) per 3 yd. logarithmic strip*				
TREATMENTS ...	*5.0-3.8*	*3.8-2.8*	*2.8-2.1*	*2.1-1.6*	*1.6-1.2*	*5.0-3.8*	*3.8-2.1*	*2.8-2.1*	*2.1-1.6*	*1.6-1.2*
DCMU 5 lb ...	18.2	20.5	20.5	22.7	26.7	129.7	112.0	118.7	100.8	111.4
Bromacil 5 lb ...	15.9	14.8	24.4	29.5	32.4	73.7	72.5	84.6	91.5	105.4
H-732 5 lb ...	19.9	21.6	28.4	27.3	33.5	84.4	95.5	94.3	95.8	96.7
H-767 5 lb ...	23.9	23.3	26.7	30.1	35.8	100.0	97.4	95.7	95.4	91.6

Duration of experiment = 161 days
Total rainfall = 49.19 in.
No. of rainy days = 129
Rainfall during 1st fortnight = 2.22 in.

3. CONTROL OF PERENNIAL WEEDS

(a) Paederia fœtida

Further experimental work on the control of this vine in stone walls was continued in 1965. From the data obtained, the potency of Tordon on the eradication of this weed was confirmed. At an application rate of 1 lb a.i. per 60 gallons water, very satisfactory results may be obtained, but a repeat application may be necessary. At the 2 lb treatment, almost complete control was obtained with one application. Best results were registered when the herbicide spray was made in summer after the rains had set in, that is after the vine had exhausted its food reserves.

(b) Bignonia unguis-cati

This plant is a vigorous leafy vine of limited distribution occurring only in some cane lands of the western part of the island. It is characterised by its opposite leaves, each of which consists of two leaflets separated by a tendril, with a three-clawed grapnel structure. It bears trumpet-shaped yellow flowers. The plant is a hard-to-kill weed owing to numerous tubers which give rise to new plants whenever aerial growth is destroyed.

Experimental work on its eradication was carried out during the years 1963-1965 with various chemicals. Two trials were laid down, one in 1963, and another in 1965. Plot size was 400 sq. ft, and there were two replicates per treatment. Rates applied were in lb a.i. per acre in 100 gallons water.

Results.

In the 1963 trial, the following treatments were used :

1. DCMU (4 lb) plus an Isoctyl ester of 2,4,-D and 2,4,5-T (3 lb).
2. Isocil (4).
3. Bromacil (4).
4. DCMU (4) + Bromacil (4).
5. DCMU (4) + Isocil (4).

None of the above treatments gave satisfactory results. A top kill was obtained the duration of which was about 3 to 4 months, thereafter the plant began to put out new growh from its underground tubers.

In the 1965 trial the following treatments were experimented :

1.	Weedazol TL.	(4 lb)
2.	,,	(2 lb)
3.	,,	(1 lb)
4.	Tordon	(4 lb)
5.	,,	(2 lb)
6.	,,	(1 lb)

Observation made six months after application showed that the Weedazol treatments were not as effective as those of Tordon throughout the concentration range. The best treatments were Tordon at 4 and 2 lb a.i./acre where 95% and 85% control of the plant were obtained respectively. At the 1 lb rate this chemical was ineffective. These preliminary data indicate that Tordon may be used to eradicate this vine, but it must be emphasized that its application should be restricted to non-crop lands until information becomes available on the persistence of Tordon in the soil.

Lysimeter experiment at Palmyre

Top left : placement of lysimeter in the ground; *top right* : three of the six lysimeter in the experimental field.

Bottom left : irrigation of experimental field; *bottom right* : germination three weeks after planting.

Petroleum mulch experiment at Belle Rive Experiment Station

Top : treated and untreated plots after planting ; white tripods indicate position of thermometers.
Bottom : experimental plots three months after planting, showing uniform growth.

CLIMATE AND CULTIVATION

1. CLIMATIC CONDITIONS DURING 1965 CAMPAIGN

PIERRE HALAIS

WEATHER conditions prevailing in 1965 are illustrated in figs. 22 to 25, which are based on data given in Tables VII, VIII and IX of the Appendix. They are average figures worked out for the sugar-producing area of the island as a whole, from observations systematically collected on selected permanent stations over the five sugar sectors. Though they differ considerably as far as the intensity of climatic characteristics from sector to sector is concerned, they are in reality quite interdependent, during a given campaign, owing to the restricted size and altitude of Mauritius. Nevertheless, the leeward western sector may exceptionally show some divergence, especially for the rainfall factor, but this is largely attenuated in practice because of irrigation.

During the eight months vegetative period extending from November 1964 to June 1965, weather conditions did not depart much from normal values :

i) The highest wind speed (V) for one hour's run reached 24 m.p.h., compared to the median figure of 26 m.p.h. taken as normal.

ii) The sum of monthly rainfall deficits (D) amounted to 14.1 inches, against the long term normal of 15.0 inches.

iii) The relative insolation was 59% against the normal of 58%.

iv) On the other hand, mean air temperature during the four critical months, March to June, differed much from normal, 22.6°C compared with the normal value of 23.3°C, that is a difference of — 0.7°C, which affected adversely late vegetative growth. The contrary happened in 1961 to an even greater extent, when air temperature reached the record value of 24.6°C which boosted cane growth.

The average T.C.A. for 1965 was the highest yet recorded, and amounted to 30.6 against the latest normal value estimated to about 31 tons.

During the four months maturation period July to October 1965, weather conditions were most abnormal as regards both rainfall and air temperature.

i) The sum of monthly rainfall excesses (E) amounted to 14.1 inches, the highest figure ever recorded in Mauritius since systematic observations started in 1875, whereas the normal value is only 2.5 inches.

ii) Minimum air temperature averaged 17.6°C, one of the highest on record since observations started in 1950, against the normal value of 16.5°C. Mean daily range of air temperature was the lowest yet observed, 6.7°C against the normal value of 8.2°C.

iii) Highest wind speed for one hour's run and relative insolation were both almost normal.

Sugar manufactured % cane was very low, 11.1 compared to the latest normal value estimated at 11.8. As a consequence, the total sugar output for the island only reached 664.5 thousand tons, compared to the latest normal sugar production potential estimated at 708 thousand tons.

The largest part of this "shortage" of 45 thousand tons of sugar is a direct result of the very high rainfall excesses and of the corresponding abnormal air temperature which prevailed during the four months maturation period, from July to October 1965. It is obvious that when harvest started in July, no one was in a position to forecast the abnormal weather conditions which set in later, and persisted continually during four months. On the other hand, if weather conditions had turned extremely favourable, the shortage of 45 thousand tons could have been altered into a "surplus" of the same magnitude, hence the great uncertainty arising from cane quality.

It must be mentioned in this connection that a "normal" year, as far as certain dominant meteorological elements are concerned, has been defined conventionally by this Institute as follows : (i) absence of destructive cyclones, that is no wind in excess of the threshold of 30 miles per hour for one hour; (ii) a sum of monthly rainfall deficits (D) during the vegetative period from November to June close to the normal value of 15.0 inches; and (iii) a sum of monthly rainfall excesses (E) during the maturation period from July to October, approaching the normal value of 2.5 inches.

It follows that the latest normal sugar production estimated at 708 thousand tons for Mauritius in 1965, as a reference potential, is much higher than the true average sugar production which is limited by the dominant weather hazard, namely, destructive cyclones.

Tables 44 and 45 give in a summarized form the most important weather data which are known to affect sugar production in Mauritius. The normal values are long-term arithmetic means, with the exception of highest wind speed, for which the median figure has been selected to represent the normal value.

Table 44. Variations in major climatic elements during the vegetative period 1963-1965.

	Months	*Normals*	*1964/65*	*1963/64*	*1962/63*	*Extremes since 1950*
Highest wind speed m.p.h. ...	Nov.-June	*26*	24 (May)	60 (Jan.)	26 (Jan.)	18 — 74 (1959) (1960)
Sum of monthly rainfall deficits, inches	Nov.-June	*15.0*	14.1	10.3	13.9	5.7 — 28.7 (1962) (1961)
Relative insolation in %	Nov.-June	*58*	59	55	53	53 — 61 (1963) (1961)
Mean air temperature °C	Mar.-June	*23.3*	22.6	22.7	23.2	22.6 — 24.6 (1965) (1961)
Tons cane/arpent		*30.9*	30.6	22.5	29.6	12.7 — 30.6 (1960) (1965)

Table 45. Variations in major climatic elements during the maturation period 1963-1965.

	Months	*Normals*	*1965*	*1964*	*1963*	*Extremes since 1950*
Highest wind speed for one hour's run m.p.h.	July-Oct.	*20*	20	20	17	17 — 25 (1957,1963) (1952)
Sum of monthly rainfall excesses, inches	July-Oct.	*2.5*	14.1	2.9	2.2	0.0 — 14.1 (1956) (1965)
Relative insolation in %	July-Oct.	*58*	56	61	51	51 — 65 (1963) (1956)
Average min. air temperature °C ...	July-Oct.	*16.5*	17.6	15.8	15.7	15.7 — 17.6 (1963) (1961,1965)
Mean daily range, air temperature °C	July-Oct.	*8.2*	6.7	7.9	8.7	6.7 — 9.3 (1965) (1956)
Sugar manufactured % cane ...		*11.8*	11.1	11.9	11.9	9.8 — 12.9 (1960) (1956,1957)
Tons sugar/arpent		*3.65*	3.42	2.66	3.53	1.26 — 3.53 (1960) (1963)
Area harvested thousand arpents ...		*194*	194.1	194.9	194.1	151.0 — 194.9 (1950) (1964)
Total sugar production, thousand tons		*708*	664.5	519.6	685.5	253.8 — 685.5 (1960) (1963)

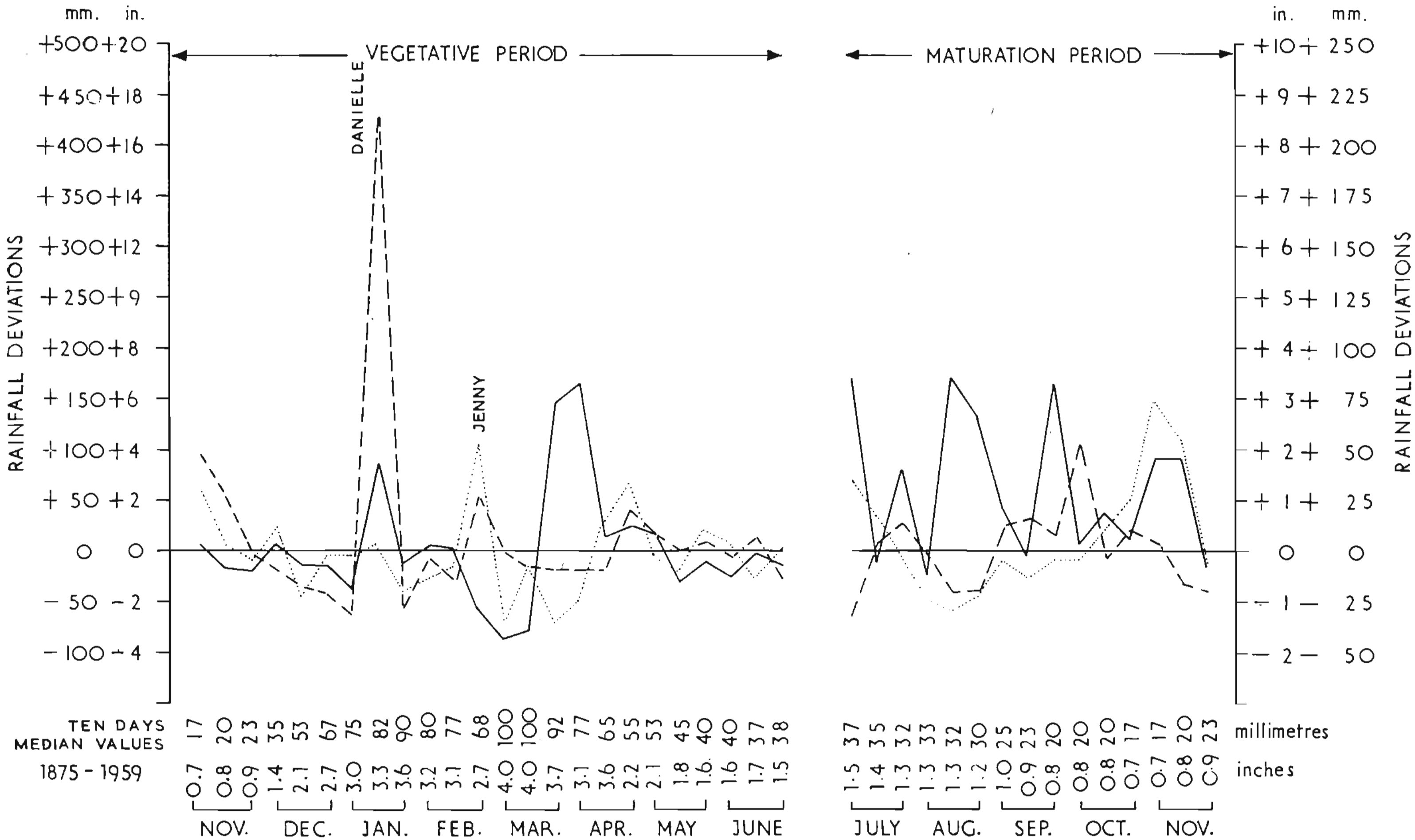


Fig. 22. Rainfall deviations from 10 days' median values.
Dotted line : 1962-63. Broken line : 1963-64. Plain line : 1964-65.
Scale used for maturation period is double that for vegetative period of sugar cane.

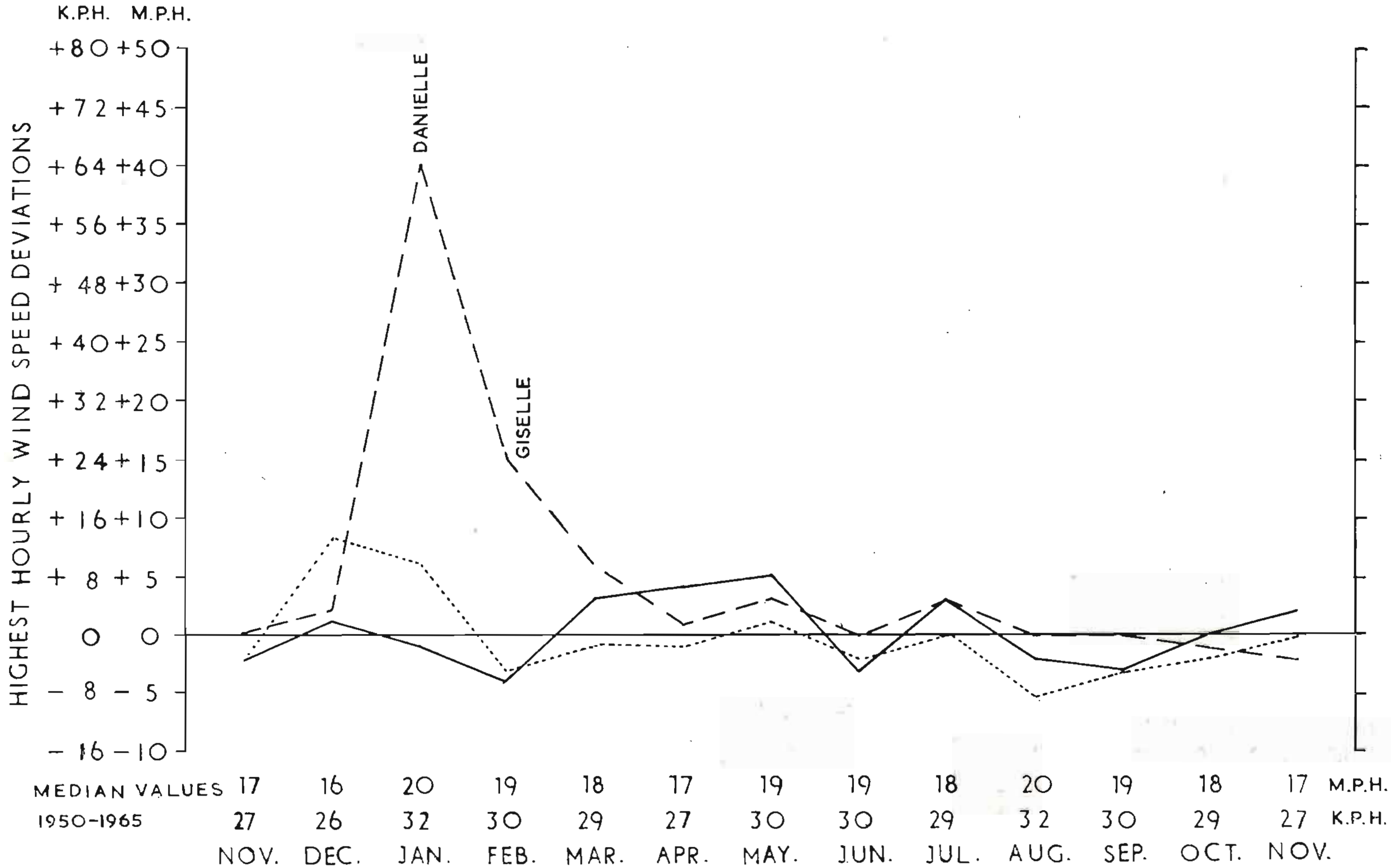


Fig. 23. Deviations of highest hourly wind speed from corresponding median values.
Dotted line : 1962-63. Broken line : 1963-64. Plain line : 1964-65.

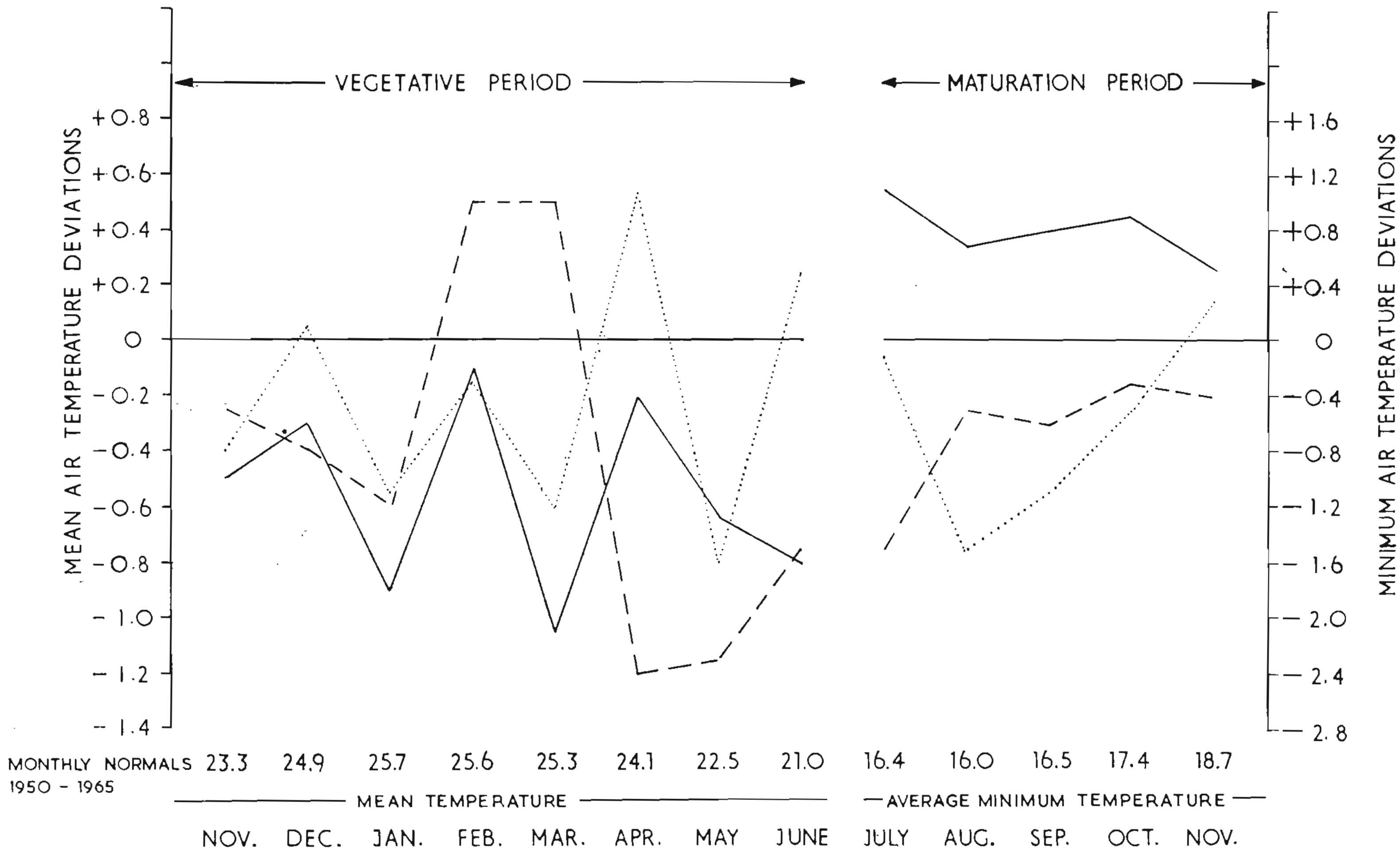


Fig. 24. Air temperature deviations from monthly normal values; average mean T for vegetative period; average minimum T for maturation period. Dotted line : 1962-63. Broken line : 1963-64. Plain line : 1964-65.

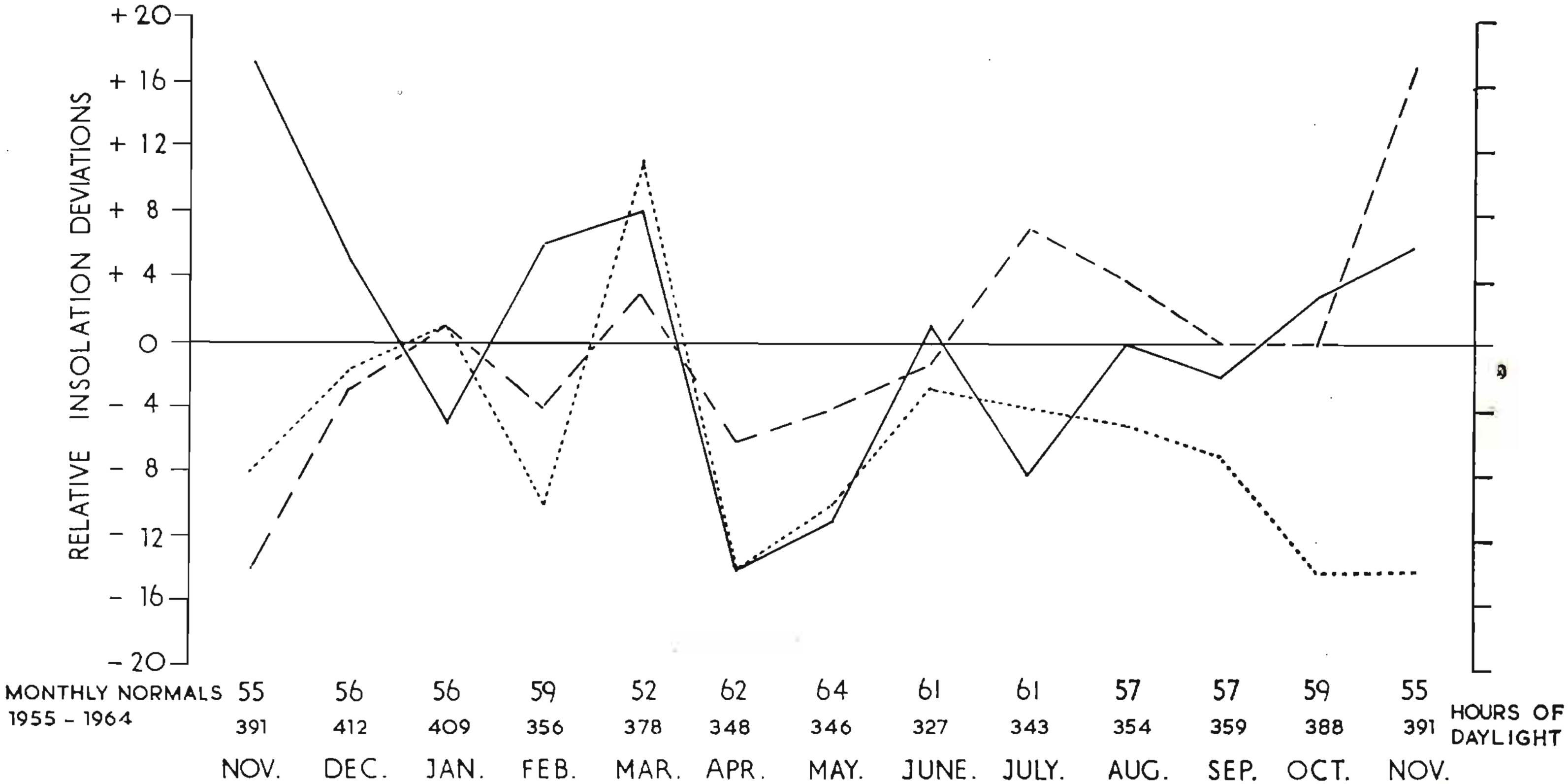


Fig. 25. Relative insolation deviations from monthly normals.
Dotted line : 1962-63. Broken line : 1963-64. Plain line : 1964-65.

2. SOME CLIMATIC FACTORS PROMOTING SUCROSE ACCUMULATION IN SUGAR CANE

PIERRE HALAIS

Cane quality, as measured by sugar manufactured % cane, shows considerable variation from year to year in Mauritius, the extreme values observed recently being 9.8 in 1960 after the passage of two destructive cyclones in January and February, followed by exceptionally heavy rains in September, and 12.9 in 1956 and 1957, two consecutive years with restricted rainfall throughout the maturation period from July to October.

The value of 11.1 obtained for the 1965 campaign is one of the lowest on record (11.0 in 1953), and a close analysis of the abnormal meteorological conditions which prevailed during the maturation period, July to October 1965, is worth attempting.

The present study covers a period of 16 years from 1950 to 1965.

Experience has shown that three meteorological factors during the four months maturation period, from July to October, exercise a predominant influence on cane quality at harvest in Mauritius. They are :

(i) The sum of monthly rainfall excesses (E) which varied from zero in 1956 to 14.1 inches in 1965. The arithmetic mean for the long term 1875 to 1949, being 2.5 inches, represents the normal value.

(ii) The average minimum air temperature, which varied from 15.7°C in 1963 to 17.4°C in 1961 and 1965, the normal value being 16.6°C.

(iii) The mean daily range of air temperature, which varied from 6.7°C in 1965 to 9.3°C in 1956, the normal value being 8.2°C.

Low rainfall, low minimum and high daily range of air temperature, favour high sucrose content of the harvested sugar cane, whereas high rainfall, high minimum and low daily range inhibit cane maturation.

A search for the better understanding of these relationships is the object of this note.

Table 46 gives the monthly values for rainfall and air temperatures observed during the maturation period for the two contrasted years: 1956 with 12.95* sugar manufactured % cane, and 1965 with only 11.1 %**.

Table 46. Rainfall and temperature during maturation period for two contrasted years

	July	*August*	*September*	*October*	*Sum of monthly rainfall excesses* (E)
Normal rainfall, inches (1875-1949) ...	*4.59*	*4.15*	*2.90*	*2.81*	*2.5*
1956	2.94	2.82	1.68	1.40	0.0
1965	9.01	9.43	6.67	3.46	14.1
					July-Oct.
Av. min. air temp. °C (normals, 1950-1965) ...	*16.4*	*16.0*	*16.5*	*17.4*	*16.6*
1956	15.0	15.6	16.6	17.8	16.2
1965	17.5	16.7	17.3	18.3	17.4
Mean daily range air temp. °C (normals, 1950-1965)	*7.6*	*8.0*	*8.4*	*8.8*	*8.2*
1956	9.0	9.2	9.2	9.6	9.3
1965	6.6	6.3	6.9	7.2	6.7

* Equivalent to 7.7 tons of cane per ton of sugar

** Equivalent to 9.0 tons of cane per ton of sugar

The normal value for the sum of monthly rainfall excesses (E) being 2.5 inches, and the relationship between excess rainfall and sugar manufactured % cane being logarithmic, it has been found necessary to transform the meteorological data and adopt the term log 4 E in order to obtain a normal value of 1.00.

On the other hand, air temperature should be expressed as the ratio of the daily range to the minimum in order to increase the sensitivity of this meteorological index. As the normal values for mean daily range and average minimum air temperatures are 8.2°C and 16.6°C respectively, it has been found convenient to multiply the ratio by 2 in order to obtain a normal value of 1.00.

Therefore, the two meteorological indices chosen for explaining fluctuations in cane quality are: (i) log 4 E, a mathematical transformation of the rainfall excess and (ii) x, twice the ratio of temperature daily range divided by minimum air tempeature. The normal values of both indices are equal to 1.00.

The indices E and x have been worked out as usual for the sugar area of Mauritius as a whole, from observations collected on 18 selected stations for rainfall, and on 5 representative stations for air temperatures.

A class analysis given in Table 47 for the monthly values of the ratio x, twice daily range over minimum temperature, and observed rainfall for the whole period of 204 months from 1950 to 1965 shows that the two values are very closely associated.

Table 47. Relationship between rainfall and temperature ratio

No. of monthly observations	*Ratio x twice daily range / min. temp.*		*Monthly rainfall*	
	Class	*Average*	*inches*	*log. inches*
6	1.20 — 1.29	1.26	1.9	0.279
12	1.10 — 1.19	1.13	2.8	0.447
24	1.00 — 1.09	1.05	3.0	0.477
40	0.90 — 0.99	0.94	4.9	0.690
42	0.80 — 0.89	0.85	6.1	0.785
46	0.70 — 0.79	0.75	9.1	0.959
27	0.60 — 0.69	0.65	12.5	1.097
5	0.50 — 0.59	0.55	19.2	1.283

The monthly values (median and extremes) for the period 1950-1965 are given in Table 48.

Table 48. Monthly variations in temperature ratio x and rainfall.

	N	*D*	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*
Temperature Ratio x												
Median ...	0.97	0.83	0.73	0.70	0.69	0.75	0.87	0.89	0.90	0.94	1.04	1.02
Extremes	1.28	0.96	0.91	0.91	0.87	0.91	1.18	1.09	1.20	1.30	1.20	1.18
	0.68	0.59	0.62	0.52	0.50	0.60	0.66	0.72	0.75	0.76	0.78	0.80
Monthly Rainfall												
Inches ...	4.0	8.7	10.6	11.0	13.7	8.2	5.7	5.7	5.5	4.2	3.4	2.8
Log inches	0.602	0.740	1.025	1.041	1.137	0.914	0.756	0.756	0.740	0.623	0.531	0.447

Table 49 gives the monthly values of the temperature ratio x for the two contrasted years 1956 and 1965.

Table 49. Monthly values of temperature ratio x for two contrasted years.

	July	*August*	*September*	*October*	*July-October*
Median ...	*0.90*	*0.94*	*1.04*	*1.02*	*0.98*
1956	1.20	1.19	1.11	1.09	1.12
1965 ...	0.75	0.76	0.80	0.80	0.78

The following six regression equations have been worked out for calculating sugar manufactured % cane (y) when the sum of monthly rainfall excesses (log. 4 E) is known for the maturation period July to October, observed over the whole sugar area of Mauritius, for 15 years between 1950 and 1965 (cyclone year 1960 excluded). The number of degrees of freedom is 13.

		correlation cœfficient r
Mauritius	$y_m = 11.87 - 1.19$ (log 4 E — 1.01)	— 0.936
West Sector	$y_w = 12.31 - 1.09$ (,, ,,)	— 0.897
North Sector	$y_n = 12.39 - 1.58$ (,, ,,)	— 0.827
East Sector	y_e 11.65 — 1.10 (,, ,,)	— 0.769
South Sector	y_s 11.45 — 1.06 (,, ,,)	— 0.914
Central Sector	$y_c = 12.12 - 0.85$ (,, ,,)	— 0.881

Figure 26 gives a generalized graphical representation of the six above mentioned regression equations relating sugar manufactured % cane to the sum of monthly rainfall excesses for July-October averaged over the whole sugar area of Mauritius.

Six other regression equations have been worked out for finding sugar manufactured % cane (y), when the temperature ratio x is known for the maturation period July to October, observed over the whole sugar area of Mauritius for 15 years between 1950 and 1965 (cyclone year 1960) excluded). The number of degrees of freedom is 13.

		correlation cœfficient r
Mauritius	$y_m = 11.87 + 5.07$ (x — 0.98)	+ 0.703
West Sector	$y_w = 12.31 + 5.04$ (,,)	+ 0.770
North Sector	$y_n = 12.39 + 7.52$ (,,)	+ 0.731
East Sector	$y_e = 11.65 + 4.65$ (,,)	+ 0.601
South Sector	$y_s = 11.45 + 4.22$ (,,)	+ 0.673
Central Sector	$y_c = 12.12 + 3.51$ (,,)	+ 0.674

Both meteorological factors selected, i.e. sum of monthly rainfall excesses (E) for July-October and ratio twice daily range over minimum air temperature (x) for July-October, show a highly significant correlation with sugar manufactured % cane for Mauritius, or for each of the five sugar sectors taken separately. Nevertheless, it is clear that the rainfall excess factor is the dominant one under the conditions which prevail locally.

The regression cœfficients b are the highest for the North Sector, 1.58 and 7.52, and the lowest for the Central Sector, 0.85 and 3.51, which means that fluctuations in cane quality are much wider for the North Sector than for the Central Sector.

The temperature ratio x may be used with advantage as a general climatic index for cane quality (in the absence of late irrigation and high water table), as shown below with reference to the maturation period July to October.

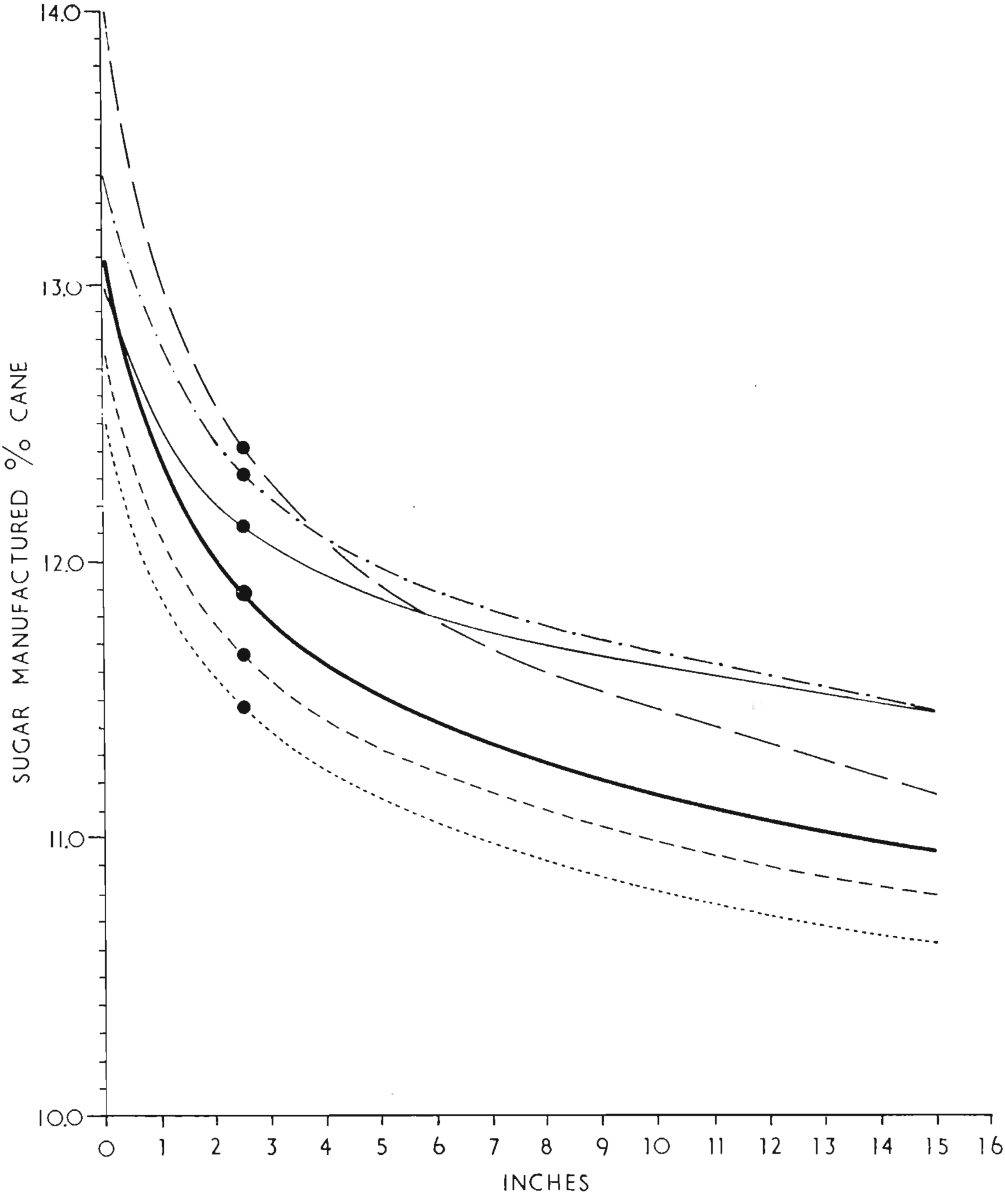


Fig. 26. Relation between sugar manufactured % cane and sum of monthly rainfall excesses from July to October.

Mauritius :	▬▬▬	East :	- - - - - -
North :	— — — —	West :	—·—·—·
South :	....	Centre :	————

Table 50. Temperature ratio x as a General climatic index for cane quality

	Mauritius	*West Médine (irrigated)*	*North Pamplemousses*	*East FUEL*	*South Plaisance*	*Centre Vacoas*
Daily range	8.2	10.3	9.0	7.3	7.0	7.3°C
Min. temp.	16.6	17.0	16.9	17.0	17.6	14.3°C
Temp. ratio	0.99	1.19	1.06	0.86	0.79	1.02
Sugar manuf. % cane for sector ...	11.9	12.3	12.4	11.6	11.4	12.1

It can be seen in the above table that a temperature ratio of 1.00 separates the sectors into two groups : West, North, Centre with high cane quality (temperature ratio above 1.00), and East and South with lower cane quality (temperature ratio inferior to 1.00).

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3. FORECASTING FINAL SUGAR PRODUCTION FROM AUGUST ONWARDS

PIERRE HALAIS

Ten years have now elapsed since the M.S.I.R.I. started to circulate, in 1955, a weekly bulletin giving essential information on the evolution of the sugar cane crop in each of the five sugar sectors.

The mass of information now available constitutes excellent material for attempting, by means of appropriate statistical methods, to devise the right procedure for making, as early as possible, and within a specified margin of error, objective forecasts of the final sugar production.

Three steps are necessary to carry out the final forecast :

(i) An estimate of the final tons of sugar per arpent on millers' plantations by means of appropriate regression equations giving a margin of error within the probability of 0.90.

(ii) A conversion factor for obtaining average (millers and planters) tons of sugar per arpent from millers' data.

(iii) An estimate of the total area expected to be harvested.

(*a*) *Estimate of millers' final sugar per arpent*

The weekly bulletin of the Institute allows the intrapolation of tons of sugar per arpent on the 1st of each month,rom August fonwards, up to the end of the crop season when the final figure, the first object of our study, is made available.

The steps to be followed will be given below as an example dealing with the final sugar production of the island as a whole.

Table 51. Tons of sugar per arpent for millers

Year	*Aug.* (x_1)	*Sept.* (x_2)	*Oct.* (x_3)	*Nov.* (x_4)	*Final* (y)
1955	3.19	3.60	3.81	3.92	*3.91*
1956	3.82	4.13	4.23	4.20	*4.14*
1957	3.72	3.98	4.14	4.17	*4.17*
1958	3.56	3.70	3.79	3.80	*3.70*
1959	3.81	3.94	4.02	4.01	*3.98*
1960	1.21	1.32	1.41	1.46	*1.51*
1961	2.97	3.19	3.40	3.53	*3.60*
1962	3.05	3.21	3.26	3.23	*3.23*
1963	3.79	4.01	4.15	4.19	*4.19*
1964	2.73	2.91	3.02	3.07	*3.11*
Average ...	*3.19*	*3.40*	*3.52*	*3.56*	*3.55*

Four regression equations have been worked out where y is the final tons of sugar per arpent, and x_1, x_2, x_3, x_4, are the successive monthly values. The number of degrees of freedom is 8.

Table 52. Regression equations

	Regression equations	*Correlation cœfficients*
Aug.	$y = 3.55 + 0.986\,(x_1 - 3.19)$	+ 0.972
Sept.	$y = 3.55 + 0.957\,(x_2 - 3.40)$	+ 0.987
Oct.	$y = 3.55 + 0.952\,(x_3 - 3.52)$	+ 0.994
Nov.	$y = 3.55 + 0.967\,(x_4 - 3.56)$	+ 0.998

As could be expected, the precision of the forecast for final tons of sugar per arpent increases from August onwards, as proved by the correlation cœfficients which rise gradually from + 0.972 in August to + 0.998 in November.

Allowing for a probability P of 0.90, the margin of error expected on the final tons sugar per arpent has been calculated for various values of *x*, the monthly values, according to the procedure of DIXON & MASSEY (1951).

Table 53. Expected margin of error on final tons sugar per arpent (P 0.90)

Monthly values of tons sugar/arpt. (x)	*Aug.*	*Sept.*	*Oct.*	*Nov.*
1.50	± 0.32	± 0.21	± 0.15	± 0.08
2.00	± 0.25	± 0.17	± 0.12	± 0.07
2.50	± 0.18	± 0.13	± 0.09	± 0.05
3.00	± 0.14	± 0.09	± 0.07	± 0.04
3.50	± 0.15	± 0.08	± 0.05	± 0.03
4.00	± 0.20	± 0.10	± 0.06	± 0.03
4.50	± 0.27	± 0.14	± 0.09	± 0.05
5.00	± 0.35	± 0.19	± 0.11	± 0.06

The following example has been worked out from data presented in the weekly bulletin for the 1965 campaign (Table 54). Appropriate regression equations were taken from Table 52, and the margin of error from Table 53.

Table 54. Final production forecast, 1965

Monthly values observed tons sugar/arpent		*Final values calculated tons sugar/arpent.*	
Aug.	3.59	*3.95*	± 0.16
Sept.	3.76	*3.90*	± 0.09
Oct.	3.89	*3.91*	± 0.06
Nov.	3.93	*3.93*	± 0.03
Final		*3.96*	(observed)

(b) Relation between Millers' and Planters' sugar yields.

The above-mentioned tons of sugar per arpent refer exclusively to mill owners plantations and what is finally needed is average tons of sugar per arpent including both millers and planters.

Table 55 gives the conversion factors (A/M) to be used for converting millers sugar yields (M) to average sugar yields (A). Obviously, the proper factor to use is the latest available, that is for 1965, the factor observed in 1964.

Table 55. Conversion factors for calculating average sugar yields

Year	*Factor A/M*	*Year*	*Factor A/M*
1955	0.810	1961	0.820
1956	0.822	1962	0.853
1957	0.795	1963	0.843
1958	0.803	1964	0.859
1959	0.797	1965	0.857
1960	0.830		

(c) Area to be harvested

The third information needed is the total area to be harvested. The latest figure should be used, in case no real estimate is available.

Table 56. Conversion factors for calculating area harvested

Year	*Thousand arpent harvested*	*Year*	*Thousand arpent harvested*
1955	168.6	1961	187.3
1956	167.9	1962	193.8
1957	169.6	1963	194.1
1958	176.7	1964	194.9
1959	183.1	1965	194.1
1960	188.4		

For the running forecast concerning the 1965 sugar campaign, assuming a conversion factor of 0.859 and the area harvested to be 195.000 arpents, the final factor works out to 0.859 × 195 = 167.5 for calculating the total sugar already estimated. (Table 57).

Table 57. Forecast of final sugar production

Final tons sugar/ arpt. expected on millers plantations.			*Conversion factors (0.859×195 = 167.5)*	*Forecast of final sugar production th. tons.*
Aug.	3.95 ± 0.16	×	167.5	662 ± 26
Sept.	3.90 ± 0.09	×	167.5	653 ± 15
Oct.	3.91 ± 0.06	×	167.5	654 ± 10
Nov.	3.93 ± 0.03	×	167.5	658 ± 5
Actual production				664.5

It is realized that the conversion factors are also subject to uncertainty, which means that the real margin of error will exceed those given above.

Similar statistical analysis has been carried out for each of the five sugar sectors separately and given in Table 58.

Table 58. Regression equation for the sugar sectors

	Regression equations	*Cœfficients of correlation*
	WEST SECTOR	
Aug.	$y = 4.06 + 1.057\ (x_1 - 3.90)$	+ 0.958
Sept.	$y = 4.06 + 0.968\ (x_2 - 4.00)$	+ 0.966
Oct.	$y = 4.06 + 0.898\ (x_3 - 4.09)$	+ 0.978
Nov.	$y = 4.06 + 0.965\ (x_4 - 4.07)$	+ 0.995
	NORTH SECTOR	
Aug.	$y = 3.70 + 0.726\ (x_1 - 3.34)$	+ 0.705
Sept.	$y = 3.70 + 0.881\ (x_2 - 3.67)$	+ 0.808
Oct.	$y = 3.70 + 0.940\ (x_3 - 3.75)$	+ 0.861
Nov.	$y = 3.70 + 0.954\ (x_4 - 3.76)$	+ 0.888
	EAST SECTOR	
Aug.	$y = 3.59 + 0.989\ (x_1 - 3.41)$	+ 0.946
Sept.	$y = 3.59 + 0.962\ (x_2 - 3.52)$	+ 0.972
Oct.	$y = 3.59 + 0.945\ (x_3 - 3.61)$	+ 0.992
Nov.	$y = 3.59 + 0.950\ (x_4 - 3.61)$	+ 0.997
	SOUTH SECTOR	
Aug.	$y = 3.35 + 1.040\ (x_1 - 3.00)$	+ 0.981
Sept.	$y = 3.35 + 0.987\ (x_2 - 3.19)$	+ 0.991
Oct.	$y = 3.35 + 0.965\ (x_3 - 3.29)$	+ 0.997
Nov.	$y = 3.35 + 0.967\ (x_4 - 3.34)$	+ 0.999
	CENTRAL SECTOR	
Aug.	$y = 3.55 + 1.072\ (x_1 - 3.15)$	+ 0.985
Sept.	$y = 3.55 + 1.000\ (x_2 - 3.43)$	+ 0.987
Oct.	$y = 3.55 + 0.975\ (x_3 - 3.55)$	+ 0.994
Nov.	$y = 3.55 + 0.982\ (x_4 - 3.57)$	+ 0.999

The expected margin of errors for P 0.90 has also been calculated for each sector separately but needs not be reproduced in this short note.

The conversion factors (A/M) for calculating average tons sugar per arpent from millers' values are given in Table 59.

Table 59. Conversion factors (A/M) for calculating average tons sugar per arpent from millers' values

	West	*North*	*East*	*South*	*Centre*
1955 ...	0.810	0.810	0.708	0.886	0.836
1956 ...	0.839	0.792	0.756	0.893	0.829
1957 ...	0.858	0.728	0.727	0.893	0.839
1958 ...	0.864	0.732	0.711	0.904	0.846
1959 ...	0.852	0.717	0.752	0.885	0.834
1960 ...	0.761	0.734	0.748	0.884	0.909
1961 ...	0.788	0.805	0.746	0.893	0.839
1962 ...	0.824	0.794	0.776	0.917	0.873
1963 ...	0.849	0.794	0.769	0.919	0.851
1964 ...	0.882	0.779	0.771	0.934	0.880
1965 ...	0.908	0.792	0.792	0.943	0.877

The general conclusion arising from this statistical study is that the Institute has now a reliable method for forecasting the final sugar production, with a reasonable margin of error for Mauritius as a whole, and for four of the sugar sectors namely West, East, South and Centre separately. However, a useful forecast for the North Sector, as shown by the much lower values of the correlation cœfficients, is difficult to obtain owing to the very nature of the local climatic conditions which may exercise a decisive influence on the sugar output, even up to an advanced date in the crop season.

REFERENCES

DIXON, W. J. *and* MASSEY, F. J. *jr.* (1951) *Introduction to statistical analysis,* 2nd. ed. London, Mc Graw Hill. p 192.

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4. IRRIGATION SURVEY, 1965

G. MAZERY & M. HARDY

A survey carried out at the end of 1965 revealed that there are approximately 30,000 arpents, representing 14.6% of cane lands, under irrigation at present, of which 21,500 arpents belong to estates and 8,500 to planters. The distribution of irrigated lands by sectors in relation to total area and cane area is given in Table 60, which shows the pre-eminent position of irrigation in the West where cane cultivation cannot be economically carried out without additional water.

The system of irrigation used is given in Table 61, which shows that overhead irrigation is practised over 38 % of the total irrigated area. A comparison with data available for 1963 is of interest. During this period area irrigated has increased by approximately 2,600 arpents, and overhead irrigation has been extended by 8 %.

Data presented in Table 62 show the area irrigated by different types of growers, as well as the system of irrigation used, and changes which have taken place during the last two years.

Table 60. Distribution of irrigated lands in relation to total area and cane area, 1965

	Approximate area of sector arpents	*Approximate cane area, arpents*	*Area under irrigation, arpents*
West	56,000	13,530	10,980
North ...	91,000	55,190	7,800
East	72,000	45,600	3,820
South	160,000	66,400	4,680
Centre ...	63,000	25,620	2,750
Total ...	442,000	206,340	30,030

Table 61. Comparison between surface and overhead irrigation

	Area irrigated, arpents	
	Surface	*Overhead*
West ...	8310	2670
North ...	3900	3900
East ...	1320	2500
South ...	2600	2080
Centre ...	2550	200
Island ...	18680	11350

Table 62. System of irrigation used by different types of growers

	Area irrigated, arpents			
	Surface		*Overhead*	
	1963	*1965*	*1963*	*1965*
Planters	7,308	6,240	2,002	2,250
Estates	12,828	12,440	6,732	9,100
Total	20,136	18,680	8,734	11,350

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5. ECONOMICS OF IRRIGATION IN MAURITIUS

G. MAZERY

The purpose of these notes is to summarize information available at the M.S.I.R.I. on the relative costs of surface and overhead irrigation.

Basic data on this subject were obtained from experiments carried out by the Institute during a period of 5 years. In addition, information on the cost of large-scale irrigation schemes was obtained from several sugar estates. Many factors have to be considered, under local conditions, before a final decision is reached on the type of irrigation — surface or overhead — best suited for a given locality. Of these, climate, availability of water, soil type, and topography of land, size and type of holding, are the most important, and are analysed separately.

Climate

The number of irrigations required in a cane growth cycle, hence the cost, will fluctuate considerably according to the particular climatic zone concerned. For example, in the West about 20 irrigations a year are required, while in other regions, 6 to 15 irrigations per year are sufficient under normal conditions for satisfactory cane growth. Essential data to be considered in this connection are rainfall deficits and evapotranspiration of the specific region to be irrigated. In this connection, the agro-climatic map of Mauritius, which will be published shortly by the Institute, will prove of great assistance in the determination of the amount of irrigation water required and of frequency of application.

Availability of Water

The main supply of irrigation water in Mauritius is from Government and privately-owned reservoirs, from water rights on rivers and springs, from residual water from factories, and from underground resources. Costs will obviously fluctuate within wide limits. Thus, water supplied by Government from "La Ferme" reservoir and Magenta canal in the west is charged at Rs. 0.25 cs for 4000 cu. ft, and that supplied from "Nicolière" to the northern sector is charged at Rs. 0.50 cs for 4000 cu. ft. The cost of ground water varies, depending on the depth of the well and the source of energy for pumping, while the cost of water is negligible for planters who enjoy water rights on rivers and springs.

Soil and Land

Surface irrigation can only be practised profitably on "free" soils (Low Humic Latosols). It cannot be considered for "gravelly" soils (Latosolic Reddish Prairie) which are too permeable. In this latter case, the most rational system is overhead irrigation, which allows an accurate control of the amount of water applied, irrespective of the type of soil and topography of the land, thus enabling an important water saving.

The following data illustrate this point :

	Quantity of water used for one irrigation	
	"Free" soils	*"Gravelly" soils*
Overhead...	2.0 inches	2.0 inches
Surface ...	6.0 ,,	19.0 ,,

In fact, in several regions of the island, cane lands which had been abandoned, as well as large areas which had never been cultivated because they required too much water by surface irrigation, have recently been put under cultivation as a result of conversion to the overhead system of irrigation.

The water saving derived from the use of overhead irrigation may result in an appreciable increase in the development of land where there are still uncultivated areas of reasonable agricultural potential, and where water is the limiting factor.

Size and Type of Holding

For the purpose of irrigation possibilities, the cane growing area of Mauritius can be classified into the following units :

(i) planters cultivating less than 20 arpents;
(ii) planters cultivating between 20 and 100 arpents;
(iii) planters cultivating more than 100 arpents;
(iv) factory grown canes.

The number and distribution of these groups in different sectors of the island are shown in Table 63.

Table 63. Number and area of cane growing units

	Less than 20 arp.		*Between 20-100 arp.*		*More than 100 arp.*		*Factories*		*Total Cane*
	Number	*Area*	*Number*	*Area*	*Number*	*Area*	*Number*	*Area*	*Area*
West ...	666	1655	30	1565	12	3205	1	7108	13533
North ...	9693	20285	111	4375	27	10340	6	20193	55193
East ...	6664	16719	79	3600	13	2981	3	22300	45600
South ...	5226	10812	98	4984	14	4204	10	46400	66400
Centre ...	4660	7633	63	2595	4	1232	3	14158	25618
Island ...	*26909*	*57104*	*381*	*17119*	*70*	*21962*	*23*	*110159*	*206344*

Irrespective of climatic conditions, under which additional water is desirable to improve yields, it is considered that cane units of less than 20 arpents cannot be irrigated economically because water losses become excessive with diminishing size of irrigated area. On the other hand, the minimum size of holding for efficient overhead irrigation using diesel oil as source of power is about 100 arpents. In any major plan for developing irrigation in Mauritius, therefore, it should be borne in mind that a gross area of 57000 arpents should be excluded, unless small growers can be grouped into larger units for the purpose of irrigation. Concerning overhead irrigation, a further area of approximately 17,000 acres should be neglected.

As indicated above, the size of cane units which can be safely considered to be minimal for irrigation are :

Surface irrigation : not less than 20 arpents
Overhead „ (diesel pumping): not less than 100 arpents
„ „ (electric pumping): not less than 50 arpents

Another factor of importance, governed by the type of holding, is that in the case of planter-grown cane, the increase in yield must alone compensate irrigation expenditure. In the case of factory-grown cane, however, the margin of return in the field may be smaller because of lower cost in processing a larger supply of raw material.

An indication of additional cane production required by planters to compensate the increased cost of cane production arising through irrigation is given in Table 64 for different sugar prices.

Table 64. Additional cane production required to compensate cost of irrigation

1. Price of sugar per ton	Rs. 400			Rs. 450			Rs. 500		
2. Value to planter of 1 ton cane at 12.00% extraction	Rs. 32			Rs. 36			Rs. 40		
3. No. of irrigations per annum	10	15	20	10	15	20	10	15	20
4. Additional *tons cane* required to cover costs and interest on capital investment :									
(i) Overhead irrigation (by semi-permanent system)	5.8	8.7	11.6	5.1	7.6	10.0	4.7	7.0	9.3
(ii) Surface irrigation	2.5	3.8	5.1	[illegible]	3.4	4.5	2.0	3.0	4.0

Cost of Irrigation

The approximate costs of surface and overhead irrigation are summarized in Table 65. These data are based on a small-scale experiment carried out on an area of 50 arpents by the M.S.I.R.I. over a period of 5 years. On estate practice, the running cost per acre inch would have to be increased so as to take into account overhead administrative charges.

Table 65. Costs of surface and overhead irrigation

	Overhead irrigation		*Surface irrigation*
	Semi-permanent system	*Mobile system*	
Capital Cost — Rs/acre	1000	650	250
Running Cost — Rs/acre inch			
Interest at 7% on capital	2.00	1.10	0.10
Depreciation of spraying equipment ...	1.40	2.20	—
Depreciation of diesel engine	0.70	0.80	—
Fuel and maintenance...	3.20	3.70	—
Maintenance of channels and reservoirs ...	—	—	0.34
Labour	1.75	2.75	0.66
Water	0.25	0.25	0.25
Total Rs/acre/inch	9.30	10.80	1.35

As indicated in a preceding section, 2″ of water applied by overhead irrigation are equivalent to the minimum of 6″ applied by surface on Low Humic Latosols. In consequence, it is necessary to determine, for comparative purposes, the cost per irrigation cycle, which works out as follows :

Overhead irrigation, semi-permanent system	=Rs. 9.30 × 2 =	Rs. 18.60/acre
Overhead irrigation, mobile system	=Rs.10.80 × 2 =	Rs. 21.60/acre
Surface irrigation ...	=Rs. 1.35 × 6 =	Rs. 8.10/acre

It will be noted from Table 65 that the cost of pumping with diesel motor represents approximately 40% of the running expenses of overhead irrigation. Considerable economy could be achieved by using electricity. Thus at the present tariff*, it is estimated that the cost of pumping, using electric motors, could be reduced to Rs. 2.50 per acre inch, instead of Rs. 3.60. In addition, electric motors are cheaper than diesel engines, both as regards maintenance and capital cost, but the capital investment would be influenced in a large measure by the proximity of existing power lines.

Finally, it should be mentioned that where advantage can be taken of natural water heads, the cost of overhead irrigation could be decreased by a very wide margin.

6. NOTES ON METHODS OF PLANTING

G. ROUILLARD

The general practice of cane planting in Mauritius is to place the cuttings in furrows, earthing up being carried out every year or every other year, chiefly in the super-humid zone where Humic Ferruginous Latosols and Latosolic Brown Forest soils are predominant. Consequently, in older ratoons, the lines of canes are raised above the interlines which form drains between the cane rows. This practice is beneficial under conditions of poor drainage.

On the Dark Magnesium Clays and Grey Hydromorphic soils, impeded drainage is the rule and 79% of the root system is to be found in the upper 9″ of soil (MONGELARD, 1963). Most of these soils occur in the sub-humid zones, in the west and north west of the island, and require irrigation. One of the difficulties in the management of these soils is to strike a balance between irrigation and drainage.

A method of planting that would allow for a drainage system between the lines should therefore be envisaged, and forms the object of the trials which are described below.

Experiments carried out by the Sugar Cane Research Station (d'EMMEREZ, 1943) to compare planting in furrows and on ridges in the super-humid zone resulted in an annual increase of 5.1 tons per acre from virgins to 2nd ratoons in favour of ridge planting. The marked increase in yield obtained might be due to the fact that in those days soil preparation was improperly done because of lack of mechanical means.

In 1962, two experiments were planted on Dark Magnesium Clays, and in 1963, three others were laid down, one on the same type of soil and two on Humic Ferruginous Latosols.

* Tariff 511 of the Central Electricity Board.

The layout employed throughout was the latin square, and the treatments were the following :

(i) Furrow planting;
(ii) Planting on flat ground;
(iii) Planting on flat ground with a drain on every other interline;
(iv) Planting on ridges.

Each plot consisted of 8 rows of cane of 50 feet in length, the two centre rows of which were weighed at harvest, and a sample analysed for sucrose content. The fields were cross ploughed mechanically, and other cultural operations were carried out by hand.

The results presented in summarised form in Table 66 are average for virgins and 1st ratoons for trials A to C, and averages for virgins, 1st and 2nd ratoons for trials D and E. Although the differences in yield have not been found to be statistically significant, they are considered to be of sufficient interest at this stage to draw attention to the importance of drainage, particularly in hydromorphic soils. These trials will be pursued until the 5th ratoon when the results will be fully analysed.

Table 66. Comparative yields obtained by different methods of planting on badly drained soils

	*Humic Ferruginous Latosol**			*Dark Magnesium Clay*			
	Trial A	*Trial B*	*Average*	*Trial C*	*Trial D*	*Trial E*	*Average*
Furrow planting (standard) ...	12.8	21.9	17.4	36.5	28.7	33.3	32.8
Planting on flat ground	12.8	21.1	17.0	36.3	30.4	31.7	32.8
Planting on flat ground with drains on every alternate interline	12.9	20.9	16.9	42.5	29.0	33.4	35.0
Planting on ridges	13.7	22.7	18.2	39.9	29.0	32.5	33.8
S.D. at 5%	1.3	2.4	—	4.7	2.3	2.7	—

* The low yields obtained in Trials A and B are due to the fact that the experiments were laid down on senile soils.

REFERENCES

D'EMMEREZ de CHARMOY, A. (1943). Methods of planting experiments. *Rep. Sug. Cane Res. Stn Mauritius.* **14** : 16

MONGELARD, C. (1963) Mathematical treatment of data upon root systems sugar cane. *Proc. int Soc. Sugar Cane Technol.* **11** : 253-261.

7. PRELIMINARY RESULTS OF EXPERIMENT WITH PETROLEUM MULCH

M. HARDY

A new artificial mulch derived from petroleum has been put locally on the market in 1964. Known under the trade name of EAP 2000, this chemical consists of a specially formulated water emulsion of petroleum resins, and is reported to have given good results on certain crops, such as vegetables, cotton, and fodder plants. It was thought, therefore, that this product was worth experimenting with, as no reference on the use of this mulch on sugar cane could be traced in the literature.

One of the leading properties claimed for this artificial mulch, apart from reducing evaporation losses, is to increase the soil temperature. Several cane lands in Mauritius have a recruiting problem when canes are planted in early winter, and moreover, germination is slow and growth seriously retarded in the early stage of the crop cycle. It was therefore believed that EAP 2000 could be beneficial in these regions, and an experiment was initiated at Belle Rive S.E.S. which is a locality fairly representative of the uplands climate. Essential climatological data for Belle Rive being as follows :

Altitude 1560 feet A.M.S.L.
Yearly mean normal temperature : 19.2°C
Insolation : 2335 hrs, or 53% normal
Annual rainfall : 157 inches
Evaporation (class "A" Pan) : 42 inches

The type of soil is the Humic Ferruginous Latosol of a moderately granulated structure.

The object of the experiment is to study the effect of EAP 2000 mulch on soil temperature, germination, growth, and cane yields.

The experimental design adopted is a latin square 4 × 4, each plot consisting of 4 lines of 4 gaulettes (about 0.02 acre/plot). The treatments include one control and 3 different mulch concentrations of 100, 300, 400 gallons per acre of sprayed crop, corresponding to 0.45, 1.35 and 1.80 litre/sq metre, respectively.*

Particular care was taken in soil preparation (Pl. VIII) in order to obtain as uniform a mulch film as possible The setts were planted in the usual manner, and covered with one inch of soil which was afterwards levelled and slightly compacted. Pre-emergence weedkillers (5 lb D.C.M.U. + 2.5 litres Phordene per acre) were first applied, and the mulch then sprayed by a multi-jet Colibri sprayer, in narrow strips one foot wide, so that the avarage mulch thickness for a 55% emulsion was :

100 g/A	0.0012 inch
300 g/A	0.0036 ,,
400 g/A	0.0048 ,,

The mulch film lasted approximately two months, but the black tar pigments remained for a longer time on the treated furrows before disappearing completely four months after application.

The experiment was planted on the 22nd of June, 1965, and rainfall and insolation (Campbell Stokes) were as follows :

	Rainfall (Inches)	*Hours of bright sunshine*	*% of theoretical insolation*
23rd to 30th June	0.50	43	55
July ...	17.30	166	49
August	13.15	178	50
September	10.10	167	47
October...	8.00	211	55

Rainfall was well distributed throughout the first two months, but the heaviest 24 hours' fall occurred on the 18th of August with 2.70 inches.

Soil Temperature

Thermometers were installed in every plot with bulbs buried to the setts' level, and readings were taken daily at 1 p.m. (time of highest soil temperature) for one week after planting but before the mulch application, in order to calibrate the 16 thermometers. The mulch was then applied, and the temperature readings continued, and 1440 individual readings were obtained with the follwing results :

	Control	100 *g/A*	300 *g/A*	400 *g/A*
Mean of 4 plots	21.3°C	22.0°C	22.6°C	22.2°C

Significant difference at 5% = ± 1.4°C

Although temperature of the treated plots was higher than those of the standard, the difference was non-significant.

Germination

Germination counts were made six weeks and 10 weeks after planting on the two inner lines of each plot with the following results :

I. Six weeks after planting :

	Control	100 *g/A*	300 *g/A*	400 *g/A*
Total no. of shoots in 2 inner lines (mean of 4 plots)	383	385	423	423

Significant difference at 5% = ± 33

* The cost of EAP 2000 is R 1.00 per gallon, with a possible 50% reduction when commercial scale manufacturing is reached.

II. Ten weeks after planting :

	Control	100 *g/A*	300 *g/A*	400 *g/A*
Total no. of shoots in 2 inner lines (mean of 4 plots)	418	423	421	432

Significant difference at 5% ± 41

These results show a beneficial effect of the higher doses of mulch on early germination, but not beyond ten weeks after planting.

Growth Measurements

Ten weeks after planting, growth measurements were made on the shoots and continued for 8 further weeks on 50 canes taken at random in the 2 inner lines of each plot with ihe following results.

	Control	100 *g/A*	300 *g/A*	400 *g/A*
Mean increase in length in cms per shoot (2/9 to 11/11/65)	8.4	7.6	7.7	8.4

Significant difference at 5% ± 2.4 cms

The experiment will be weighed in 1966 to investigate whether the initial significant germination increase has any effect on cane yields.

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8. NOTES ON SPACING EXPERIMENTS

GUY ROUILLARD

In most sugar cane growing countries the distance between furrows varies between 4 and 6 feet. Experiments carried out in Queensland to compare spacings of 4½, 5 and 5½ feet have not shown any significant difference in yield for most of the varieties tested (B.S.E.S. Brisbane, 1961). In South Africa, experiments reported in 1964-65 (S.A.S.E.S., 1964-1965) to compare 1½, 3, and 4½ feet spacing between rows, have shown that «*the trend towards higher yields at close row spacings may be reversed when unnessary high levels of fertilizers are applied*». The reason is excessive mortality in the higher fertilized plots of the closest spacing. The highly fertilized plots had received 60 kg of nitrogen per acre compared with 30 kg for the plots having been fertilized normally.

In Mauritius, experiments carried out by the Sugar Cane Research Station (d'EMMEREZ, 1942) to compare planting distances of 4, 4½ and 5 feet, showed the advantage of a closer planting distance than 5 feet irrespective of varieties, but the experiments were only pursued in virgins.

In 1963, ten experiments were planted, two in each of the following localities.

(a)	Sub-humid	< 50″	of rain	annually
(b)	Sub-humid irrigated	50″	,,	,,
(c)	Humid, low elevation	50-75″	,,	,,
(d)	Humid, high elevation	75-100″	,,	,,
(e)	Super-humid	< 100″	,,	,,

The layout employed was the latin square including four spacings : 3′, 3′, 5′ and 6′. and split plots allowing for two varieties of different growth habits in each trial : erect and procumbent. The varieties chosen were the best adapted to the five localities. They included M.147/44, B.37172, M.93/48, Ebène 50/47, and B.3337.

The plots were 30 feet wide and 60 feet long, and the subplots were of the same width and half as long.

High levels of fertilizers were applied to prevent any deficiency, one ton of guano phosphaté was broadcast before planting. At planting, 100 kg of soluble phosphate and potassium were applied in the furrows. A dose of 60 kg of nitrogen was applied annually in addition to 50 kg of soluble phosphate and potassium.

Yield comparisons were obtained by weighing the centre rows of each plot in order that the area was the same except in the 5′ spacing in which a correction factor had to be used. (x 1.2, correction for difference in area). Cane weight was therefore obtained as follows :

(a) 3 feet spacing 4 rows per plot
(b) 4 ,, ,, 3 ,, ,, ,,
(c) 5 ,, ,, 2 ,, ,, ,,
(d) 6 ,, ,, 2 ,, ,, ,,

Each plot was sampled for analysis of sugar, but it was found that spacing exerts no influence on sucrose content of cane.

Discussion of results

Data have been obtained so far for virgins and 1st ratoons in eight trials, two other trials of the super-humid zone having failed because of accidental causes.

A spacing distance of 4 feet has given the best results for the six trials of the sub-humid and humid localities irrespective of the variety and climate, but no significant difference has been found between the other treatments for all the trials (Table 67).

It is not intended to make any recommendations at this stage since the experiments will be pursued until the 5th ratoon.

Table 67. Yields obtained for different spacing distances under different climatic conditions

Locality	*Sub-humid* $< 50''$		*Sub-humid Irrigated*		*Humid Low elevation 50″-75″*		*Average for A to F**	*Humid High elevation 75″-100″*		*Average for G and H*
Variety	*A M.147/44*	*B B.37172*	*C M.147/44*	*D B.37172*	*E M.147/44*	*F B.37172*		*G M.93/48*	*H Ebéne50/47*	
Spacing										
3 feet	27.6	22.8	42.8	34.9	42.1	44.7	35.82	42.6	35.3	38.9
4 feet	31.5	24.6	44.9	38.2	44.3	44.8	38.05	42.5	35.8	39.1
5 feet	26.5	22.3	41.0	32.4	42.7	41.0	34.32	44.9	36.3	40.6
6 feet	27.9	24.8	37.7	31.0	43.5	41.2	34.52	42.3	34.3	38.4

* Sig. diff. at 5%, 1.95

REFERENCES

B.S.E.S., Queensland (1961). The effect on crop of varying interspaces. *Rep. Bur. Sug. Exp. Stn Qd* **61** : 35

D'EMMEREZ de CHARMOY, A. (1942). Spacing trials. *Rep. Sug. Cane Res. Stn Mauritius* **13** : 22 - 25

S.A.S.E.S. (1964 - 1965). Plant populations. *Rep. Exp. Stn S. Afr. Sug. Ass.*, 1964 - 65 : 50 - 52

SUGAR MANUFACTURE

1. THE PERFORMANCE OF SUGAR FACTORIES IN 1965

J. D. de R. de SAINT ANTOINE

A SYNOPSIS of the chemical control figures of the twenty-three factories of the island is given in Appendix XVIII (i) to (v).

Cane and sugar production

The climatic conditions which prevailed during the vegetative period of the crop were characterized by good rainfall distribution which was close to normal, except for the coastal areas which suffered from drought in February and March. As a result a large cane crop was standing when the first mills started crushing in early July, in spite of the fact that temperatures were 0.6°C below normal during the vegetative period. The prospects were then excellent, and hopes were high that a record sugar production would be achieved. Unfortunately, climatic conditions were disastrous for ripening during the maturity period, rainfall excesses above normal being the highest ever recorded in Mauritius, whilst minimum air temperatures were high, and difference between maximum and minimum temperatures was low. Although these conditions were favourable to the production of a high cane tonnage, yet they affected cane quality very adversely. Thus the tonnage of cane harvested hit a new record figure of almost six million tons, but sugar production amounted, to only 664,000 tons. Table 68 gives the area cultivated, cane crushed and sugar produced during the period 1961-65.

Table 68. Area cultivated (thousand arpents), cane crushed and sugar produced (thousand metric tons), 1961 - 1965.

	1961	*1962*	*1963*	*1964*	*1965*
Area cultivated	201	205	204	207	207
Cane crushed	4,943	4,624	5,547	4,375	5,984
Sugar produced	553.3	532.8	685.5	519.0	664.5

Cane quality

As a result of the most abnormal climatic conditions which prevailed during the maturation period, sucrose per cent cane was very low, amounting to only 12.50, as against an average, of 13.23 for the past four years. As may be seen from Table 69, the northern sector was the most affected, and the central sector the least, these sectors being in the drier and wetter regions of the island respectively.

Table 69. Sucrose per cent cane, 1961-65

Year	*Island*	*West*	*North*	*East*	*South*	*Centre*
1961	12.81	13.06	13.46	12.53	12.42	12.91
1962	13.19	13.61	13.73	12.85	12.85	13.26
1963	13.47	14.26	13.97	12.91	13.18	13.79
1964	13.45	13.75	14.35	13.14	13.02	12.97
Av. 1961-64	*13.23*	*13.67*	*13.88*	*12.86*	*12.87*	*13.23*
1965	12.50	13.06	12.28	12.39	12.40	12.96
% Reduction	5.8	4.5	11.5	3.7	3.7	2.0

The climatic conditions which prevailed during the harvesting season were also conducive to lower fibre in cane in 1965, as shown in Table 70. Concerning the mixed juice purity reported in the same table, it must be pointed out that, for the first time in 1965, all the sugar factories of the island adopted precision sugar refractometers for chemical control. As a result, all the purity figures given in this section for the past crop cannot be compared with those for previous crops when Brix was determined by spindle. However, since mixed juice purity calculated with densimetric Brix is about 1.5 units higher than that calculated with refractometric Brix, it may be said that juice purity was practically the same in 1965 as in 1963 and 1964.

Table 70. Fibre % cane and mixed juice Gravity Purity, 1961-65.

Year	*Fibre % Cane*	*Mixed juice Gravity Purity*
1961	12.61	85.2
1962	13.85	85.9
1963	13.11	86.3
1964	13.85	86.4
1965	12.92	88.0

All factories adopted in 1965 the Rietz Varigrator for bagasse analyses and for fibre determination of cane. Unfortunately some mechanical setbacks were encountered, due mainly to the fact that the driving shaft protrudes from the bottom of the bowl. Frequent failures of the seal between this shaft and the bowl led the Institute to modify an existing Rietz so that the drive would be from the top instead. The details of the modification are shown in fig. 27. This equipment was tested during the latter part of the crop, and the results obtained were quite satisfactory. The disintegrating performance was very good, being in fact even better than that of the standard varigrator.

Milling

A synopsis of crushing data and milling figures is given in Table 71.

With the record tonnage of cane harvested the duration of the crop was a little longer, amounting to 128 crushing days per factory on the average. Several factories started operating in early July to stop only in late December.

Average tonnage of cane crushed per hour exceeded for the first time the 100 metric ton mark, but tonnage of fibre ground per hour was slightly lower than in 1964 as a result of the lower fibre figure obtaining in 1965.

Table 71. Milling results, 1961-65

	1961	*1962*	*1963*	*1964*	*1965*
No. of factories	23	23	23	23	23
No. of crushing days ...	123	116	123	100	128
No. of net crushing hrs/day	18.86	19.08	20.82	19.96	20.28
Hours of stoppages/day* ...	0.80	1.03	0.88	0.83	0.72
Time efficiency	95.8	94.9	95.9	96.0	96.6
Tons cane/hour ...	92.8	91.0	97.8	95.4	100.6
Tons fibre/hour ...	11.70	12.60	12.82	13.21	13.00
Imbibition % fibre ...	222	222	221	228	220
Pol. % bagasse ...	2.09	2.18	2.08	2.03	1.93
Moisture % bagasse ...	48.6	47.1	48.4	48.5	48.9
Reduced mill extraction ...	95.8	95.8	96.0	96.2	96.0
Extraction ratio ...	33.3	33.9	31.7	31.0	31.7

* Exclusive of stoppages due to shortage of cane.

Because of the low sucrose content of the cane, reduced mill extraction was only 96.0 as against 96.2 the previous year. The only factories where major alterations were brought to the milling plant are Highlands, where the old tandem was replaced by five turbine-driven 38 × 72 inch mills, and FUEL where three of the intermediate mills were replaced by larger units in order to cope with the increased tonnage. The milling plant of this factory, which in 1965 crushed over 250 metric tons of cane per hour on the average, now consists of two sets of knives and seven turbine-driven 38 × 75 inch mills.

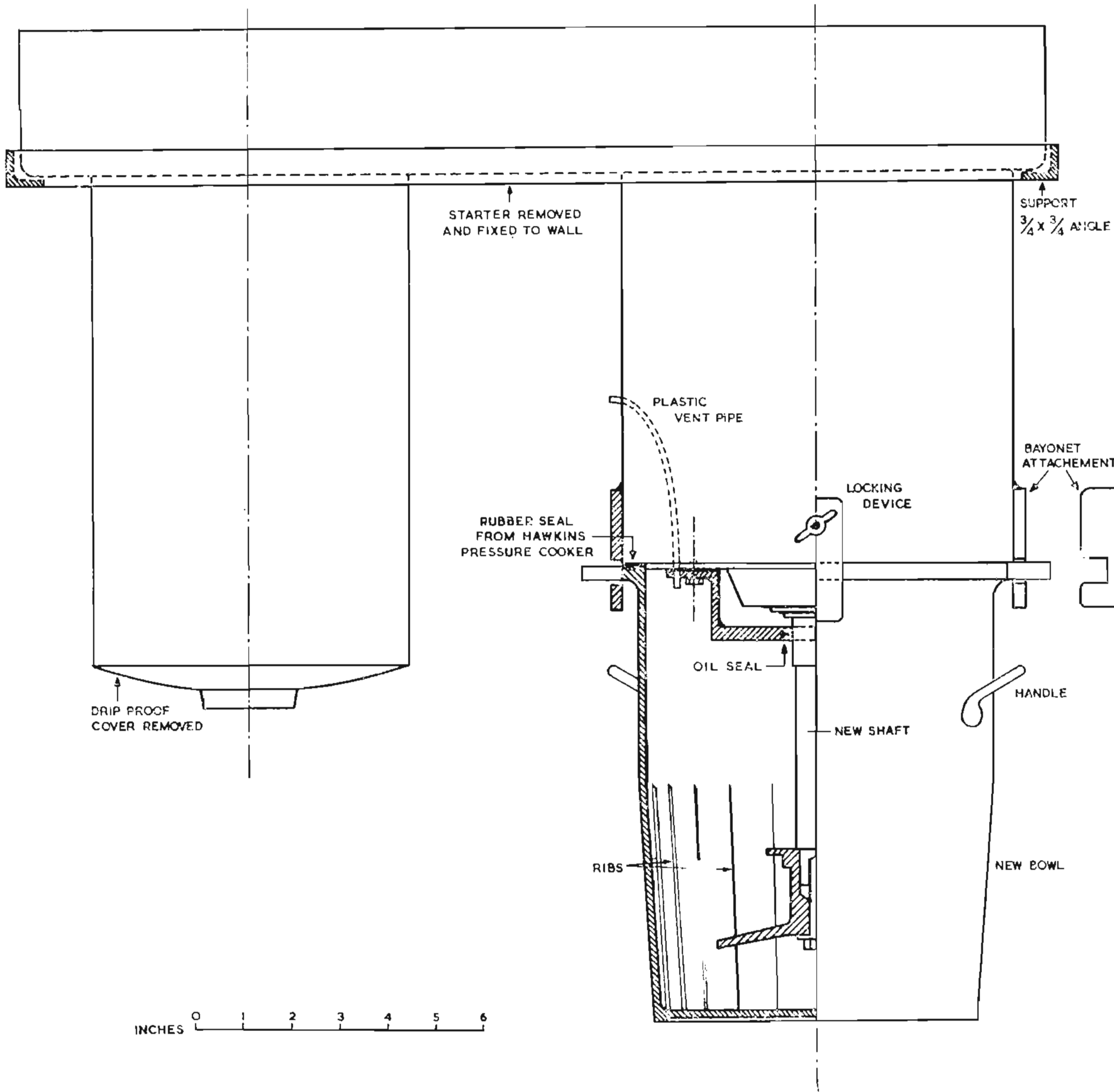

Fig. 27 Modified Rietz Varigrator.

Excellent results were also achieved at St. Felix, following the addition of 7-ft tall Donnelly-type vertical chutes to the last three units of the short four-mill tandem. The gain in reduced mill extraction attributable to the chutes was 0.44 and the benefit derived from the installation in 1965 exceeded the cost of manufacture and erection of the chutes, Rs. 25,000. Other factories in Mauritius would no doubt increase their mill extraction at little cost by installing similar equipment.

As in 1964, Table 72 has been prepared in an attempt to take into consideration the major factors which influence the milling efficiency of different tandems. Once again, the factories are listed in the order of their specific feed rates, expressed in lbs of fibre ground per hour per cubic foot of total roller volume.

As pointed out in the Annual Report for 1964, dilution ratio is a measure of the efficiency with which imbibition water and dilute juices are mixed with the residual juices left in the mill bagasses. Hence, it will be influenced by a number of factors, namely efficiency of cane preparation, percentage of juice extracted by first unit of tandem, number of imbibition

Table 72. Comparative milling results, 1965 crop

Factory	*Sets of knives*	*Shredder*	*No. of Rolls*	*Specific Feed Rate*	*Imbibition %fibre*	*Dilution Ratio*	*Extraction Ratio*	*Reduced Mill Extraction*
Médine ...	2 of 36	1	15	79.8	198	66	38.1	95.2
Belle Vue ...	1 ,, 34 1 ,, 72	—	12	69.4	237	74	29.3	96.4
Mon Loisir ...	2 ,, 35	1	15	67.9	227	71	31.0	96.2
St. Antoine ...	1 ,, 36 1 ,, 44	—	15	64.6	189	69	38.7	95.3
FUEL ...	1 ,, 60 1 ,, 80	—	21	63.9	210	77	29.3	96.3
St Felix ...	1 ,, 12	1	12	62.4	213	72	31.5	96.1
Savannah ...	1 ,, 28 1 ,, 48 1 ,, 92	—	12	60.4	236	72	33.0	95.9
Constance ...	1 ,, 24 1 ,, 32	1	15	57.1	182	69	28.2	96.5
Bel Ombre ...	1 ,, 16	1	12	56.9	278	74	30.3	96.3
Solitude ...	1 ,, 40 1 ,, 32/60*	—	14	56.6	192	68	35.9	95.6
Beau Champ ...	1 ,, 42 1 ,, 72	—	15	55.1	240	73	27.7	96.6
Mon Désert ...	1 ,, 48 1 ,, 96	—	15	54.9	214	74	30.6	96.1
Riche En Eau ...	1 ,, 54 1 ,, 100	—	15	54.0	245	79	27.1	96.7
Rose Belle ...	1 ,, 24 1 ,, 42	—	12	52.0	239	78	33.4	95.8
Ferney ...	1 ,, 64 1 ,, 84	—	12	49.6	231	70	34.5	95.8
Réunion ...	1 ,, 36	1	15	48.5	224	75	31.8	96.0
Mon Trésor ...	1 ,, 40 1 ,, 92	—	12	45.8	220	72	34.4	95.7
Beau Plan ...	1 ,, 42 1 ,, 54	—	14	45.2	206	75	28.5	96.5
Bénarès ...	1 ,, 44 1 ,, 62	—	14	44.3	213	60	37.1	95.4
Britannia ...	1 ,, 30 1 ,, 60	—	14	39.9	235	69	35.6	95.6
The Mount ...	1 ,, 36 1 ,, 88	—	15	38.6	219	72	28.7	96.4
Union St. Aubin	1 ,, 28 1 ,, 32	—	15	33.5	266	74	30.9	96.1
Highlands ...	1 ,, 32 1 ,, 64	—	15	30.2	214	80	29.6	96.3

* The second set had 60 knives as from the end of October

steps, method of application of imbibition liquids, and specific feed rate. Concerning the latter, it is interesting to note that many mills are heavily loaded in Mauritius, Médine in particular. On the other hand, several factories have milling plants capable of crushing much more cane per unit time. The average specific feed rate for all the mills was 54 lbs/hr./cu.ft as compared to 46 for the South African factories in 1964.

Clarification and filtration

There is nothing of particular interest to report in these departments. No clarification difficulties were encountered throughout the crop. A number of other factories have adopted the Rapi-floc system of filtration. The amount of muds from the clarifiers was lower than in 1964, but was accompanied by a slightly higher pol in cake, as shown in Table 73.

Table 73. Filtration results, 1961-65

	1961	*1962*	*1963*	*1964*	*1965*
Pol % cake	2.46	2.38	2.28	1.98	2.13
Cake % cane	2.8	3.2	3.1	3.4	2.9
Pol in cake % cane	0.07	0.08	0.07	0.07	0.06

Boiling house work

Following the adoption of refractometer Brix by all the factories for chemical control as from the 1965 crop, it is difficult to compare boiling house work for that year with that of previous years as given in Table 74.

Table 74. Syrup, massecuites and molasses, 1961-65

	1961	1962	1963	1964	1965
Syrup gravity purity	85.3	86.5	86.6	87.0	88.0
A-mcte app. purity	82.0	82.2	83.0	82.8	84.9
Purity drop : A massecuite ...	22.3	20.3	20.3	20.7	20.3
B ,, ...	22.2	21.2	22.2	20.7	21.0
C ,, ...	24.6	22.9	24.3	23.6	25.1
Crystal % Brix in C massecuite ...	36.0	34.6	35.9	35.5	38.6
Magma purity	82.3	82.4	82.8	83.4	86.7
Final molasses : gravity purity ...	35.7	36.2	35.6	36.1	38.3
Red. Sug. % Bx ...	16.6	13.8	15.0	12.8	15.5
Tot. Sug. % Bx ...	52.4	50.1	50.4	48.9	53.8
Wt % cane @ 85° Bx	3.14	2.98	3.04	2.85	2.64

Thus, in spite of the fact that the average gravity purity for final molasses was 38.3, as against 36.1 in 1964, yet better exhaustion was probably obtained in 1965 since the average difference between gravity purities when calculated from refractometric and densimetric Brix is normally somewhat higher than 2.2 points.

In 1965, several other factories have double-cured C massecuites with the object of improving raw sugar filterability. As a result, average magma purity was higher in 1965.

Excellent results were obtained at Riche En Eau with a mechanical circulator fitted to a C-massecuite pan. The circulator is driven from the top by a motor of 87 H.P. and revolves at 80 R.P.M. As a result the duration of the C-strike was reduced from eight and a half to about three hours only.

Finally, as may be seen from Table 75, losses were further reduced in 1965.

Table 75. Losses and recoveries, 1961-65.

	1961	1962	1963	1964	1965
Sucrose lost in final molasses % cane	0.96	0.92	0.89	0.91	0.86
Undetermined losses % cane ...	0.21	0.21	0.18	0.18	0.12
Industrial losses % cane	1.24	1.21	1.14	1.15	1.04
Boiling house recovery	89.9	90.4	91.2	91.0	91.4
Reduced boiling house recovery ...	89.7	89.7	90.2	90.0	88.8

Raw sugar filterability

The major activity of the Sugar Technology Division during the crop was devoted to studies on the filterability of raw sugars with emphasis on starch, clarification, juice and syrup flotation, double-curing of C-sugar and remelting process.

(*a*) *Starch*

Starch balances carried out on several factories have shown, as anticipated, that very little starch is found in the filter cake, elimination taking place mostly in final molasses. Since it is not possible, under present circumstances, to control the amount of starch entering the factory, it is necessary to keep down the starch level of the sugar, either by reducing the starch content of the juice, or by eliminating more of this undesirable non-sugar in the final molasses.

Starch removal from juice may be partly obtained with the help of natural enzymes present in the juice. This enzymatic process was tried experimentally at Mon Désert factory during the crop, and forms the subject of a special article in this report.

In those factories where the C-sugar is still used as footing for the A and B strikes, the starch content of the bagged sugar can be greatly reduced by double-curing the C-sugar. A number of experiments were carried out in which C-massecuite samples collected from various factories were centrifuged in such a way as to obtain, for each massecuite, C-sugars of different purities. The results of one of the tests are shown graphically in fig. 28, from which it will be observed that the starch content of the sugar is inversely proportional to its purity. The results of all the tests made show that by increasing the purity of the C-sugar from 83 to 92, that is by double-curing, the starch content of the sugar is reduced by 45 per cent on the average. It is true that the C-wash is returned to the C-strike and its starch is not eliminated directly. Yet, by reducing drastically the starch content of the A and B footings, these sugars automatically contain less starch and their filterability is markedly improved.

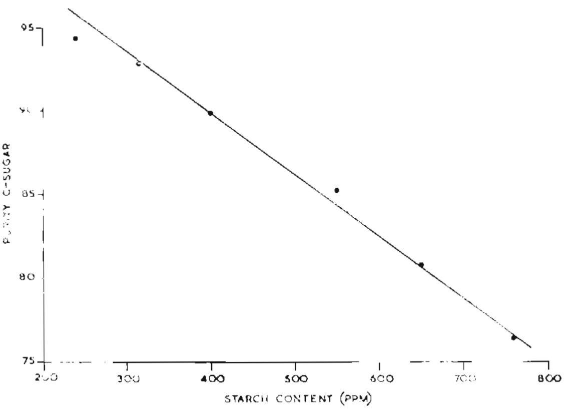

Fig. 28. Influence of C-sugar purity on starch content.

b) Clarification

(i) Figures were collected in several factories in order to determine whether there exist correlations between filterability of raw sugar and such variables as pH, turbidity, and phosphate content of clarified juice. The results obtained were somewhat contradictory. Thus, at Mon Désert, when the amount of phosphate added to the raw juice was reduced, filterability was improved, but no correlation was found between soluble phosphate, total phosphate, or turbidity of clarified juice and sugar filterability. On the other hand, filterability was improved at Union-Ducray where the pH of the clarified juice was raised from 6.9 - 7.0 to about 7.3. Thus the conditions conducive to good clarification and to improved filterability vary from factory to factory and each case should be studied on its own merits.

(ii) It has already been shown in Queensland that juice deterioration in clarifiers has a detrimental effect on raw sugar filterability. Similar results were obtained at Mon Désert factory in 1965 where the average filterability on Mondays was 4 points lower than that for the other days of the week.

c) Juice flotation

An interesting experiment was carried out at Mon Désert Factory by the chemist, J. Leclézio. It consisted in heating the raw juice to 75°C and in bubbling compressed air through it with the help of perforated pipes placed at the bottom of a cylindrical tank of 6 minutes retention time. The foam produced was scraped into a gutter and sent to the vacuum filter. Following the adoption of this process, a marked improvement in filterability was observed, but the drop which ensued during the three days when the process was discontinued, prior to the end of the crop, was not as marked. Hence it is difficult to assess the merits of the process, but it is intended to carry out further studies next crop.

d) Syrup flotation

Following the results obtained in Queensland where raw sugar filterability was increased by a process of flotation in which solid impurities, including insoluble phosphates, are removed by blowing air through the heated syrup (temperature 80-85°C, Brix 68), similar experiments were conducted at Saint Antoine factory. The treated syrups, however, did not yield better filtering raws under the prevailing conditions. Yet the results obtained showed that A massecuites boiled on syrup only yielded raws with an average filterability 7 to 9 points higher than those produced from A massecuites on which A-molasses were recycled. Hence the importance again, of adopting a straight boiling system.

e) Double curing of C-Sugar

Further evidence was obtained in 1965 on the beneficial effect of double-curing the C-sugar on the filterability of the bagged product. Thus, at Mon Désert, filterability was increased by about 60 per cent, whilst at Bel Ombre it was improved by 40 per cent.

Excellent results were also obtained at Riche en Eau but, in addition to double-curing, this factory followed a straight boiling system throughout the crop and used a mechanical circulator on its C-massecuite pan. It is interesting to point out that the circulator has doubled the capacity of the pan. It has also doubtless contributed towards the improvement in bagged sugar filterability both by helping to provide well-formed sugar nuclei, free of conglomerates, and by facilitating the adoption of a straight boiling system.

f) Remelting process

Several factories not equipped for double-curing the C-sugar have remelted this sugar instead of using the low purity seed as footing for the shipment strikes. In most cases, an increase in filterability has followed, but such a practice should only be considered as a temporary measure. C-sugar should no doubt be remelted to improve the filterability of the bagged product, but this should be done after efficient removal of final molasses in foreworkers, followed by a second purging in afterworkers.

Since the filterability of A sugars is 2 to 3 times higher than that of B sugars, average filterability of the bagged product would doubtless be considerably increased if only A sugars were produced. Unfortunately, most of the factories of the island are not equipped to adopt such a process. However, it is anticipated that next crop a few factories will be in a position to remelt all their double-cured C-sugar, and also remelt most or part of their B sugars. The adoption of this process, even by only a few factories, will thus contribute to increase the average filterability of Mauritius raws.

Conclusion

A number of steps have already been taken in the sugar factories of the island to improve filterability. Yet, with the low prices prevailing at the moment and the large surplus of the commodity on the world market, still other measures must be adopted by the industry. It is not possible to elaborate here on these measures, the more so that they may vary somewhat from factory to factory. However further recommendations have been made to the industry lately, and there is no doubt that their adoption will lead to the production of better filtering raws as from the 1966 crop.

REFERENCES

SAINT ANTOINE, J.D. R. de (1964). The performance of sugar factories in 1964. *Rep. Maurit. Sug. Ind. Res. Inst.* **11** : 99-105.

PERK, C.J.M. (1964) Thirty ninth annual summary of chemical laboratory reports of the South African sugar factories. *Proc. S. Afr. Sug. Technol. Ass.* **39** : 15.

2. INVESTIGATIONS ON THE REMOVAL OF STARCH FROM CANE JUICE

E. C. VIGNES & J. D. de R. de SAINT ANTOINE

With the low prices of sugar on the world market and the large stocks carried by many raw sugar producing countries, coupled with the fact that the commodity is in most cases sold on a straight pol, and not on a quality basis, it is these days still more important than in the past to produce raws having good refining properties. Of these properties, one of the most important is filterability. The raw sugar producer should therefore manufacture a product that causes no filtration problem in the refinery. In other words, the raw sugar should not contain impurities which impede refining filtration.

Unfortunately the influence of various non-sugars on filterability has not been well defined yet. Thus, whereas in Australia the total phosphate content of the raw sugar is claimed to be the dominant factor (ANON, 1962), in Formosa CHU and CHU (1961) found a significant correlation between silica and filterability, but observed no correlation between starch, gum, or wax, and filterability. Recently, YAMANE, SUZUKI and KAGA (1965) have obtained significant correlations between filterability of raw sugar, as determined by the Nicholson and Horsley filtration test, and each of the following impurities : gum, wax, phosphate, silica and starch, but the correlation cœfficient in the case of starch was much lower than for the other impurities. However, in a still more recent study (1966), these authors have shown that there exists a clear relationship between the filterability of affined sugars and that of the carbonation slurries, and obtained a remarkably close correlation between filterability and starch content. They therefore conclude that *starch is the most detrimental impurity in affined sugars, so far as the filterability of carbonation slurries is concerned.* VIGNES (1960), working on Mauritius raws, obtained a correlation between filterability — also determined by the Nicholson & Horsley test — and starch, but found no correlation with gums, wax, silica and phosphate. DOUWES DEKKER (1964) is of the opinion that *the most important filtration-impeding impurity is obviously starch, but the effect of gums is also appreciable.* This opinion is shared by many refiners in the U.K. and Canada, who even claim that as soon as the starch content of the raw sugar exceeds 200 p.p.m., filtration difficulties are encountered.

The best explanation as to why various authors do not agree on the influence of various non-sugars on filterability is probably that given by ALEXANDER and GRAHAM (1964), who write : "*When one considers the enormous effect of degree of hydration, surface area, and particle size of impurittes impeding filtration, it is perhaps not surprising that some conflicting, data are often obtained when attempts are made to correlate the weight of various impurities as determined chemically, and the results of filtration tests. A further complication to such correlation is the fact that most of the impurities normally tested for are not definite compounds but represent classes or groups of compounds. The relative proportions of the constituents of any one of these groups may vary markedly from one sugar to another.*" It should also be pointed out that the methods of analysis followed for the determination of some of the non-sugars, starch and gums in particular, were not very accurate a few years ago, but have since been modified and are now more reliable.

Until more precise information is obtained on the influence of various non-sugars on filterability it may be said that starch is most probably one of the major causes of poor filterability. According to BUCHANAN (1959) starch blocks the filter and exerts a viscosity effect during filtration. On the other hand, a considerable portion of starch degradation products find their way inside the sugar crystals, impeding filtration in refineries. Affination does not help very much, as most of the starch is not present in the film of molasses, but is occluded. The analyses of average 1965 crop samples from the 23 local factories have shown that affination in the laboratory removed on the average only 24 per cent of the starch present in the raws. YAMANE, SUZUKI and KAGA (*loc. cit.*) obtain a figure of the same order, 29 per cent from the analyses of sugars sampled from 28 cargoes originating from six different raw sugar producing countries.

It would appear, therefore, that one way of improving raw sugar filterability, at least in those factories where the starch content of the raws exceeds 200 p.p.m., would be to eliminate as much of the starch as possible from the juice before sending the latter to the boiling house, and one method of achieving this result is by enzymatic action.

The enzymatic removal of starch was first advocated by HADDON (1928). He patented a method of starch elimination using a powerful enzyme called Ubase. Although it was claimed that the latter could liquefy more than 2400 times its own weight of starch in less than 30 minutes, the cost of treating all the juice in a factory proved prohibitive. The question of enzymatic treatment of cane juices was again brought forward when BOYES (1958) added malt to syrup prior to boiling. Factory scale experiments were disappointing, results showing that mixed juice was the best place for enzymatic action. Treatment of the latter, followed by boiling, liming to pH 7.5 and settling removed up to 84 per cent of the total starch content. There again, the calculated costs of juice treatment were shown to be uneconomical.

Some years ago NICHOLSON and HORSLEY (1958) established that cane juice contained sufficient natural enzymes which could remove most of the starch from cane juices under certain conditions. They found that the optimum pH for enzymatic activity was very close to the natural pH of the juice, and that whereas cane starch gelatinises at 70°C, the enzyme is rapidly destroyed above 75°C. Therefore, storing cane juice for a certain period of time at 70°C - 75°C would destroy a large portion of the starch present in the juice. However, there is always the danger that a certain amount of inversion should take place, so that the time of storage must not be prolonged.

BOYES (1960) reports the case where factories situated within the same area had widely different amounts of starch in their sugars, although processing juices of similar starch contents. Sugar from those factories where raw juice was left for a definite time in settling tanks after being heated to between 70° and 80°C had much less starch. The latter was undoubtedly being eliminated by the action of natural enzymes.

Early this year, the Sugar Technology division decided to carry out preliminary investigations into the problem of enzymatic starch removal in cane juice on a laboratory scale in the first place. Canes were passed through a Jeffco cutter-grinder and pressed to extract the juice. Pol % g. of the juice was determined, as well as starch content and reducing sugars before and after incubation at 73°C in a water bath for various lengths of time. Data obtained are shown in Tables. 76 and 77.

Table 76. Effect of juice storage on starch at 73°C

Date	*Initial starch content (p.p.m.)*	*Starch content in p.p.m. after*				*Per cent decrease in starch after*			
		5 mins.	*10 mins.*	*15 mins.*	*30 mins.*	*5 mins.*	*10 mins.*	*15 mins.*	*30 mins.*
24.5	47	30	—	—	—	36	—	—	—
26.5	24	15	—	—	—	37	—	—	—
28.5	142	66	63	56	47	54	56	61	67
2.6	427	257	223	213	194	40	48	50	55
Average	—	—	—	—	—	42	52	56	61

Table 77. Effect of juice storage on reducing sugars at 73°C

Date	*Increase in reducing sugars in mg. after*				*Per cent loss of sucrose after*			
	5 mins.	*10 mins*	*15 mins.*	*30 mins.*	*5 mins.*	*10 mins.*	*15 mins.*	*30 mins.*
24.5	20	—	—	—	0.15	—	—	—
26.5	36	—	—	—	0.28	—	—	—
28.5	26	26	29	54	0.20	0.20	0.22	0.41
2.6	18	24	25	35	0.11	0.15	0.15	0.21
Average	—	—	—	—	0.18	0.18	0.19	0.31

The amount of inversion is calculated from the increase in reducing sugars. It was found that the raw juice kept for 5 minutes at 73°C lost 42 per cent of its starch content. Per cent elimination increased to 52 after 10 minutes, and to 56 after 15 minutes. At the same time there was a loss of sucrose of between 0.18 and 0.19 per cent. Extending the time of storage caused starch removal to increase to only 61 per cent, whilst sucrose loss rose to 0.31 per cent.

On a plant scale since inversion of sucrose depends on pH, temperatures, and time, it is evident that a compromise must be arrived at between these factors and destruction of starch. Therefore, judging from the laboratory results, it appeared that storing the juice for up to 15 minutes would eliminate more than half the starch without significantly affecting the sucrose. Towards the end of the crushing season, this was put to the test on an industrial scale in a factory. Three storage tanks, placed in series, were available for the test. The mixed juice was heated to 75°C and sent to the first tank where it was retained for 6½ minutes. For the first two days of the experiment, liming was effected in the second tank. Composite samples were taken before the heaters and from the juice emerging from the first tank. These samples were analysed for sucrose and reducing sugars. As in the laboratory experiments, increase in reducing sugars was taken as indicating sucrose loss, and calculated as a percentage of the original sucrose in the juice. Other samples were taken at the same time as the above, and kept for starch determination. The procedure in this case was as follows : a pre-determined mixture of acid and alcohol was prepared, and every 15 minutes mixed juice (20 g.) was weighed and poured into the acid/alcohol mixture. Sampling was continued for 1¼ hours. Similar experiments were carried out for three more days, when the juice was allowed to settle for 12 minutes in the first two tanks and liming was shifted to the third tank. Results are shown in Tables 78 and 79.

Table 78. Enzymatic removal of starch from mixed juice at 75°C

Date	*Initial starch content*	*Starch content in p.p.m. after*		*Per cent decrease in starch after*	
		6½ minutes	*12 minutes*	*6½ minutes*	*12 minutes*
26.11	170	124	—	27.1	—
27.11	150	108	—	28.0	—
2.12	50	—	25	—	50.0
3.12	135	—	62	—	54.1
4.12	150	—	86	—	42.7
Average	—	—	—	27.5	48.9

Table 79. Change in reducing sugars during enzymatic elimination of starch

Date	*Increase in reducing sugars in mg after*		*Per cent loss of sucrose after*		*Initial*	*Final*
	6½ minutes	*12 minutes*	*6½ minutes*	*12 minutes*	*Glucose Ratio*	*Glucose Ratio*
26.11	14	—	0.09	—	3.05	3.14
27.11	38	—	0.28	—	3.50	3.75
2.12	—	26	—	0.20	3.90	4.07
4.12	—	21	—	0.15	3.30	3.46
Average	—	—	0.16	0.18	—	—

A small amount of evaporation did occur during heating and storage. This was taken into account, and analytical results were accordingly corrected. Keeping the juice for 6½ minutes caused 27 to 28 percent of the starch to be destroyed, loss of sucrose being on average 0.16 per cent. Between 42.7 and 54.1 of the starch in the juice is successfully eliminated after 12 minutes, average loss in sucrose amounting to 0.18 per cent, a figure equivalent to a drop of only 0.024 in sucrose per cent grams of juice.

Thus both laboratory and industrial results, although scanty, indicate a definite possibility of reducing the starch content of mixed juice and confirm the results obtained in Natal, where the process has been adopted industrially. Despite the small amount of inversion taking place, it would be worthwhile pursuing the investigation further under local conditions. The greatest difficulty in carrying out the experiment on an industrial scale is the problem of sampling. During a short period of time, considerable fluctuations in the starch content of the juice may take place. The only way to obtain accurate information is to carry out investigations over a long period. For a complete picture to be obtained, the influence of the process on the starch content of the resulting sugars and their filterability must also be studied. Should it be shown, as anticipated, that the enzymatic removal of starch improves the refining qualities of certain Mauritius raws, its adoption by the factories where the starch content of the juice is above average, could go a long way towards solving their particular problem, provided that loss of sucrose is kept within limits.

REFERENCE

ALEXANDER, J.B. (1957). Some observations on the filterability of Natal raw sugars. *Proc. S. Afr. Sug. Technol. Ass.* **31** : 68-75.

ALEXANDER J.B. *and* GRAHAM, W.S. (1964). Private communication.

ANON, (1962). General chemistry report, October 1962. *Sug. Res. Inst., Mackay*, p. 3.

BOYES, P.N. (1960). Starch in the manufacture of raw sugar. *Proc. S. Afr. Sug. Technol. Ass.* **34** : 91-97.

BUCHANAN, E.J. (1959). Recent observations on sugar cane starch and its effect on filterability of sugar. *S. Afr. Sug. J.* **42** (1) : 32-47.

DOUWES DEKKER, K. (1964). The filterability of raw sugars. *Proc. Sug. Ind. Techn.* **23** : 159-170.

HADDON, E. (1928). Influence of starch on the manufacture of sugar and its removal from the juice. *Rev. agric. sucr. Ile Maurice* **38** : 80-82.

NICHOLSON, R.I. *and* HORSLEY, M. (1960). Starch removal from cane juices. *Int. Sug. J.* **60** : 260-263.

POWERS, H.E. (1959). Crystallography of sucrose. Principles of Sugar Technology. Elsevier, Amsterdam, v.2

ST. ANTOINE, J.D. de R. *and* PARISH, D.H. (1959). The composition of cane juice. *Rep. Maurit. Sug. Ind. Res. Inst.* **6** : 44-46.

TAKEO YAMANE, KAZUMASA SUZUKI *and* TOSHIO KAGA (1965-66). Filtration-impeding materials in raw sugars of various origins. I.
II. The filtrability of laboratory carbonatation slurries. *Int. Sug. J.* **67** (803) : 333-337; **68** (805): 3-6.

VIGNES, E.C. (1961). Filterability of raw sugar. *Rep. Maurit. Sug. Ind. Res. Inst.* **8** : 80-85.

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3. CURING LOW GRADE MASSECUITE IN AN ALLIS-CHALMERS 2750 CONTINUOUS CENTRIFUGAL

ERIC PIAT & MAURICE RANDABEL

The purpose of this experiment was, initially, to compare the merits of a continuous centrifugal to those of a batch machine. However, it soon became evident that before comparative tests could be carried out it was necessary to obtain first as much information as possible on the operation of the continuous machine, and to determine whether the whole installation was such that it could lend itself to a fair comparison.

Description of machine

The Allis-Chalmers 2750 continuous centrifugal consists of a conical basket mounted horizontally on two self-aligning roller bearings. The cone is driven through a belt drive by a 30 H.P. electric motor. The dimensions of the cone are are as follows :

External diameter : 27.5 inches
Slope of cone : 30°
Number of revolutions per minute : 2200
Type of screen : stainless steel 0.006 inch thick, diameter of holes 0.006 inch (0.15 mm), open area : 28.2 %

Massecuite is introduced into a funnel placed on the front plate of the machine, and flows through a slightly sloping pipe to the apex of the cone. There the massecuite is distributed evenly over the screen. The slope of the cone and the centrifugal force cause the massecuite to travel outwards, molasses being at the same time separated from the sugar crystals.

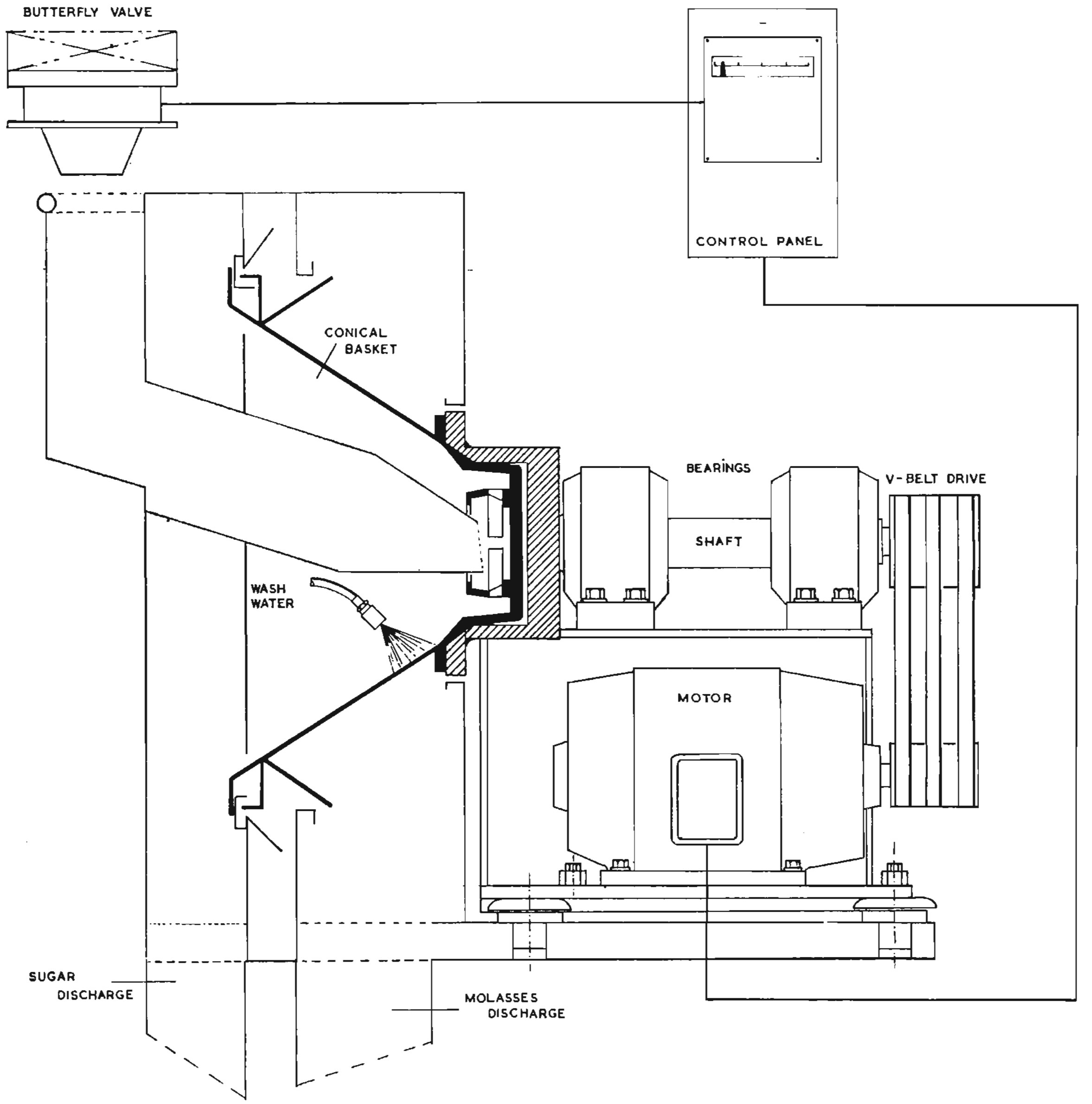

Fig. 29. Allis-Chalmers continuous centrifugal model 2750.

The sugar is thrown out of the open end of the cone into the sugar chamber.

In order to increase the capacity of the machine, the viscosity of the massecuite is momentarily reduced by :

(i) Rapid reheating to about 50°C. Below that temperature, the massecuite does not spread evenly, and serious vibrations occur.

(ii) Washing the layer of massecuite on the screen with water. The time of contact of wash water and sugar is so small that practically no dilution of sugar takes place.

There is also a small amount of water added above the funnel; this enables particularly sticky massecuites to flow freely through the funnel without adhering to the metal. This amount of water is negligible.

The basket is driven at constant speed by a synchronous motor. When massecuite is introduced into the cone, it is accelerated centrifugally, and therefore the torque on the motor is proportional to the feeding rate and to the consistency of the massecuite. The power taken by the motor is used to regulate the supply as follows : on the control panel of the centrifuge is a wattmeter with an adjustable pointer on its dial. When the pointer of the wattmeter goes beyond any selected position of the adjustable pointer, a signal is sent to the butterfly valve controlling the feed so as to reduce it. Conversely, when the power taken falls below the selected value, the butterfly valve opens.

The batch machine selected for this series of comparisons was a Broadbent 40 × 30 spinning at 1800 r.p.m.

Set up of experiment

For every run, the C strike discharged from one large vacuum pan was divided between two similar crystallisers, and the cooling time kept the same in both cases. The massecuite going to the Broadbent was reheated through a large heater, feeding a bank of batch machines, and fitted with a thermostatic controller in the hot water line, whilst the massecuite fed to the continuous machine was reheated in a locally-made rotating coil mingler. The water temperature was not controlled in the latter, and the flow of hot water through the element was manually adjusted.

The practice at Belle Vue factory where the tests were carried out was to cool down the massecuite to about 35°C, while maintaining its viscosity within acceptable limits by the addition of water.

Each test lasted at least one hour, and during that period samples of massecuite, sugar, and molasses were taken from each machine. Meanwhile the following data were recorded :

(i) Temperature of massecuite;
(ii) Temperature of water in heating element;
(iii) Number of cycles per hour for Broadbent;
(iv) Thickness of massecuite inside the Broadbent basket;
(v) Level of massecuite in crystalliser feeding Allis-Chalmers at the beginning and at the end of the experiment;
(vi) Amount of wash water used on Allis-Chalmers.

The capacity of each machine was determined from (iii), (iv) and (v) above.

The samples of massecuite were divided into two portions : one for direct determination of Brix and purity; the other for determination of cyclone molasses Brix and purity, i.e. Brix and purity of mother liquor obtained by centrifuging the massecuite in a laboratory centrifugal. The cyclone molasses were essential for the comparisons, since two reheaters of different design were used, one of which could, for instance, cause more re-solution of sucrose than the other.

Observations and results

The reheater of the Allis-Chalmers was found to be inadequate. Fluctuations occurred in the massecuite temperature, and if the capacity of the Allis-Chalmers was raised too high, the temperature of the massecuite kept falling until the experiment had to be stopped because of vibrations. Therefore, the throughput of the Allis-Chalmers was governed by the ability of the reheater to cope with the amount of massecuite fed to it.

During the first tests, it was found that while the butterfly valve was fully open, the power output of the motor was still below the set point. This was obviously due to the small diameter (6″) of the pipe leading from the reheater to the valve. The pipe was therefore replaced by an 8-inch one which proved adequate.

On one occasion, the gate valve, placed just on top of the butterfly valve, was closed, and fifteen minutes later opened again : the screen was immediately torn off. The same accident occurred some time later with a new screen. It was then suggested that during the fifteen minutes interval, sugar had dried on the screen, and that when massecuite was re-admitted, it adhered to the rough surface of the dry sugar and increased the load on the screen considerably, causing the failure of the latter. To avoid any further mishap of that sort, it was decided to wash the screen with water each time the machine was stopped. Consequently, no other screen was damaged until the end of the crop.

The results shown in Table 80 represent eight tests carried out with various motor settings and various ratios of wash water to massecuite.

Table 80. Results of comparative tests between the Allis-Chalmers and a Broadbent batch machine

	Massecuite		*Cyclone Mols.*		*Molasses*		*C-sugar*	*Dilution*	*Temp.M.C.*	*Capacity*
	Brix	*Pty*	*Brix*	*Pty*	*Brix*	*Pty*	*Pty*	*Gls/ft³*	*°C*	*ft³/hr*
Batch ...	93.78	58.6	90.42	35.7	90.66	34.1	79.4	—	48.1	34
Cont.	93.60	59.0	90.42	35.9	85.08	35.4	88.1	0.32	50-46	70
Batch.	94.68	60.4	90.60	34.9	91.98	34.5	79.8	—	40.3	34
Cont.	95.28	61.2	91.38	35.6	79.06	36.7	89.1	0.72	50-51	25
Batch ...	95.28	61.9	90.42	35.3	91.62	34.8	82.8	—	50.3	34
Cont.	94.94	61.6	91.62	34.9	86.04	36.3	88.7	0.33	51-45	46
Batch ...	95.64	60.7	90.96	36.6	92.64	35.6	80.2	—	50.0	34
Cont.	94.08	62.3	91.50	35.8	85.02	37.3	87.3	0.50	49-45	30
Batch ...	95.34	58.4	91.92	36.2	93.30	35.1	75.4	—	47	34
Cont.	95.22	60.3	91.92	36.9	89.34	38.1	86.6	0.50	53-59	30
Batch ...	93.12	57.9	90.42	34.2	91.08	33.1	—	—	46.5	34
Cont.	95.16	56.5	91.14	33.7	90.12	34.0	82.4	0.60	53-59	25
Batch ...	95.46	59.5	90.66	34.4	92.34	33.8	79.6	—	44.0	34
Cont.	94.62	60.1	90.54	35.0	91.14	35.9	79.9	0.33	—	46
Batch ...	95.10	58.5	90.78	33.2	91.20	32.8	79.8	—	47.7	40
Cont.	94.26	59.6	89.82	33.7	88.98	34.5	83.6	Nil	44-48	39
Mean Batch ...	*94.80*	*59.5*	*90.77*	*35.1*	*91.85*	*34.2*	*79.6*	—	—	35
Mean Cont.	*94.64*	*60.1*	*91.04*	*35.2*	*86.84*	*36.0*	*86.2*	—	—	39

Discussion of results

It is difficult to comment on the capacity of the Allis-Chalmers since it was purposely kept down because of the lack of capacity of the massecuite re-heater. However, it must be pointed out that on one occasion a capacity of 70ft³/hr. was achieved. It can be safely assumed that a capacity of 50-60ft³/hr would be achieved if the machine were equipped with an adequate re-heater. The re-heater best suited for that purpose would be either of the resistance type, or of the Green type, because both provide rapid reheating of the massecuite, with practically no remelt.

The molasses purities of the two machines cannot be directly compared because the purities of the mother liquors differ slightly. In order to compensate for this, the difference in mother liquor purity must be added to or subtracted from the difference in molasses purity. After correction, the nett difference in molasses purity averaged 1.7 in favour of the batch machine. It will be noted that the cyclone purities are higher than they should have been due to the use of a laboratory centrifugal which doubtless let more crystals through. But since the same laboratory machine was used for all the determinations, the difference in cyclone purities may still be used for correction.

At first sight, this result would seem to indicate that the continuous machine cannot compete with the batch machine. However, such a hasty conclusion cannot be drawn for a number of reasons, the most important of which are :

(i) Although the 1.7 difference in molasses purity is significant, yet the number of comparisons made is small, amounting only to eight;

(ii) As already pointed out, the heating surface of the reheater used with the Allis-Chalmers was so inadequate that comparisons at high throughputs of the continuous machine could not be made;

(iii) The average capacity of the batch machine was only 35 cu. ft/hour, as against 39 for the continuous machine in spite of the limitation mentioned in (ii) above. It would not appear that the batch machine could be used at a higher throughput, under the conditions prevailing during the tests, since the average purity of the C-sugar amounted to only 79.6, as against 86.2 for that from the Allis-Chamers. It should not be forgotten that the lower the sugar purity, the larger the proportion of molasses recycled. It is estimated that a drop of purity of the C-sugar from 86.2 to 79.6 would account for an increase in molasses recycling of about 85 per cent, with all its inherent disadvantages.

(iv) For all the tests, the same type of screen was used in the Allis-Chalmers, namely one with holes 0.15 mm in diameter, giving an open area of about 28 per cent. However, another type of screen with 0.06 mm slits and an open area of about 8 per cent is apparently also available. Whereas the first screen should increase the capacity of the machine, the second should yield lower molasses purity. Comparative tests carried out with the two screens (ANON, 1963) in a B.M.A. centrifugal have shown that the coarser screen yielded a molasses purity 2.4 points higher than that from the finer. Other authors (*vide* References) mention that continuous centrifugals of various makes, using screens with slits 0.06 mm wide, yield molasses the purities of which vary but slightly from those of corresponding cyclone molasses, while molasses purities 1.5-2.5 points higher than cyclone purities are obtained when using screens with 0.15 mm diameter holes instead.

Conclusion

Due to its simplicity, easy maintenance, low power consumption and price, the continuous centrifugal is a very promising machine. However, if the results to be obtained from it are to match the standards obtained with the batch machine for the curing of C-strikes, greater attention should be paid to the selection of the right screen and to the choice of the massecuite reheater.

In those factories where double-curing of the C-sugar has to be resorted to and where the C-fugal station is already adequate and up to date, the continuous centrifugal should prove better than the batch.

Also, if it becomes necessary to increase the B-fugals capacity, or to replace existing machines in a factory where the double magma system is followed, or where the B-sugar is remelted, strong consideration should be given to the installation of continuous machines.

REFERENCES

ANON, (1963). Notes on the use of continuous centrifugals for low grade massecuites. *Sug. J.* (New Orleans) **26**(1): 69-73.

B.S.E.S. (Brisbane), Div. Mill Technology. An Investigation into the performance of B.M.A. continuous fugal. *Operation Report 1964, no. 1.*

DAVIES, J.G. (1963). An evaluation of continuous centrifugals for C-massecuites. *Sug. J.* (New Orleans) **26**(5) : 32-35; 44.

KELLER, A.G. (1964). Continuous Centrifugals Operating problems. *Sug. J.* (New Orleans) **26**(11) : 46-49.

LUI, E.L. (1963). Operating data of Silver continuous centrifugals at Hutchinson. *Proc. Hawaiian Sug. Technol.* **22** : 203-204.

SIEPE, W. (1963). The fully continuous flow centrifugal. *Sug. J.* (New Orleans) **26** (3) : 25-28.

SILVER, B. (1963). The continuous centrifugal for processing low and high grade massecuite. *Sug. J.* (New Orleans) **25**(11): 49-55.

SOCKHILL, B.D. (1964). Continuous fugal on cane low grade massecuite. *Proc. Qd Soc. Sug. Cane Technol.* **31** : 271-279.

WULFEKUHLER, A.F. (1963). Western States continuous centrifugal. *Proc. Hawaiian Sug. Technol.* **22**: 205.

4. CHEMICAL CONTROL NOTES

NOTES ON THE USE OF THE BAUSCH AND LOMB PRECISION SUGAR REFRACTOMETER FOR CHEMICAL CONTROL OF SUGAR FACTORIES

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The refractometer has been used in Hawaii for Brix measurement in chemical control for the last twenty-five years, but it is only recently that other countries have studied the possibility of using it to replace the densimeter or Brix spindle. Mauritius has been the second country to adopt refractometeric Brix. After preliminary investigations carried out during the last few years by LAMUSSE (1960), LE GUEN and RANDABEL (1961), the Baush and Lomb precision sugar refractometer was adopted in 1965 by all factories of the island for chemical control. The purpose of these notes is to summarize various points of interest relating to the use of that instrument.

In 1961 when LE GUEN and RANDABEL studied the results of 550 Brix determinations in juice by densimeter and by refractometer, they found that the latter gave on the average a reading smaller than the former by 0.25 unit. For final molasses, the difference was usually of 6 to 7 points, spread between 3.0° and 10.0° Brix. In 1965, however, some factories obtained abnormally high differences of up to 13.00 between the Brix values of the same final molasses, whilst in other cases, very small differences were observed. It is intended, prior to next season, to investigate into the possible causes of such abnormal differences.

Whilst, with some instruments, no difficulties were encountered as to the sharpness of the dividing line between the dark and bright portions of the fields, in other cases, this line was not as sharp as could be desired. The advice of the Experiment Station of the Hawaiian Sugar Planters Association was sought in this connection, and in the light of their comments which were confirmed subsequently by local experience, the following precautions should be taken :

(i) There should be no moisture or condensation upon the back of the prism, i.e. the part which is just opposite the telescope;

(ii) Bright light falling on the back face of the prism causes a lack of contrast between the dark and bright portions of the field, and should therefore be avoided. It is helpful to set up the instrument inside a darkened box where it is sheltered from extraneous light, as is usually done with saccharimeters;

(iii) Too much light from the sodium lamp can also give rise to a lack of contrast. It sometimes helps to diffuse that light by means of opalescent glass, or a 100-mesh wire screen;

(iv) Juice or moisture on the front face of the prism should not affect the reading. It is nevertheless advisable to keep this part of the instrument clean;

(v) The sharpness of the dividing line is affected by the amount of suspended matter in the juice, and by its turbidity. In Hawaii, the practice is to filter with Kieselghur all the samples or else to centrifuge them at 18,000 or 20,000 g. Such a procedure should remove all suspended matter and give a more accurate Brix, as well as provide a sharper dividing line. At first sight, however, this procedure appears to be rather inconvenient for everyday practice. However it is also intended, prior to the next campaign, to study the effect of the removal of solids on the Brix of final molasses;

(vi) Lack of sharpness of the dividing line may also be caused by a too wide spacing of the prisms, the distance between which should lie between 0.08 and 0.15 mm, according to the manufacturers. However, it appears that when the juice is extremely turbid, the maximum spacing allowed by this tolerance is too wide. In such cases, the prism should be readjusted only by the manufacturers.

(vii) The most common sources of trouble with the instrument are given hereunder :

(a) Failure of sodium vapour lamps.

(b) Corrosion of parts in general. It is therefore highly important to keep the instrument clean. It should, moreover, not be kept in a corrosive atmosphere (vicinity of acids) in the laboratory;

(c) Corrosion of the scale. This is best prevented by wiping it once a week with benzene;

(d) Freezing of the telescope barrel in its housing. This is easily prevented by removing the telescope from its barrel and using a silicone grease as lubricant.

(e) Alidade action not free. This does not affect the accuracy of the instrument, but results in a backlash whenever the motion of the telescope bearing arm is reversed. It is usually due to improper adjustment, or to lack of stiffness of the spring (springs usually last from two to five years.);

(f) Prism cement failure. In Hawaii, dental cement (resin type) has been successfully used for repair;

(g) Scratching of measuring prism. This is best prevented by washing with distilled water after use, so as to remove any abrasive particles and by using extreme care whenever the measuring prism is being wiped. Very severe scratching can even impair the contrast between the dark and bright portions of the field;

(h) Corrosion of prism box or case. This is best prevented by washing after use ;

(i) Corrosion of prism box mounting screws. These should be removed once a year and lubricated;

(j) Seeping of juice under the prism box. This is best prevented by operating the instrument so that it slopes towards the sodium lamp.

Difficulties were also encountered in connection with the sodium vapor spectral lamps used with the instruments. These lamps have a nominal life of 500 hours, but in practice, they sometimes last 1000 hours or more. In several cases, however, lamps burned after only a few days, and the trouble was traced to voltage fluctuations of the mains supply.

In this connection the following points should be noted :

(a) The lamp is particularly vulnerable to voltage fluctuations, and a voltage stabiliser is desirable whenever such fluctuations are to be encountered;

(b) The effect upon lamp life of a too low voltage is far worse that of a too high voltage. For the GEC lamps supplied by Bausch and Lomb, the 120 volts nominal primary voltage should not fall below 112 volts nor rise above 125 volts at most.

At one time during the crushing season, the stock of spare lamps was completely exhausted. As a substitute, sodium lamps of a type used for lighting, and which were known to be satisfactory for use with saccharimeters, were tried. These lamps appear to be quite satisfactory and have the advantage of being much cheaper.

In conclusion, it may be said that the adoption of the precision refractometer for the chemical control of sugar factories in Mauritius has presented no problem in the laboratories and has been most successful.

REFERENCES

DEICKE, R. (1958) Preliminary investigations into the influence of suspended solids on the Brix of first expressed juice. *Proc. Qd Soc. Sug. Cane Tech.* **25** : 159-161.

CLAYTON, J.L. (1959). Brix and purity of raw juices. *Proc. Qd Soc. Sug. Cane Tech.* **26** : 131-137.

CLAYTON, J.L. (1962). Refractometer Brix for factory control. *Proc. Qd Soc. Sug. Cane Tech.*, **29** : 235-241.

JENSEN, E.D. (1962). A comparison of methods for the determination of dissolved solids. *Proc. Qd Soc. Sug. Cane Tech.* **29** : 227-233.

LAMUSSE, J.P. (1960). Preliminary studies on the use of the refractometer for routine chemical control. *Rep. Maurit. Sug. Ind. Res. Inst.* **7** : 101-103.

LE GUEN, F. *and* RANDABEL, M. (1961). Further studies on the use of the refractometer for routine chemical control. *Rep. Maurit. Sug. Ind. Res. Inst.* **8** : 86-88.

BY-PRODUCTS

IV. PROTEIN RECOVERY FROM CANE JUICE AND SYRUP

R. de FROBERVILLE

THE possibility of recovering protein from cane juice has been studied at this Institute since 1960 and the results obtained have formed the subject of several papers (*vide* Annual Reports 1960 - 1962)

It will be recollected that the major difficulties encountered were the relatively high proportion of fats and waxes present in the coagulate obtained, the lack of an efficient continuous separator to replace the batch type KG 10006 Westfalia machine used, and the small amount of protein, about 0.1 per cent, contained in the juice.

In spite of these difficulties and the unfavourable results obtained so far, another attempt to recover proteins was made in 1965. Investigations were carried out on a pilot plant scale, starting from syrup instead of cane juice. It was hoped that efficient separation of the proteins could be obtained from a more concentrated solution, in the same way as the separation of fats and proteins is obtained from a glucose solution of 45° Brix in the industrial production of glucose from starch in Germany (HUSTER, 1964)

The machines used were a Westfalia separator : SAOH 205 of the bowl type fitted with an automatic de-sludging device and a nozzle separator Westfalia SKOG 205.

Trials were made at Médine factory. A flow diagram of the installation is shown in Fig. 30. Juice heated in one of the industrial heaters was by-passed and screened over a 120-mesh monel stationary filter to remove bagacillo. The juice temperature was then raised to approximately 90°C by blowing steam by means of perforated pipes placed at the bottom of a tank. The pH of the juice was then adjusted to neutrality with the help of a 15% solution of sodium hydroxide. Evaporation took place in a small single effect evaporator working under 26″ vacuum, and the syrup was fed to the SAOH separator.

Syrups of varying brix values were obtained with the object of investigating the influence of density on the capacity of the machine and on the efficiency of protein recovery. De-sludging intervals were also varied in order to obtain a thicker sludge. Finally the SKOG machine was installed in series with the bowl-type machine. Protein content was determined on samples of syrups entering and leaving the separators, and of sludges, in each of the trial runs.

In none of the cases was it possible to clarify the syrup in a satisfactory manner, more than 90% of the protein remaining in the syrup after centrifuging. In addition, these syrups retained a high proportion of microscopic solid impurities.

It appears from the results obtained that the separation of proteins from syrups is even more difficult than separation from cane juice.

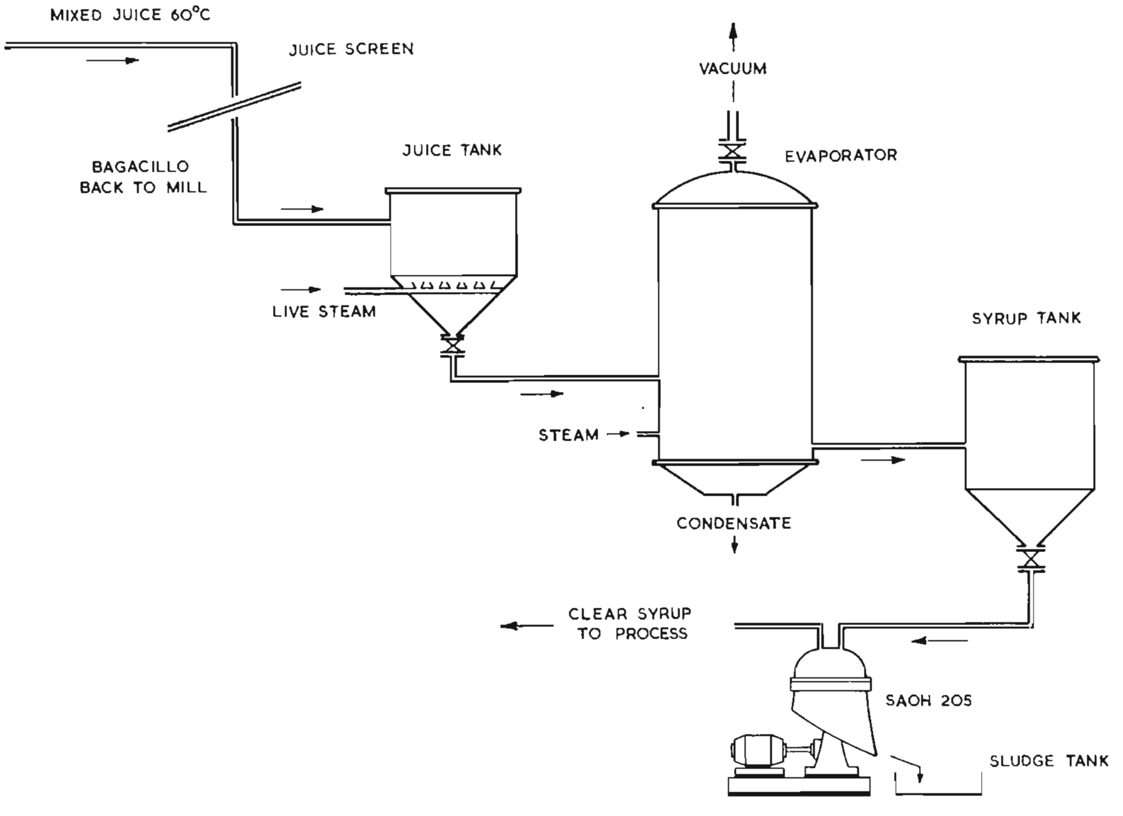

Fig. 30. Flow diagram of pilot plant erected at Médine factory.

REFERENCES

HUSTER, H. (1964). Reinigung von Glukosesirup und Dextroserohsäften met Separatoren. *Die Starke* **16** : 225-229.

SAINT ANTOINE, J.D. de R. de *and* VIGNES, E.C. (1961). The extraction of cane juice protein and the assessment of its value as a feeding stuff. *Rep. Maurit. Sug. Ind. Res. Inst.* **8** : 104-109.

VIGNES, E.C. *and* FROBERVILLE, R. de (1960). Protein extraction from sugar cane juice. *Rep. Maurit. Sug. Ind. Res. Inst.* **7** : 93 - 97.

VIGNES, E.C. *and* FROBERVILLE, R. de (1962). Further experiments on the recovery and nutritive value of cane juice protein. *Rep. Maurit. Sug. Ind. Res. Inst.* **9** : 103-104.

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* *Grateful acknowledgment is made to the Secretary, Mauritius Chamber of Agriculture, for providing the necessary data to compile Tables II to VI.*

Table I. General description of sugar cane sectors of Mauritius

SECTORS	WEST	NORTH	EAST	SOUTH	CENTRE
DISTRICT	Black River	Pamplemousses & Rivière du Rempart	Flacq	Grand Port & Savanne	Plaines Wilhems & Moka
ORIENTATION	Leeward	—	Windward	Windward	—
PHYSIOGRAPHY	Lowlands and Slopes	Lowlands	Lowlands and Slopes	Lowlands and Slopes	Plateau
GEOLOGY	Late lava — Pleistocene				
PETROLOGY	Compact or vesicular doleritic basalts and subordinate tuffs				
ALTITUDE	Sea level - 900 ft.	Sea level - 600 ft.	Sea level – 1,200 ft.	Sea level - 1,200 ft.	900 - 1,800 ft.
HUMIDITY PROVINCE	Sub-humid	Sub-humid to humid	Humid to super-humid		
ANNUAL RAINFALL, inches. Range and mean	(30 - 60) 44	(40 - 75) 55	(60 - 125) 94	(60 - 125) 90	(60 - 150) 90
MONTHS RECEIVING LESS THAN TWO INCHES RAIN	June to October	September to October	None		
AVERAGE TEMPERATURE °C — JAN.	27.0°	26.5°	25.5°	25.0°	23.5°
AVERAGE TEMPERATURE °C — JUL.	21.0°	20.5°	19.5°	19.0°	17.5°
CYCLONIC WINDS, greater than 30m.p.h. during 1 hour	December to May				
PEDOLOGY Great Soil Groups	Soil Families				
Low Humic Latosol	« Richelieu »	« Richelieu » « Réduit »	« Réduit » « Bonne Mère »	« Réduit »	« Réduit » « Ebène »
Humic Latosol	—	« Rosalie »	—	« Riche Bois »	« Riche Bois »
Humic Ferruginous Latosol	—	—	« Sans Souci »	« Belle Rive » « Sans Souci » « Midlands » « Chamarel »	« Belle Rive » « Sans Souci » « Midlands »
Latosolic Reddish Prairie	« Médine »	« Labourdonnais » « Mont Choisy »	« Mont Choisy »	« Labourdonnais » « Mont Choisy »	« Médine »
Latosolic Brown forest	—	—	« Rose Belle »	« Rose Belle » « Bois Chéri »	« Rose Belle » « Bois Chéri »
Dark Magnesium Clay	« Lauzun » « Magenta »	« Lauzun »	—	—	—
Grey Hydromorphic	« Balaclava »	« Balaclava » « St. André »	« Balaclava »	—	—
Low Humic Gley	—	—	« Valetta »	—	« Valetta » « Petrin »
Lithosol	—	« Melleville »	« Pl. des Roches » « Melleville »	« Melleville »	—
IRRIGATION	Common	Some	Rare		
APPROXIMATE AREA 1000 arpents — Sector	56	91	72	160	63
APPROXIMATE AREA 1000 arpents — Cane	12	54	47	65	27
CANE PRODUCTION 1000 metric tons (1965)	468	1,461	1,333	1,935	788
SUGAR PRODUCTION 1000 metric tons (1965)	54	159	148	213	91
SUGAR FACTORIES Production in 1000 metric tons (1965)	Médine 54	Belle Vue 33 Mon Loisir 29 St. Antoine 26 Solitude 25 Beau Plan 23 The Mount 23	Union Flacq 83 Beau Champ 37 Constance 28	Savannah 32 Mon Trésor 29 Riche en Eau 26 Rose Belle 23 Union 21 Bel Ombre 20 Britannia 18 St. Félix 16 Bénarès 14 Ferney 14	Mon Désert 41 Réunion 25 Highlands 25

Table II. Area under sugar cane in thousand arpents (1), 1957 - 1965

Year	Area under cane Island	Area reaped					
		Island	West	North	East	South	Centre
1957	182.67	169.58	8.95	48.27	35.72	54.25	22.29
1958	189.22	176.69	9.20	49.14	38.78	56.62	22.95
1959	195.31	183.12	9.62	50.37	40.93	58.77	23.43
1960	201.61	188.36	10.22	51.50	42.15	60.34	24.14
1961	201.17	187.29	10.33	50.71	41.98	60.29	23.98
1962	204.97	193.77	11.07	52.60	42.61	62.41	25.08
1963	204.20	194.08	11.63	51.17	43.61	62.67	25.00
1964	206.94	195.41	11.79	52.70	42.23	62.45	25.24
1965 (2)	207.00	194.10	11.85	51.96	43.08	62.00	25.21

NOTE : (*1*) *To convert into acres, multiply by 1.043*
" " " hectares, " " 0.422

(2) *Provisional figures*

TABLE III. Sugar production in thousand metric tons (1), 1957 - 1965

Crop Year	No. of factories operating	Av. Pol.	Island	West	North	East	South	Centre
1957	26	98.5	562.0	36.05	141.28	103.31	198.86	82.50
1958	25	98.5	525.8	31.80	137.17	106.07	178.80	72.01
1959	24	98.6	580.4	35.22	141.95	123.76	195.86	83.59
1960	23	98.0	235.8	18.06	75.22	50.02	72.24	20.24
1961	23	98.8	553.3	32.62	140.05	111.92	183.77	84.90
1962	23	98.6	532.8	35.09	154.51	109.25	176.74	56.87
1963	23	98.8	685.5	47.3	175.2	145.5	222.0	95.5
1964	23	98.9	519.0	40.5	148.7	108.9	161.4	59.5
1965 (2)	23	98.6	664.5	53.8	158.1	148.7	212.5	91.4

NOTE : (*1*) *To convert into long tons, multiply by 0.984*
" " " short " " " 1.102

(2) *Provisional figures*

Table IV. Yield of cane metric tons per arpent (1), 1957 - 1965

SECTORS	1957	1958	1959	1960	1961	1962	1963	1964	1965 (2)
ISLAND									
Millers ...	32.2	30.5	32.5	15.3	32.2	28.0	35.1	26.2	35.7
Planters	19.1	19.1	19.7	10.2	20.5	19.5	23.7	18.5	25.6
Average ...	25.6	24.5	25.9	12.7	26.4	23.9	29.6	22.4	30.8
WEST									
Millers ...	35.9	32.4	34.4	21.3	35.3	31.8	37.8	32.3	43.5
Planters	27.8	25.2	26.4	13.5	23.4	22.7	27.8	25.0	35.7
Average ...	30.8	28.0	29.3	16.2	27.8	26.2	32.1	28.1	39.5
NORTH									
Millers ...	29.0	29.5	30.0	19.2	29.2	31.1	35.0	29.0	35.5
Planters	16.9	17.5	17.1	11.4	20.6	21.4	24.0	19.2	24.2
Average ...	21.1	21.6	21.5	14.1	23.5	24.7	27.8	22.5	28.1
EAST									
Millers ...	31.5	31.5	33.0	16.3	32.7	29.0	37.6	28.0	39.0
Planters	17.2	16.8	19.2	9.3	17.9	17.1	21.3	16.0	23.5
Average ...	22.9	22.4	24.8	12.2	24.4	22.5	28.9	21.5	30.9
SOUTH									
Millers ...	32.8	30.3	32.3	14.6	31.7	27.8	33.4	24.5	33.1
Planters	22.0	22.5	21.4	9.4	20.8	20.1	24.6	18.7	27.3
Average ...	29.3	27.4	28.6	12.9	28.3	25.5	30.7	22.7	31.2
CENTRE									
Millers ...	34.1	30.6	34.9	9.7	36.7	22.1	36.2	23.3	35.7
Planters	20.4	19.9	22.0	7.6	23.7	15.8	24.1	16.9	25.7
Average ...	28.6	25.9	29.1	8.8	30.8	19.3	30.8	20.5	31.3

NOTE: (1) To convert in metric tons/acre, multiply by 0.959
,, ,, ,, long tons/acre, ,, ,, 0.945
,, ,, ,, short tons/acre, ,, ,, 1.058
,, ,, ,, metric tons/hectare, ,, ,, 2.370

(2) Provisional figures

Table V. Average sugar manufactured % cane (1), 1956 - 1965

Crop Year	Island	West	North	East	South	Centre
1956	12.95	13.17	13.59	12.84	12.47	12.89
1957	12.94	13.07	13.86	12.64	12.49	12.88
1958	12.14	12.36	12.95	12.22	11.53	12.12
1959	12.24	12.48	13.08	12.22	11.64	12.27
1960	9.84	10.94	10.34	9.73	9.29	9.56
1961	11.19	11.40	11.76	10.94	10.78	11.47
1962	11.52	12.07	11.90	11.38	11.12	11.76
1963	11.93	12.66	12.32	11.54	11.54	12.40
1964	11.85	12.22	12.52	11.70	11.39	11.50
1965 (2)	11.10	11.50	10.82	11.16	10.98	11.60

NOTE : (*1*) *To convert into tons cane per ton sugar manufactured : divide 100 by above percentage*

(*2*) *Provisional figures*

Table VI. Tons sugar manufactured per arpent reaped, 1956 - 1965

Crop Year	Island	West	North	East	South	Centre
1956	3.41	3.56	3.47	3.07	3.53	3.49
1957	3.31	4.02	2.92	2.89	3.66	3.68
1958	2.98	3.46	2.79	2.74	3.16	3.14
1959	3.17	3.66	2.81	3.03	3.33	3.57
1960	1.26	1.96	1.49	1.19	1.20	0.84
1961	2.95	3.16	2.76	2.67	3.05	3.54
1962	2.75	3.16	2.94	2.56	2.84	2.27
1963	3.53	4.06	3.42	3.34	3.51	3.82
1964	2.66	3.43	2.82	2.52	2.58	2.35
1965 (1)	3.42	4.54	3.04	3.45	3.43	3.63

NOTE : (*1*) *Provisional figures*

Table VII. Monthly rainfall in inches, 1949 - 1965. Average over whole sugar cane area of Mauritius

Crop year	GROWTH PERIOD (deficient months in italics)								NOV-JUNE (sum of monthly deficits)	MATURATION PERIOD (excess months in italics)				JULY-OCT. (sum of monthly excesses)
	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE		JULY	AUG.	SEPT.	OCT.	
Normals 1875-1949	3.77	7.09	11.04	11.06	12.09	9.50	6.91	4.96	15.00	4.59	4.15	2.90	2.81	2.50
Extremes to date	0.52 13.18	1.74 44.81	2.69 32.46	2.59 36.04	3.35 38.98	1.45 27.60	1.62 21.41	0.97 16.49	2.20 29.20	1.62 10.23	0.60 12.52	0.69 8.06	0.76 9.83	0.00 14.12
1949	4.01	*5.48*	*4.81*	16.71	*8.86*	*7.01*	*3.30*	10.09	17.17	4.11	1.91	1.39	1.39	0.00
1950	*3.34*	*3.42*	*10.20*	*5.21*	23.18	11.39	*2.98*	7.02	14.72	4.47	*5.02*	2.80	2.35	0.87
1951	*3.15*	*5.86*	11.65	*8.20*	*10.89*	*7.98*	7.00	7.26	7.43	*4.91*	*5.41*	*4.16*	*3.84*	3.87
1952	4.08	*2.22*	*5.26*	11.17	16.88	10.11	*5.69*	*4.86*	12.31	*8.22*	*5.20*	*3.47*	*3.13*	5.61
1953	6.06	18.05	11.65	*6.59*	*10.57*	*8.35*	11.95	12.75	7.14	*10.10*	*4.72*	*3.07*	2.68	6.25
1954	*3.76*	11.47	*5.00*	*7.96*	14.89	*6.20*	*6.49*	6.06	12.88	*6.44*	*5.04*	*4.11*	1.53	3.76
1955	4.81	*5.19*	*4.50*	23.28	19.60	10.97	8.83	7.73	8.44	*4.66*	3.85	*3.68*	1.12	0.85
1956	*3.03*	7.70	12.02	13.59	*10.60*	*4.14*	*5.93*	*4.90*	8.63	2.94	2.82	1.68	1.40	0.00
1957	*2.08*	8.11	*7.80*	*6.98*	*8.93*	10.66	*6.14*	*3.66*	14.24	3.55	2.54	*3.32*	0.96	0.42
1958	*2.09*	10.26	13.49	13.28	29.54	13.29	*4.95*	*2.20*	6.40	*8.22*	*4.51*	1.50	2.47	3.99
1959	*1.18*	*3.06*	13.64	*9.48*	13.93	*4.81*	*3.04*	*1.80*	19.91	3.07	*6.01*	2.67	*6.53*	5.59
1960	11.43	*6.58*	23.46	18.29	16.97	*1.73*	*3.23*	5.06	11.96	3.57	2.29	*8.06*	1.49	5.16
1961	*2.48*	*3.13*	*4.31*	*2.59*	*7.96*	*7.58*	*4.70*	7.13	28.71	*7.84*	*5.65*	2.05	2.26	4.75
1962	3.89	44.81	11.17	15.42	14.47	*5.12*	*5.62*	5.49	5.67	2.89	3.50	*3.79*	*5.28*	3.36
1963	4.68	*5.26*	*8.41*	11.46	*5.02*	*9.49*	*5.41*	*4.09*	13.91	*6.13*	0.82	1.76	*3.50*	2.23
1964	7.43	*2.24*	22.12	*9.75*	*10.58*	*8.28*	*6.42*	*4.05*	10.29	3.71	2.07	*4.05*	*4.54*	2.88
1965	*1.08*	*5.27*	11.13	*6.85*	*10.70*	16.19	*4.66*	*3.23*	14.09	*9.01*	*9.45*	*6.67*	*3.46*	14.12

NOTE: To convert into millimetres, multiply by 25.4

Table VIII. Monthly maximum and minimum air temperatures, 1950 - 1965. Average over whole sugar cane area of Mauritius

YEAR	NOV.		DEC.		JAN.		FEB.		MAR.		APR.		MAY		JUNE		JULY		AUG.		SEPT.		OCT.	
	M	m	M	m	M	m	M	m	M	m	M	m	M	m	M	m	M	m	M	m	M	m	M	m
Normals 1950-65	27.9	18.7	29.2	20.6	29.7	21.7	29.4	21.8	29.1	21.5	27.9	20.2	26.4	18.6	24.8	17.1	24.0	16.4	23.8	16.0	24.8	16.5	26.1	17.4
1950	28.1	18.0	29.6	20.0	30.0	22.1	29.0	21.9	28.5	21.2	27.4	20.3	26.4	16.6	24.7	17.1	23.2	16.0	23.6	15.7	24.0	15.8	26.4	17.2
1951	28.1	18.1	29.2	21.0	29.9	22.2	28.7	22.0	29.1	21.7	28.4	19.1	26.8	18.3	24.6	17.5	24.5	16.9	24.0	16.3	24.9	16.2	26.1	17.7
1952	27.7	19.3	29.8	21.0	30.8	22.3	29.6	21.9	28.8	22.2	28.0	21.2	26.9	20.0	23.8	17.3	24.0	16.8	23.8	15.6	25.0	17.2	25.9	16.7
1953	27.7	18.6	28.7	19.7	29.2	21.5	29.6	21.5	30.4	21.2	28.6	20.2	27.1	19.9	26.0	19.1	24.1	17.2	23.7	16.1	24.7	16.6	25.9	17.5
1954	28.1	19.0	28.8	21.1	29.8	21.7	30.4	22.3	29.8	21.4	27.9	21.0	26.6	20.0	24.9	17.3	24.1	17.4	24.2	17.0	24.6	17.4	26.5	17.3
1955	27.4	19.2	29.1	20.2	30.9	21.6	29.4	21.3	29.1	22.1	28.1	20.4	26.6	18.9	24.7	17.6	24.0	16.8	23.4	15.9	24.9	16.4	25.8	16.5
1956	28.4	18.7	28.4	20.4	29.4	21.7	28.4	21.6	28.6	21.3	27.5	19.4	26.2	19.2	24.5	16.4	24.0	15.0	24.7	15.5	25.8	16.6	27.2	17.6
1957	29.2	17.8	29.8	20.3	30.4	21.6	28.8	21.1	29.4	21.3	27.4	19.2	26.7	18.4	24.6	16.7	24.9	16.2	24.4	16.0	25.6	16.5	27.6	17.4
1958	29.2	17.8	30.5	21.3	29.9	21.9	29.6	21.8	29.6	22.4	28.8	22.1	26.0	17.7	24.4	16.3	24.2	15.6	24.4	16.7	25.9	16.2	26.1	17.3
1959	28.4	17.9	30.1	19.9	30.1	21.1	29.8	21.7	28.7	22.5	28.1	20.0	26.6	17.6	25.0	15.8	23.5	15.6	23.7	15.9	24.8	16.2	25.8	17.8
1960	27.3	20.5	28.9	20.9	28.8	22.0	29.1	22.4	28.7	21.5	27.8	19.1	26.8	18.6	24.7	17.7	23.4	16.2	24.0	17.0	24.3	17.5	25.7	17.5
1961	26.6	18.6	29.2	20.6	29.8	21.9	30.8	21.2	29.8	21.8	29.4	21.1	28.3	19.6	26.4	18.3	25.5	18.4	24.3	16.8	25.4	16.5	26.7	18.0
1962	28.3	19.9	28.6	22.1	29.2	21.7	29.5	22.2	29.5	22.1	27.6	19.3	25.8	18.0	24.7	16.0	24.0	15.1	23.6	15.7	25.1	17.0	25.7	17.8
1963	27.3	18.4	29.1	20.8	29.1	21.3	29.3	21.6	28.7	20.7	28.6	20.8	25.8	17.8	25.2	17.4	23.8	16.3	23.6	14.4	24.3	15.4	25.9	16.7
1964	27.1	18.9	29.0	20.0	29.2	21.1	29.1	23.1	28.9	22.7	26.1	19.8	24.8	18.1	24.1	16.5	22.7	14.9	22.9	15.4	23.7	15.9	25.2	16.9
1965	27.3	18.2	28.8	20.4	28.3	21.4	29.2	21.8	28.0	20.5	27.1	20.8	25.2	18.7	24.4	16.1	24.1	17.5	22.9	16.6	24.2	17.3	25.3	18.1

Table IX. Highest wind speed during one hour in miles*(1)*. Average over Mauritius

Crop Year	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
November	17	24	18	18	14	16	12	13	13	19	16	18	15	17	15
December	24	21	15	16	15	17	13	13	14	15	15	*43(2)*	24	18	17
January	21	22	18	28	13	20	20	14	17	*53(2)*	16	20	26	*60(2)*	19
February	20	25	15	15	*34(2)*	16	19	18	17	*74(2)*	13	*59(2)*	16	*34(2)*	15
March	18	25	15	15	29	19	18	*33(2)*	18	15	13	18	17	24	21
April	17	22	20	16	16	17	16	28	17	15	12	21	16	18	21
May	20	24	22	22	19	18	15	14	16	17	13	20	20	22	24
June	23	25	23	20	22	17	13	14	17	17	19	17	18	20	17
July	21	20	24	16	17	15	12	11	16	15	19	19	17	20	20
August	24	25	24	23	20	14	17	20	18	16	20	22	15	20	18
September	21	21	20	19	19	17	17	17	17	20	21	18	17	20	17
October	20	20	19	20	14	18	15	17	18	18	19	22	16	17	18

NOTE: (*1*) *To convert into knots, multiply by 0.87*
,, ,, kilometres/hr., multiply by 1.61
,, ,, metres/sec., multiply by 0.45

(*2*) *Cyclonic wind above 30 miles per hour*

X. Highest wind speed during one hour in miles in different sectors. Cyclone years

Cyclone Years	West	North	East	South	Centre
February 1955	—	30	—	37	35
March 1958	34	29	22	35	31
January 1960 *Alix*	60	48	43	60	—
February 1960 *Carol*	83	82	78	74	55
December 1961 *Beryl*	49	45	33	51	40
February 1962 *Jenny*	64	74	49	58	54
January 1964 *Danielle*	48	61	55	81	53
February 1964 *Gisele*	37	33	26	42	32

Table XI. Variety trend in Mauritius, 1951 - 1965

% Area cultivated (Estate lands)

YEAR	M. 134/32	M. 147/44	M. 31/45	M. 202/46	M. 93/48	M. 253/48	M. 442/51	Other M. seedlings	Ebène 1/37	Ebène 50/47	B. 3337	B. 34104	B. 37161	B. 37172	Others
1951	92	—	—	—	—	—	—	4	2	—	—	—	—	—	—
1952	90	—	—	—	—	—	—	3	4	—	—	—	—	—	1
1953	86	—	—	—	—	—	—	3	8	—	—	—	—	—	1
1954	83	—	—	—	—	—	—	3	9	—	1	—	1	—	1
1955	74	—	—	—	—	—	—	2	15	—	3	—	2	1	1
1956	66	1	1	—	—	—	—	3	17	—	4	—	3	2	1
1957	55	6	3	—	—	—	—	1	21	—	4	1	3	3	1
1958	43	10	4	—	—	—	—	2	24	—	5	1	3	5	1
1959	33	15	5	—	—	—	—	1	25	—	5	2	3	8	1
1960	25	19	5	—	—	—	—	1	26	—	6	2	3	10	1
1961	19	23	5	2	1	1	—	—	24	1	7	2	2	11	1
1962	13	26	4	4	3	1	—	—	21	3	7	3	2	11	1
1963	9	29	4	6	5	2	—	—	18	4	6	3	2	11	1
1964	6	31	3	8	9	2	—	1	15	5	6	2	—	11	1
1965	5	29	4	11	12	2	2	1	11	6	5	2	—	9	1

TABLE XII. Percentage annual plantations under different cane varieties on sugar estates, 1961 to 1965.

Years / Varieties	Island					West					North					East					South					Centre				
	1961	1962	1963	1964	1965	1961	1962	1963	1964	1965	1961	1962	1963	1964	1965	1961	1962	1963	1964	1965	1961	1962	1963	1964	1965	1961	1962	1963	1964	1965
M.134/32 ...	1.0	1.7	—	0.6	1.3	—	—	—	0.9	1.4	5.0	8.0	0.6	1.8	3.2	—	—	—	0.5	1.2	0.4	1.0	—	0.4	1.0	0.1	—	—	—	—
M.147/44 ...	30.1	28.9	31.0	22.5	3.6	17.8	44.1	55.1	40.1	13.1	55.4	53.3	68.1	56.8	13.4	34.4	32.5	30.9	22.0	1.6	27.9	23.6	23.1	14.9	—	8.9	3.6	1.0	0.4	—
M.31/45 ...	0.8	1.2	1.7	6.2	9.4	—	—	—	1.3	6.2	3.3	1.9	1.0	2.4	7.5	1.0	2.7	6.1	14.9	22.3	0.2	0.8	1.0	5.5	7.9	—	1.0	—	—	0.6
M.202/46 ...	12.6	16.1	14.8	21.3	21.1	18.3	15.6	23.9	28.4	29.2	11.2	12.1	12.4	22.0	23.7	15.3	26.3	19.3	23.0	23.3	11.5	15.7	15.8	25.1	24.8	10.8	8.1	7.8	4.0	0.6
M.93/48 ...	11.6	20.4	24.4	25.5	26.3	—	3.3	1.8	—	0.9	2.9	3.1	9.3	12.3	18.8	12.8	28.6	16.4	20.6	19.1	18.7	24.0	28.7	23.4	22.9	5.5	27.4	46.6	62.7	67.9
M.99/48 ...	—	—	—	—	3.4	—	—	—	—	1.1	—	—	—	—	0.6	—	—	—	—	5.7	—	—	—	—	4.4	—	—	—	—	1.8
M.253/48 ...	3.6	3.7	1.7	1.4	2.7	12.8	7.4	2.4	10.9	20.6	3.1	3.7	3.3	0.3	1.6	4.0	3.3	1.3	1.3	0.9	2.2	3.1	1.9	1.2	1.5	3.4	3.6	—	—	—
M.442/51 ...	—	—	—	4.2	18.8	—	—	—	7.0	23.8	—	—	—	1.8	26.6	—	—	—	5.0	18.4	—	—	—	5.4	20.9	—	—	—	1.0	1.8
Ebéne 1/37 ...	12.7	3.0	4.5	1.7	1.7	—	—	—	—	—	3.3	—	—	—	—	11.7	—	4.1	—	—	12.3	1.2	3.6	3.6	3.4	30.3	16.4	13.5	1.3	1.5
Ebène 50/47...	7.3	12.6	9.7	7.6	4.4	3.1	2.9	0.7	—	—	0.5	6.3	4.0	2.1	1.4	6.4	4.4	3.5	3.5	2.4	3.9	12.5	9.2	8.6	7.1	26.3	35.5	26.0	20.4	5.5
B.3337 ...	6.0	2.4	5.8	3.1	—	—	—	—	—	—	—	—	—	—	—	5.7	0.1	14.8	4.9	—	6.9	5.4	7.6	4.7	—	12.9	1.7	—	—	—
B.34104 ...	4.0	3.5	1.2	0.2	—	26.7	24.5	9.0	3.2	—	0.6	2.2	—	—	—	1.5	0.9	—	—	—	4.3	2.5	1.9	—	—	0.6	0.6	—	—	—
B.37172 ...	8.7	5.4	2.4	1.5	0.4	18.7	1.3	4.9	3.2	0.2	14.0	8.6	—	0.5	0.4	6.1	0.6	—	—	—	9.2	9.4	5.1	3.1	0.7	0.6	0.2	—	—	—
Other varieties	1.6	1.1	2.8	4.2	6.9	2.6	0.9	2.2	5.0	3.5	0.7	0.8	0.7	—	2.8	1.2	0.6	3.6	4.3	5.1	2.5	0.8	2.1	4.1	5.4	0.6	2.9	5.1	10.2	20.3
Total area arpents	15,451	13,406	12,290	13,755	13,400	1,042	1,203	531	741	1,045	2,559	2,251	2,445	2,176	2,255	3,071	2,800	2,274	3,164	2,554	6,318	5,225	4,902	5,696	5,593	2,461	2,077	2,127	1,978	1,953

Table XIII. Percentage weight of ratoons in total cane production on estates

Year	Island	West	North	East	South	Centre
1952	88.6	85.0	83.4	87.9	90.2	86.7
1953	87.8	85.9	87.7	88.1	88.5	85.4
1954	88.0	83.8	86.8	89.6	89.4	85.3
1955	87.1	86.7	88.6	87.7	86.4	86.1
1956	84.5	87.5	86.4	84.9	83.8	82.9
1957	85.0	79.0	86.9	83.6	85.7	83.7
1958	82.9	77.9	86.3	77.5	83.1	85.5
1959	86.1	87.8	85.9	82.1	87.2	87.8
1960	81.9	82.2	82.7	78.3	75.2	84.8
1961	85.4	78.5	84.4	85.1	86.3	86.7
1962	82.9	72.8	83.3	82.1	84.6	82.1
1963	86.2	77.8	86.2	84.6	88.3	85.8
1964	88.2	89.9	86.9	88.9	89.3	83.7
1965	86.7	87.2	87.2	85.0	78.5	87.2

NOTE : The weight of cane produced on estates in 1965 was : virgins 483,990 tons ; ratoons 3,165,018

Table XIV. Average yields of virgin and ratoon canes on estates
Tons per arpent. A: 1961 - 1964 B: 1965

Crop Cycle	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
Virgin	35.0	38.8	42.3	51.3	35.7	40.0	38.6	41.3	32.7	36.1	32.8	36.4
1st Ratoon	32.4	37.7	36.1	38.5	33.3	38.4	34.0	41.5	31.2	35.6	31.1	38.1
2nd ,,	30.7	37.6	33.3	43.7	31.4	36.3	32.6	42.1	29.5	34.4	29.4	37.5
3rd ,,	29.7	35.0	31.3	39.0	30.4	35.6	31.7	37.6	28.8	32.3	28.2	35.5
4th ,,	29.1	33.5	29.6	41.2	29.8	33.8	30.5	37.6	28.2	30.9	28.3	32.8
5th ,,	28.7	34.1	29.1	37.6	29.2	34.4	29.9	38.3	27.8	31.3	28.8	35.1
6th ,,	28.0	34.0	29.1	36.2	28.6	33.5	28.6	37.4	27.4	31.7	27.7	36.5

Table XV. Evolution of 1965 crop — Production data at weekly intervals

	Island	West	North	East	South	Centre
17th July						
Cane crushed (1000 m. tons)	253	36	—	77	135	5
Sugar manufactured % cane	10.13	10.51	—	10.24	9.94	10.75
Sugar manufactured (1000 m. tons)	25.6	3.8	—	7.9	13.4	0.5
24th July						
Cane crushed (1000 m. tons)	467	56	12	140	230	29
Sugar manufactured % cane	10.16	10.48	9.44	10.33	9.98	10.54
Sugar manufactured (1000 m. tons)	47.5	5.9	1.2	14.5	22.9	3.0
31st July						
Cane crushed (1000 m. tons)	717	75	62	202	313	65
Sugar manufactured % cane	10.29	10.65	9.94	10.56	10.02	10.64
Sugar manufactured (1000 m. tons)	73.8	8.0	6.2	21.4	31.3	6.9
7th August						
Cane crushed (1000 m. tons)	1,013	95	125	267	424	102
Sugar manufactured % cane	10.40	10.79	10.04	10.69	10.16	10.73
Sugar manufactured (1000 m. tons)	105.4	10.3	12.6	28.5	43.0	11.0
14th August						
Cane crushed (1000 m. tons)	1,319	116	205	330	526	142
Sugar manufactured % cane	10.50	10.90	10.18	10.79	10.27	10.82
Sugar manufactured (1000 m. tons)	138.5	12.6	20.9	35.6	54.0	15.4
21st August						
Cane crushed (1000 m. tons)	1,531	131	263	375	595	167
Sugar manufactured % cane	10.57	10.96	10.23	10.83	10.35	10.87
Sugar manufactured (1000 m. tons)	161.8	14.3	26.9	40.7	61.7	18.2
28th August						
Cane crushed (1000 m. tons)	1,814	152	326	442	694	200
Sugar manufactured % cane	10.61	11.02	10.28	10.92	10.40	10.90
Sugar manufactured (1000 m. tons)	192.5	16.7	33.6	48.2	72.2	21.8
4th September						
Cane crushed (1000 m. tons)	2,106	172	405	503	790	236
Sugar manufactured % cane	10.66	11.05	10.30	10.96	10.47	10.96
Sugar manufactured (1000 m. tons)	224.5	19.0	41.8	55.1	82.7	25.9
11th September						
Cane crushed (1000 m. tons)	2,406	192	484	567	886	277
Sugar manufactured % cane	10.72	11.08	10.34	11.00	10.57	11.04
Sugar manufactured (1000 m. tons)	258.0	21.3	50.0	62.4	93.7	30.6
18th September						
Cane crushed (1000 m. tons)	2,712	213	562	632	985	320
Sugar manufactured % cane	10.78	11.14	10.40	11.10	10.62	11.16
Sugar manufactured (1000 m. tons)	292.5	237.0	58.5	70.1	104.6	35.6
25th September						
Cane crushed (1000 m. tons)	3,016	234	642	694	1,084	362
Sugar manufactured % cane	10.87	11.22	10.45	11.16	10.72	11.27
Sugar manufactured (1000 m. tons)	328.0	26.2	67.7	77.5	116.6	40.8
2nd October						
Cane crushed (1000 m. tons)	3,283	247	720	750	1,168	398
Sugar manufactured % cane	10.93	11.25	10.50	11.20	10.79	11.36
Sugar manufactured (1000 m. tons)	358.7	27.8	75.6	84.0	126.0	45.3
9th October						
Cane crushed (1000 m. tons)	3,571	266	798	808	1,259	440
Sugar manufactured % cane	10.97	11.29	10.54	11.22	10.85	11.42
Sugar manufactured (1000 m. tons)	391.7	30.1	84.1	90.7	136.6	50.2
16th October						
Cane crushed (1000 m. tons)	3,858	287	876	869	1,347	479
Sugar manufactured % cane	11.00	11.33	10.57	11.27	10.88	11.49
Sugar manufactured (1000 m. tons)	424.7	32.5	92.6	97.9	146.6	55.1
23rd October						
Cane crushed (1000 m. tons)	4,096	304	939	914	1,426	513
Sugar manufactured % cane	11.03	11.35	10.62	11.28	10.91	11.53
Sugar manufactured (1000 m. tons)	451.9	34.5	99.7	103.0	155.6	59.1
30th October						
Cane crushed (1000 m. tons)	4,383	323	1,014	974	1,518	554
Sugar manufactured % cane	11.05	11.39	10.65	11.28	10.95	11.54
Sugar manufactured (1000 m. tons)	484.5	36.8	108.0	109.8	166.0	63.9
6th November						
Cane crushed (1000 m. tons)	4,566	336	1,063	1,013	1,574	580
Sugar manufactured % cane	11.08	11.41	10.68	11.30	10.97	11.57
Sugar manufactured (1000 m. tons)	506.0	38.4	113.5	114.4	172.7	67.0
13th November						
Cane crushed (1000 m. tons)	4,822	356	1,132	1,061	1,656	617
Sugar manufactured % cane	11.09	11.45	10.71	11.28	10.98	11.59
Sugar manufactured (1000 m. tons)	535.0	408.0	121.2	119.7	181.8	71.5
20th November						
Cane crushed (1000 m. tons)	5,087	375	1,206	1,117	1,734	655
Sugar manufactured % cane	11.10	11.47	10.76	11.25	10.98	11.61
Sugar manufactured (1000 m. tons)	564.8	43.0	129.8	125.6	190.4	76.0
27th November						
Cane crushed (1000 m. tons)	5,340	394	1,280	1,170	1,803	693
Sugar manufactured % cane	11.10	11.48	10.77	11.25	10.98	11.61
Sugar manufactured (1000 m. tons)	593.5	45.3	138.0	131.8	198.0	80.4
4th December						
Cane crushed (1000 m. tons)	5,583	413	1,353	1,223	1,863	731
Sugar manufactured % cane	11.10	11.49	10.77	11.21	11.00	11.60
Sugar manufactured (1000 m. tons)	620.0	47.5	145.7	137.2	204.9	84.7
11th December						
Cane crushed (1000 m. tons)	5,791	432	1,412	1,271	1,909	767
Sugar manufactured % cane	11.09	11.49	10.81	11.20	10.98	11.60
Sugar manufactured (1000 m. tons)	643.0	49.7	152.7	142.3	209.5	88.8
18th December						
Cane crushed (1000 m. tons)	5,944	452	1,455	1,314	1,935	788
Sugar manufactured % cane	11.09	11.49	10.81	11.17	10.98	11.60
Sugar manufactured (1000 m. tons)	659.6	51.9	157.3	146.7	212.3	91.4
Total crop production (preliminary figs.)						
Cane crushed (1000 m. tons)	5,984	468	1,461	1,333	1,935	788
Sugar manufactured % cane	11.10	11.50	10.82	11.16	10.98	11.60
Sugar manufactured (1000 m. tons)	664.5	53.8	158.1	148.7	212.5	91.4

Table XVI. Evolution of cane quality during 1965 sugar crop

Week Ending	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
17th July	11.95	10.28	12.12	10.75	—	—	12.08	10.40	11.81	10.07	12.40	10.75
24th „	11.85	10.20	12.25	10.65	11.48	9.44	12.02	10.42	11.65	10.01	11.96	10.54
31st „	11.96	10.44	12.50	11.16	11.81	10.08	12.11	10.79	11.72	10.15	12.20	10.68
7th August	12.17	10.64	12.58	11.31	11.77	10.09	12.36	11.13	12.05	10.47	12.51	10.88
14th „	12.30	10.82	12.73	11.42	11.96	10.40	12.46	11.21	12.24	10.69	12.68	11.08
21st „	12.20	10.81	12.79	11.41	11.76	10.34	12.43	11.22	12.18	10.74	12.51	11.03
28th „	12.31	10.96	12.84	11.43	11.85	10.51	12.54	11.32	12.28	10.89	12.47	11.06
4th September	12.32	10.96	12.71	11.23	11.81	10.42	12.49	11.24	12.38	11.01	12.78	11.41
11th „	12.53	11.19	12.87	11.39	11.90	10.56	12.77	11.54	12.62	11.28	12.97	11.53
18th „	12.79	11.38	13.20	11.70	12.04	10.65	12.91	11.70	13.03	11.45	13.29	11.84
25th „	12.85	11.52	13.53	12.03	12.23	10.87	13.02	11.81	12.85	11.49	13.45	12.16
2nd October	12.69	11.39	13.22	11.74	12.21	10.82	12.73	11.53	12.75	11.41	13.36	12.11
9th „	12.83	11.48	13.30	11.76	12.36	10.97	12.85	11.63	12.85	11.46	13.45	12.14
16th „	12.77	11.45	13.31	11.84	12.44	11.01	12.66	11.58	12.77	11.38	13.32	12.06
23rd „	12.83	11.48	13.22	11.75	12.57	11.07	12.63	11.52	12.83	11.50	13.30	12.03
30th „	12.75	11.41	13.53	11.99	12.64	11.18	12.37	11.34	12.70	11.29	13.19	11.95
6th November	12.68	11.42	13.45	12.01	12.67	11.23	12.29	11.26	12.56	11.32	13.23	11.99
13th „	12.75	11.38	13.68	12.11	12.77	11.28	12.15	10.97	12.67	11.23	13.21	11.92
20th „	12.58	11.25	13.24	11.73	12.67	11.18	12.15	10.91	12.55	11.16	13.09	11.80
27th „	12.65	11.22	13.46	11.76	12.71	11.20	11.94	10.77	12.62	11.16	13.08	11.76
4th December	12.45	10.99	13.52	11.78	12.52	11.01	11.86	10.61	12.30	10.75	12.77	11.43
11th „	12.53	10.95	13.40	11.49	12.84	11.26	11.98	10.54	12.38	10.68	12.46	11.08
18th „	12.65	11.05	13.38	11.48	12.89	11.19	12.03	10.45	12.40	10.97	12.80	12.04

NOTE A = Sucrose % cane

B = Sugar manufactured % cane

Table XVII. Duration of harvest in days (A) and weekly crushing rates of factories in 1000 metric tons (B) in different sectors of the island, 1948 - 1965

YEARS	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
1948	132	167.6	140	7.3	122	42.1	136	33.6	140	60.0	125	24.6
1949	133	176.5	142	7.7	128	44.0	129	37.0	140	62.4	127	25.4
1950	141	184.6	130	10.1	140	47.9	145	35.1	144	65.0	135	26.5
1951	154	197.8	150	10.3	169	52.0	159	40.3	140	65.8	132	29.4
1952	149	192.4	151	9.9	149	50.5	155	40.2	154	63.4	131	28.4
1953	158	205.7	162	11.8	167	57.7	161	42.5	153	66.0	145	27.7
1954	140	214.1	142	11.7	137	60.5	138	42.9	147	68.7	134	30.3
1955	133	222.6	134	12.8	122	64.2	140	41.5	140	71.6	127	32.5
1956	136	227.3	129	12.7	137	62.7	138	43.4	138	76.2	128	32.3
1957	128	237.5	144	13.3	104	68.2	133	42.9	141	78.6	129	34.5
1958	131	232.2	131	13.7	109	68.2	142	42.9	142	76.4	135	30.9
1959	134	248.4	127	15.5	106	71.8	152	46.7	148	79.4	136	35.1
1960	113	148.3	110	10.5	116	43.9	123	29.5	118	46.2	81	18.2
1961	150	230.2	147	13.6	126	66.2	160	44.6	165	72.2	154	33.6
1962	140	231.4	158	12.9	136	66.9	159	42.2	141	78.8	111	30.6
1963	153	263.3	160	16.3	132	75.4	174	50.6	156	86.0	154	34.9
1964	121	252.9	119	19.5	115	72.1	127	51.3	130	76.2	107	33.7
1965	156	268.7	178	18.3	145	70.5	164	56.7	155	87.4	154	35.7

Table XVIII. Summary of chemical control data 1965

(i) CANE CRUSHED AND SUGAR PRODUCED

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
CRUSHING PERIOD	From	2/7	16/7	29/7	23/7	23/7	30/7	6/8	16/7	3/7	2/7	23/7	5/7	5/7	5/7	9/7	7/7	14/7	18/7	8/7	2/7	14/7	17/7	20/7	—
	To	24/12	14/12	6/12	17/12	18/12	23/12	16/12	14/12	22/12	23/12	16/12	9/12	17/12	4/12	23/11	20/11	16/12	9/12	14/12	20/12	14/12	18/12	16/12	—
	No. of crushing days	145	122	109	121	122	114	107	126	143	143	144	131	137	127	113	113	128	133	132	141	128	110	125	128
	No. of crushing hours per day	22.00	21.71	23.02	20.77	20.61	22.26	19.81	20.45	19.59	20.99	17.76	16.76	18.19	20.18	20.57	19.19	17.45	17.42	19.94	18.37	18.10	21.83	22.32	20.28
	Hours stoppage per day	1.17	0.69	0.46	0.57	0.84	0.76	0.98	0.55	0.50	0.23	0.45	0.22	1.00	0.73	0.96	0.35	0.18	0.45	0.94	2.12	0.68	0.63	0.93	0.72
	Overall time Efficiency	94.9	96.9	98.1	97.4	96.1	96.7	95.2	95.8	97.0	90.9	97.5	98.6	94.8	96.4	95.6	98.2	99.0	97.5	95.6	89.7	96.4	97.2	96.0	96.6
CANE CRUSHED (Metric Tons)	Factory	250,930	62,140	70,313	143,316	119,627	80,463	158,347	117,796	456,353	231,622	78,287	198,591	209,280	206,286	141,857	136,409	128,795	192,270	60,632	74,115	132,932	130,342	237,482	3,618,185
	Planters	216,829	172,080	139,410	64,868	173,439	172,064	104,858	151,528	262,516	112,797	68,227	33,548	43,300	68,715	60,311	23,860	1,919	174	90,059	118,683	91,926	77,494	117,703	2,366,308
	Total	467,759	234,220	209,723	208,184	293,066	252,527	263,205	269,324	718,869	344,419	146,514	232,139	252,580	275,001	202,168	160,269	130,714	192,444	150,691	192,798	224,858	207,836	355,185	5,984,493
	Factory % Total	53.6	26.5	33.5	68.8	40.8	31.9	60.2	43.7	63.5	67.3	53.4	85.5	82.9	75.0	70.2	85.1	98.5	99.9	40.2	38.4	59.1	62.7	66.3	60.5
	Per day	3,226	1,920	1,924	1,721	2,402	2,215	2,460	2,137	5,027	2,409	1,017	1,772	1,844	2,165	1,789	1,418	1,021	1,446	1,142	1,367	1,757	1,889	2,841	2,040
	Per hour actual crushing	146.6	88.4	83.6	82.8	116.5	99.5	124.2	103.0	251.7	114.7	57.3	107.5	101.3	106.6	87.0	75.7	58.5	83.0	57.2	74.4	96.8	86.5	127.3	100.6
VARIETIES CRUSHED (Factory)	M.134/32 per cent	6.4	2.2	8.2	1.0	22.6	—	13.7	—	0.4	0.7	—	0.3	3.2	12.4	—	—	5.2	12.9	4.0	16.3	2.1	—	0.1	4.4
	M.147/44 per cent	34.1	35.6	56.3	44.2	51.5	66.0	70.2	62.5	23.5	41.1	35.5	47.6	38.0	22.0	2.4	17.9	19.9	21.7	38.5	39.1	21.2	0.4	8.4	31.9
	M.31/45 per cent	1.9	0.3	3.8	8.1	1.4	2.6	1.4	4.4	5.7	9.9	3.2	1.5	4.0	3.0	1.4	1.3	6.1	5.5	6.0	3.2	1.2	—	—	3.6
	M.202/46 per cent	14.2	35.4	12.9	14.0	4.9	5.0	0.5	17.8	14.3	9.2	12.9	7.9	8.0	11.0	17.7	5.7	11.8	11.8	8.2	9.5	12.3	2.1	4.3	10.7
	M.93/48 per cent	1.0	3.1	2.8	8.7	2.5	0.8	3.2	0.2	17.0	6.3	7.4	6.0	5.0	9.3	31.6	34.6	6.9	9.8	6.0	2.9	16.4	11.6	28.2	11.0
	M.253/48 per cent	9.0	5.4	0.9	2.1	1.7	0.2	—	1.1	2.4	2.6	1.9	1.9	1.9	2.0	0.5	—	1.4	1.5	3.2	0.2	4.4	0.9	0.8	2.2
	Ebène 1/37 per cent	—	—	0.7	4.0	0.4	—	0.2	1.2	14.9	9.4	3.4	5.6	12.5	10.7	24.1	20.7	2.9	9.1	7.0	0.9	20.0	20.1	40.7	11.0
	Ebène 50/47 per cent	1.6	1.3	1.1	5.0	1.7	—	1.1	2.6	4.5	2.7	2.9	2.8	5.2	4.5	2.9	1.6	6.4	12.0	4.1	3.5	9.0	54.1	11.9	6.3
	B.3337 per cent	—	—	—	0.1	—	—	—	—	8.5	1.2	4.8	12.1	—	2.3	19.3	14.8	0.5	3.8	0.5	0.7	6.5	3.1	2.8	4.1
	B.37172 per cent	11.7	16.0	6.9	11.0	9.7	24.5	8.7	9.6	4.6	14.5	9.1	13.0	10.5	17.3	0.1	—	37.4	10.9	16.0	17.8	2.8	—	—	9.9
	B.34104 per cent	15.4	—	3.4	1.0	1.1	—	—	—	—	1.1	11.0	0.9	4.6	0.5	—	—	0.4	—	6.0	0.5	2.3	—	—	2.1
	Other varieties per cent	4.7	0.7	3.0	0.8	2.5	0.9	1.0	0.6	4.2	1.3	7.9	0.4	7.1	5.0	—	3.4	1.1	1.0	0.5	5.4	1.8	7.7	2.8	2.8
SUGAR PRODUCED (Metric Tons)	Raw Sugar	53,800	24,962	22,736	22,695	32,736	18,086	28,907	28,524	83,360	36,795	4,882	25,687	29,526	31,962	22,983	17,808	5,528	20,978	16,032	19,943	24,860	25,407	41,200	639,397
	White Sugar	—	—	—	—	—	8,052	—	—	—	—	9,196	—	—	—	—	—	8,156	—	—	—	—	—	—	25,404
	Total Sugar	53,800	24,962	22,736	22,695	32,736	26,138	28,907	28,524	83,360	36,795	14,078	25,687	29,526	31,962	22,983	17,808	13,684	20,978	16,032	19,943	24,860	25,407	41,200	664,801
	Tons Sugar at 96° Pol.	55,210	25,656	23,365	23,307	33,609	26,926	29,696	29,280	84,836	37,872	14,548	26,406	30,366	32,881	23,618	18,313	14,195	21,292	16,481	20,496	25,559	26,132	42,350	682,394

Table XVIII. Summary of chemical control data 1965

(ii) CANE, BAGASSE, AND JUICES

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
CANE/SUGAR RATIO	Tons cane per ton sugar made	8.7	9.4	9.2	9.2	9.0	9.7	9.1	9.4	8.6	9.4	10.4	9.0	8.6	8.6	8.8	9.0	9.5	9.2	10.6	9.7	9.0	8.2	8.6	9.0
	„ „ „ „ „ of 96° Pol.	8.5	9.1	9.0	8.9	8.7	9.4	8.9	9.2	8.5	9.1	10.1	8.8	8.3	8.4	8.6	8.8	9.2	9.0	10.9	9.4	8.8	8.0	8.4	8.8
	Sucrose per cent	13.06	12.~~81~~ 28	12.09	12.16	12.60	12.17	12.36	12.01	12.64	12.16	11.35	12.26	13.08	12.95	12.67	12.37	12.38	12.14	12.06	12.09	12.32	13.64	12.96	12.50
	Fibre per cent	13.64	13.25	13.85	12.93	14.16	14.95	14.08	14.19	11.93	13.15	14.49	13.38	12.86	12.73	11.48	11.79	13.06	11.16	13.69	13.85	11.81	11.23	11.04	12.92
BAGASSE	Pol. per cent	2.35	2.13	1.70	1.77	1.85	2.20	1.89	1.75	1.74	1.70	1.89	1.62	2.16	2.07	1.97	2.11	2.35	1.80	1.87	1.78	1.85	1.92	1.93	1.93
	Moisture per cent	49.30	48.96	48.16	47.10	47.53	50.28	48.14	45.80	50.10	47.10	49.40	49.06	49.21	48.70	51.09	49.10	46.23	49.62	48.20	49.20	50.32	50.10	48.98	48.85
	Fibre per cent	47.49	48.19	49.46	50.49	50.03	46.73	49.26	51.69	47.50	50.58	47.90	48.75	48.04	48.70	46.37	48.21	50.74	47.98	49.29	48.30	47.22	47.50	48.51	48.56
	Weight per cent cane	28.7	27.5	28.0	25.6	28.3	32.0	28.6	27.5	25.1	26.0	30.3	27.4	26.8	26.2	24.8	24.5	25.7	23.3	27.8	28.7	25.0	23.6	22.8	26.6
1st EXPRESSED JUICE	Brix (B_1)	18.50	17.79	17.60	17.04	18.12	18.26	17.47	17.39	17.34	17.35	16.41	17.33	18.17	17.67	17.13	17.03	17.30	16.63	16.37	16.34	17.15	17.81	17.26	17.37
	Gravity Purity	89.2	89.0	89.1	90.4	90.8	89.3	89.6	88.7	89.9	89.6	87.5	89.5	90.5	90.2	90.1	91.3	90.1	90.7	89.4	89.4	90.5	91.5	90.2	89.8
	Reducing sugar/sucrose ratio	3.0	2.9	3.3	3.6	2.4	4.3	3.2	4.0	2.8	2.6	4.1	2.9	2.1	2.0	2.3	3.4	2.3	3.1	2.7	3.0	2.4	2.9	2.4	2.9
LAST EXPRESSED JUICE	Brix	3.35	3.30	2.30	1.58	3.51	3.53	2.64	2.70	3.73	2.72	2.84	2.83	4.11	3.06	3.09	3.11	3.69	2.17	3.26	2.38	2.59	3.10	2.76	2.93
	Apparent Purity	73.2	74.5	71.5	73.6	75.8	73.1	72.6	70.4	72.9	73.2	71.1	74.5	78.8	77.8	77.3	78.5	77.5	75.2	74.5	72.4	75.2	76.1	76.8	74.6
MIXED JUICE	Brix	14.31	13.78	13.34	13.02	12.96	13.70	12.99	13.55	13.80	12.63	12.13	12.78	13.93	13.49	13.41	12.94	13.07	12.53	13.02	12.09	13.21	14.63	13.98	13.38
	Gravity Purity	88.1	86.6	86.6	87.6	88.4	87.0	88.1	86.5	88.4	87.9	86.0	87.7	88.4	88.6	88.4	88.7	88.3	87.9	87.4	87.2	88.6	89.8	88.7	88.0
	Reducing sugar/sucrose ratio	3.4	3.7	4.1	4.5	3.1	5.3	3.8	5.3	3.5	3.1	4.6	3.9	2.5	2.7	3.1	4.1	3.0	4.0	3.3	3.7	2.8	2.9	2.9	3.6
	Gty. Pty. drop from 1st expressed juice	1.1	2.4	2.5	2.8	2.4	2.3	1.5	2.2	1.5	1.7	1.5	1.8	2.1	1.6	1.7	2.6	1.8	2.8	2.0	2.2	1.9	1.7	1.5	1.8
ABSOLUTE JUICE	Brix (B_A)	17.35	16.47	16.34	16.06	16.70	16.63	16.49	16.34	16.35	16.06	15.59	16.25	17.08	16.85	16.28	15.90	16.22	15.64	16.10	16.23	15.88	17.20	16.50	16.44
	B_A/B_1	0.938	0.926	0.929	0.942	0.922	0.911	0.944	0.940	0.943	0.930	0.950	0.937	0.940	0.953	0.950	0.934	0.938	0.939	0.980	0.993	0.926	0.966	0.956	0.946
	Gravity Purity	87.2	86.0	85.9	87.0	87.9	86.0	87.3	85.7	87.8	87.2	85.1	87.1	87.9	88.0	88.0	88.2	87.8	87.4	86.8	86.4	88.0	89.3	88.3	87.3
CLARIFIED JUICE	Brix	14.27	13.78	12.87	12.90	12.96	13.10	12.46	12.96	14.08	12.47	11.97	12.53	13.20	13.59	12.40	13.26	13.23	12.51	13.04	12.41	13.25	14.90	13.58	13.12
	Gravity Purity	—	87.9	87.3	88.1	89.1	86.9	—	86.6	88.1	88.0	85.9	89.0	89.1	88.9	—	90.2	88.0	—	87.9	87.6	89.1	90.3	89.0	88.3
	Reducing Sugar/sucrose ratio	3.6	3.5	4.5	4.6	3.2	5.0	—	4.7	3.2	3.0	4.5	3.1	2.4	2.6	3.2	4.3	2.8	—	3.0	3.4	2.8	3.4	2.8	3.5

Table XVIII. Summary of chemical control data 1965

(iii) FILTER CAKE, SYRUP, pH, FINAL MOLASSES, SUGAR

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
FILTER CAKE	Sucrose per cent	0.36	1.29	1.57	2.01	0.65	1.18	1.13	1.80	0.56	1.50	0.97	0.58	1.82	1.03	2.33	1.78	1.36	1.00	7.83	6.30	7.60	2.16	2.07	2.13
	Weight per cent cane	2.5	2.8	3.9	3.0	3.5	4.8	3.4	2.5	3.1	2.9	2.9	4.7	4.2	1.9	2.6	2.8	2.5	2.2	1.8	2.3	1.8	2.0	3.7	2.9
SYRUP	Brix	59.1	51.6	52.0	60.1	57.2	57.9	54.6	57.4	62.5	52.9	57.7	61.3	58.3	58.9	66.8	63.1	55.7	58.7	52.9	51.2	56.0	58.7	62.9	57.7
	Gravity Purity	—	86.4	86.6	88.2	89.0	86.9	—	86.8	87.5	88.2	85.8	88.9	89.0	88.8	—	89.5	87.5	—	87.9	87.0	88.7	89.8	89.1	88.0
	Reducing sugar/sucrose ratio	4.0	3.6	4.4	4.4	3.3	4.8	—	4.8	3.5	2.5	4.5	3.1	2.8	1.4	2.9	4.5	—	—	2.7	3.2	3.1	3.5	3.1	3.1
pH VALUES	Limed juice	7.5	—	8.4	8.1	—	8.1	—	8.3	8.3	8.0	—	8.0	7.9	7.8	7.7	7.8	8.3	7.9	—	7.9	8.3	7.8	7.6	8.0
	Clarified juice	7.0	7.0	7.2	7.0	7.2	7.3	7.1	6.9	7.2	7.0	7.1	7.2	7.2	7.1	7.0	7.0	6.8	7.2	6.8	7.1	7.3	7.0	7.0	7.1
	Filter Press juice	—	—	9.1	—	7.2	8.3	7.6	6.7	8.6	7.7	—	8.9	7.0	7.2	7.5	—	—	6.6	—	—	6.7	—	8.0	7.7
	Syrup	—	—	6.7	6.4	6.7	6.9	—	6.8	6.9	6.8	7.0	7.0	6.7	7.0	—	7.1	6.0	6.7	—	7.2	7.0	7.0	6.9	6.8
FINAL MOLASSES	Brix	90.1	89.9	90.7	89.6	89.1	88.2	89.0	87.8	88.4	89.2	86.2	89.2	89.0	90.6	91.5	88.0	87.1	89.4	89.2	88.5	84.2	86.8	89.1	88.8
	Sucrose per cent	36.64	34.67	31.31	33.10	34.48	33.40	33.85	31.21	34.80	34.54	32.07	33.83	31.70	33.39	34.93	33.20	37.45	35.62	33.90	35.33	32.97	34.26	35.65	33.99
	Reducing sugar per cent	17.00	13.70	17.20	15.00	12.00	12.88	14.79	18.17	10.90	13.79	15.78	11.14	14.32	11.80	13.87	16.60	11.11	12.31	12.60	13.32	12.86	14.71	13.39	13.78
	Total sugars	50.64	48.37	48.51	48.10	46.48	46.28	48.64	49.38	45.70	48.33	47.85	44.97	46.02	45.19	48.80	49.80	48.56	47.93	46.50	48.65	45.83	48.97	49.04	47.77
	Gravity Purity	37.3	38.6	34.5	36.9	38.7	37.9	38.0	35.4	39.4	38.7	37.3	37.9	35.6	36.8	38.1	37.7	43.0	39.8	38.0	39.9	39.1	39.5	40.0	38.3
	Reducing sugar/sucrose ratio	50.5	39.5	54.9	45.3	34.8	38.6	43.7	58.2	31.3	39.9	49.2	32.9	45.2	35.3	39.7	50.0	29.7	34.4	37.1	37.7	39.0	42.9	37.6	40.5
	Weight per cent cane at 85° Brix	2.54	2.95	2.63	2.29	2.49	2.96	2.45	2.80	2.37	2.72	3.01	2.42	2.34	2.37	2.10	2.17	2.80	2.49	2.41	2.82	2.30	2.32	2.59	2.53
SUGAR MADE	White sugar recovered per cent cane	—	—	—	—	—	3.19	—	—	—	—	6.28	—	—	—	—	—	6.24	—	—	—	—	—	—	0.42
	Raw „ „ „ „ „	11.50	10.66	10.84	10.90	11.17	7.16	10.98	10.59	11.60	10.68	3.33	11.07	11.69	11.62	11.37	11.11	4.26	10.90	10.63	10.34	11.05	12.22	11.60	10.68
	Total „ „ „ „ „	11.50	10.66	10.84	10.90	11.17	10.35	10.98	10.59	11.60	10.68	9.61	11.07	11.69	11.62	11.37	11.11	10.50	10.90	10.63	10.34	11.05	12.22	11.60	11.11
	Average Pol. of sugars	98.52	98.67	98.66	98.60	98.56	98.90	98.62	98.74	97.70	98.81	99.20	98.69	98.73	98.76	98.65	98.72	99.34	98.71	98.69	98.66	98.70	98.74	98.68	98.58
	Total sucrose recovered per cent cane	11.33	10.52	10.69	10.75	11.01	10.24	10.83	10.45	11.32	10.35	9.53	10.92	11.54	11.48	11.21	10.97	10.42	10.76	10.49	10.20	10.91	12.07	11.45	11.40
	Moisture content of raw sugar per cent	0.22	0.30	0.28	0.39	0.42	0.48	0.42	0.31	0.49	0.32	0.37	0.36	0.33	0.22	0.33	0.34	0.47	0.35	0.27	0.39	0.39	0.42	0.34	0.36
	Dilution indicator	17.7	29.1	26.4	38.6	41.2	44.8	43.1	32.6	27.1	36.8	31.6	38.1	35.1	26.1	32.3	35.8	—	37.2	25.9	41.1	42.4	49.1	34.7	34.0

Table XVIII. Summary of chemical control data 1965

(iv) MASSECUITES

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
MAGMA	Apparent Purity	79.9	91.6	85.5	85.9	90.6	84.1	83.6	82.8	89.4	86.1	93.8	92.3	87.3	93.0	81.9	84.0	84.2	85.5	85.6	85.5	84.8	85.2	91.0	86.7
A—MASSECUITE	Brix	91.0	91.6	91.8	90.6	90.9	90.9	92.0	89.0	92.4	91.6	89.2	90.9	91.3	92.1	92.0	91.4	89.4	91.7	91.6	92.3	90.5	92.1	92.1	91.4
	Apparent Purity	85.4	86.7	85.4	85.4	86.7	83.5	81.4	82.0	81.2	84.2	86.2	89.9	88.9	83.1	88.8	86.1	88.3	88.1	84.9	83.7	85.3	87.8	85.6	84.9
	„ „ of A—Molasses	70.0	65.0	65.2	67.0	67.1	62.9	58.9	58.4	59.7	60.9	68.4	71.2	66.2	61.7	66.9	64.6	76.2	69.7	63.9	61.8	68.8	66.0	66.8	64.6
	Drop in Purity	15.4	21.7	20.2	18.4	19.6	20.6	22.5	23.6	21.5	23.3	17.8	18.7	22.7	21.4	21.9	21.5	12.0	18.4	21.0	21.9	16.5	21.8	16.8	20.3
	Crystal per cent Brix in massecuite	51.3	62.0	58.0	55.8	59.6	55.5	54.7	56.7	53.3	59.6	56.3	64.9	67.2	55.8	28.0	60.7	50.6	60.7	58.1	74.3	52.9	64.1	49.4	57.3
	Cubic feet per ton Brix in Mixed Juice	27.8	26.4	25.9	24.3	23.3	36.7	34.5	29.6	31.8	29.1	31.0	27.9	24.3	32.2	29.9	26.6	33.2	28.0	25.8	28.7	26.6	23.7	33.9	29.0
	A—Massecuite per cent total massecuite	54.3	56.0	56.4	54.0	57.1	64.6	62.5	59.9	71.0	58.8	46.8	56.0	53.4	62.3	55.9	55.4	48.3	52.1	50.9	58.0	61.1	55.4	67.5	59.0
B—MASSECUITE	Brix	91.9	91.8	91.5	92.7	91.9	92.6	92.1	91.0	92.7	92.0	89.3	91.3	92.1	92.8	92.7	92.0	89.4	92.9	91.2	94.1	91.6	91.9	93.1	92.0
	Apparent Purity	74.5	74.2	71.8	75.6	74.5	72.6	71.6	72.6	71.3	73.0	76.9	79.3	74.4	74.1	76.5	73.9	80.6	77.6	75.4	74.0	77.3	76.7	75.3	74.8
	„ „ of B—Molasses	55.4	52.7	47.6	52.6	54.1	50.4	50.7	50.0	54.0	48.4	66.9	56.6	48.6	53.9	50.7	50.7	67.7	57.7	52.1	53.4	56.2	52.1	55.1	53.8
	Drop in Purity	19.1	21.5	24.2	23.0	20.4	22.2	20.9	22.6	17.3	24.6	10.0	22.7	25.8	20.2	25.8	23.2	12.8	19.9	23.3	20.6	21.1	24.6	20.2	21.0
	Crystal per cent Brix in massecuite	42.8	45.4	46.2	48.5	44.4	44.8	42.3	45.2	37.6	47.7	30.2	52.3	50.2	43.8	52.3	47.1	39.7	47.0	48.6	59.0	48.2	51.4	45.0	45.5
	Cubic feet per ton Brix in Mixed Juice	14.5	9.7	12.1	13.2	9.0	9.7	12.3	10.4	6.8	10.2	18.9	11.1	13.0	11.3	14.1	13.4	20.5	16.5	15.0	12.0	10.2	11.0	9.2	11.5
	B—Massecuite per cent total Massecuite	28.3	20.6	26.3	29.2	22.1	17.1	22.3	25.1	15.2	20.7	28.5	22.5	28.6	21.9	26.4	28.0	29.7	30.8	29.7	24.2	23.4	25.7	18.4	23.3
	Kg. Sugar per cubic foot of A & B Massecuite	19.4	21.9	21.3	21.8	25.3	16.9	17.9	19.9	21.7	20.4	15.4	21.0	21.9	19.0	18.9	20.8	14.6	18.3	19.6	19.2	22.5	24.0	19.0	20.1
C—MASSECUITE	Brix	93.6	93.6	93.5	94.1	94.7	96.1	93.4	94.0	94.1	93.9	93.2	94.6	94.2	96.4	95.4	94.0	92.7	95.3	93.3	94.5	93.4	93.4	97.9	94.4
	Apparent Purity	59.5	60.4	55.3	59.2	60.6	59.2	57.2	56.0	58.7	59.0	62.8	62.1	60.0	58.7	59.7	59.9	68.0	62.3	61.4	59.1	59.6	63.7	60.7	60.0
	„ „ of final Molasses	33.5	35.2	27.9	34.5	36.4	36.6	35.9	29.8	36.0	34.6	33.7	35.0	32.1	32.6	34.6	37.7	39.4	36.5	34.9	36.6	35.9	34.9	37.8	34.9
	Drop in Purity	26.0	25.2	27.4	24.7	24.2	22.6	21.2	26.2	22.7	24.4	29.1	27.1	28.9	26.1	25.1	22.2	28.6	25.8	26.5	22.5	23.7	28.8	22.9	25.1
	Crystal per cent Brix in massecuite	39.1	38.9	38.0	37.7	38.1	35.6	33.2	37.3	35.5	37.3	43.9	41.6	41.1	38.7	38.4	35.6	47.2	40.6	40.7	35.5	37.0	44.2	36.8	38.6
	Cubic feet per ton Brix in Mixed Juice	8.9	11.1	8.0	7.6	8.5	10.4	8.4	7.4	6.2	10.1	16.3	10.7	8.2	8.1	9.5	8.0	15.2	9.2	9.7	8.8	6.8	8.1	7.1	8.7
	C—Massecuite per cent total massecuite	17.4	23.5	17.3	16.8	20.8	18.3	15.2	15.0	13.8	20.5	24.7	21.5	18.0	15.8	17.7	16.6	22.0	17.1	19.4	17.8	15.5	18.9	14.1	17.7
TOTAL	Cubic feet per ton Brix in Mixed Juice	51.1	47.1	46.0	45.1	40.8	56.8	55.1	47.4	44.8	49.4	66.2	49.8	45.5	51.7	53.5	48.0	68.9	53.7	50.6	49.4	43.5	42.8	50.2	49.3
MASSECUITE	„ „ „ „ sugar made	62.5	59.7	56.9	55.3	49.9	72.3	65.9	59.7	53.4	61.7	86.4	60.7	55.0	62.3	64.9	57.6	87.5	65.7	62.9	63.4	52.7	51.4	61.0	60.4

Table XVIII. Summary of chemical control data 1965

(v) MILLING WORK, SUCROSE LOSSES AND BALANCE RECOVERIES

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
MILLING WORK	Imbibition water % cane	27.0	25.4	28.6	28.3	33.6	28.2	31.9	25.8	25.1	31.6	33.5	32.8	28.3	30.0	27.5	27.7	27.8	29.6	29.1	38.5	26.4	24.0	23.7	28.4
	,, ,, % fibre	198	192	206	219	237	189	227	182	210	240	231	245	220	236	239	235	213	266	213	278	224	214	214	220
	Extraction ratio	38.1	35.9	28.5	28.7	29.3	38.7	31.0	28.2	29.3	27.7	34.5	27.1	34.4	33.0	33.4	35.6	37.1	30.9	31.5	30.3	31.8	29.6	30.6	31.7
	Mill extraction	94.8	95.2	96.1	96.3	95.9	94.2	95.6	96.0	96.5	96.4	95.0	96.4	95.6	95.8	96.2	95.8	95.2	96.6	95.7	95.8	96.2	96.7	96.6	95.9
	Reduced mill extraction	95.2	95.6	96.5	96.4	96.4	95.3	96.2	96.5	96.3	96.6	95.8	96.7	95.7	95.9	95.8	95.6	95.4	96.1	96.1	96.3	96.0	96.3	96.1	96.0
SUCROSE LOSSES	Sucrose lost in bagasse % cane	0.68	0.58	0.48	0.45	0.52	0.70	0.54	0.48	0.44	0.44	0.57	0.45	0.58	0.54	0.49	0.51	0.60	0.42	0.52	0.51	0.46	0.45	0.44	0.51
	,, ,, in filter cake % cane	0.01	0.04	0.06	0.06	0.02	0.06	0.04	0.04	0.02	0.04	0.03	0.03	0.08	0.02	0.06	0.05	0.03	0.03	0.14	0.15	0.13	0.04	0.08	0.06
	,, ,, in molasses % cane	0.85	1.02	0.82	0.76	0.86	0.99	0.83	0.87	0.82	0.94	0.96	0.82	0.74	0.79	0.73	0.72	1.05	0.88	0.82	1.00	0.76	0.79	0.92	0.86
	Undetermined losses % cane	0.19	0.12	0.04	0.14	0.19	0.18	0.13	0.17	0.04	0.19	0.28	0.05	0.14	0.12	0.18	0.12	0.28	0.05	0.09	0.23	0.06	0.29	0.07	0.12
	Industrial losses % cane	1.05	1.18	0.92	0.96	1.07	1.23	0.99	1.08	0.88	1.17	1.27	0.90	0.96	0.93	0.97	0.89	1.36	0.96	1.05	1.38	0.95	1.12	1.07	1.04
	Total losses % cane	1.73	1.77	1.40	1.41	1.59	1.93	1.53	1.56	1.32	1.61	1.84	1.34	1.54	1.47	1.46	1.40	1.96	1.38	1.57	1.89	1.41	1.57	1.51	1.55
SUCROSE BALANCE	Sucrose in bagasse % sucrose in cane	5.21	4.75	3.95	3.72	4.13	5.75	4.36	4.00	3.48	3.62	5.05	3.63	4.43	4.17	3.84	4.12	4.85	3.45	4.31	4.22	3.76	3.30	3.38	4.10
	,, ,, filter cake % sucrose in cane	0.08	0.33	0.51	0.49	0.18	0.49	0.31	0.33	0.14	0.33	0.25	0.22	0.61	0.15	0.47	0.40	0.28	0.22	1.16	1.24	1.09	0.29	0.59	0.49
	,, ,, molasses % sucrose in cane	6.51	8.31	6.80	6.25	6.80	8.13	6.69	7.24	6.53	7.73	8.51	6.67	5.66	6.10	5.76	5.83	8.47	7.12	6.79	8.27	6.16	5.79	7.13	6.87
	Undetermined losses % sucrose in cane	1.45	0.98	0.27	1.11	1.51	1.49	1.04	1.41	0.29	1.56	2.47	0.43	1.07	0.93	1.42	0.97	2.25	0.57	0.74	1.90	0.49	2.13	0.54	0.92
	Industrial losses % sucrose in cane	8.04	9.62	7.58	7.86	8.49	10.11	8.04	8.99	6.96	9.62	11.19	7.33	7.34	7.18	7.66	7.20	10.99	7.91	8.70	11.41	7.71	8.21	8.26	8.29
	Total losses % sucrose in cane	13.25	14.37	11.53	11.57	12.62	15.86	12.40	12.99	10.44	13.24	16.21	10.95	11.77	11.35	11.52	11.32	15.83	11.36	13.01	15.63	11.44	11.51	11.65	12.39
RECOVERIES	Boiling house recovery	91.5	89.9	92.1	91.9	91.2	89.3	91.6	90.7	92.8	90.1	88.5	92.4	92.3	92.5	92.5	92.5	88.5	91.5	90.9	88.1	92.0	91.5	91.5	91.4
	Reduced boiling house recovery (Pty. M. J. 85°)	88.9	88.5	91.0	89.8	88.2	87.4	89.0	89.4	90.3	87.1	87.5	90.4	89.7	89.0	89.3	89.6	84.6	88.9	88.8	86.2	88.8	86.8	88.2	88.8
	Overall recovery	86.8	85.6	88.5	88.4	87.4	84.1	87.6	87.0	89.6	86.8	84.0	89.0	88.2	88.6	88.5	88.7	84.2	88.6	86.9	84.4	88.5	88.5	88.4	87.6
	Reduced overall recovery (Pty. M.J. 85°, F % C 12.5)	84.6	84.5	87.8	86.6	85.0	83.3	85.6	86.3	87.0	84.1	83.8	87.4	85.8	85.3	85.5	85.7	80.7	85.4	85.3	83.0	85.2	83.6	84.7	85.3
	Boiling house efficiency	98.9	99.0	99.7	99.5	98.8	97.7	99.3	98.6	100.4	98.0	97.5	99.8	99.1	99.2	99.5	99.6	97.6	99.9	99.1	97.0	99.7	98.3	99.3	99.1

Table XIX. Production and utilisation of molasses, 1948 - 1965

Year	Production M. tons	Exports M. tons	Used for production of alcohol M. tons	Available as fertilizer M. tons	N.P.K. equivalent in molasses available as fertilizer M. tons		
					N	P_2O_5	K_2O
1948	85,308	—	42,640	42,768	222	107	2,198
1949	96,670	1,867	41,728	53,075	276	133	2,728
1950	98,496	79	25,754	72,643	378	182	3,734
1951	125,819	3,601	44,896	77,322	402	193	3,974
1952	113,756	40,537	29,878	43,339	225	108	2,228
1953	141,449	67,848	16,037	57,564	299	144	2,958
1954	120,495	89,912	8,300	22,383	116	56	1,145
1955	106,839	53,957	9,005	43,877	228	110	2,255
1956	118,716	52,694	8,661	57,361	298	143	2,948
1957	110,471	72,539	7,796	30,136	157	75	1,549
1958	113,811	59,158	8,435	46,218	240	116	2,376
1959	118,056	59,985	9,632	48,439	252	121	2,490
1960	72,991	45,180	8,871	18,940	98	47	970
1961	139,234	64,633	7,357	67,244	350	168	3,456
1962	122,890	76,800	7,750	38,340	199	96	1,955
1963	149,586	109,770	8,192	31,141(2)	162	78	1,588
1964	113,781	96,830	7,172	9,333(2)	46	23	476
1965(1)	151,152	105,360	7,824	37,514(2)	195	94	1,913

(1) *Provisional figures*

(2) *In 1963, four hundred and eighty three tons, in 1964, four hundred and forty six tons, in 1965, four hundred and fifty four tons were used in the preparation of animal foodstuff, and have therefore been deducted from production figures*

Table XX. Importation of inorganic fertilizers, in metric tons, 1950 - 1965

YEAR	N	P_2O_5	K_2O
1950	3,990	870	1,930
1951	5,710	1,020	4,080
1952	5,800	1,140	2,960
1953	5,080	560	2,380
1954	4,170	1,110	3,340
1955	5,620	570	3,110
1956	8,870	2,170	3,940
1957	6,900	2,770	4,390
1958	6,210	3,020	4,690
1959	8,500	2,740	5,310
1960	8,170	4,382	5,765
1961	7,462	4,769	4,569
1962	9,467	5,377	6,373
1963	9,762	5,079	6,952
1964	10,095	5,698	8,838
1965	9,520	7,236	6,222

Table XXI. Sale of herbicides 1964 - 1965

HERBICIDES	1964			1965		
	Quantity		Sale in Rupees	Quantity		Sale in Rupees
	Imperial gallons	Kg.		Imperial gallons	Kg.	
MCPA — Metallic salt	9,859		130,558	9,072		137,277
2,4-D Amines	27,361		424,216	23,172		370,786
2,4-D and 2, 4, 5-T Esters	11,029		419,869	13,086		524,494
Pentachlorophenol	595		8,330	100		1,600
Sodium Chlorate		398,053	539,155		272,823	471,587
Sodium Trichloroacetate (TCA)		389,449	1,201,856		309,746	929,415
Sodium 2,2-dichloro-propionate (Dalapon, Basfapon, Unipon)		6,670	76,740		2,261	21,867
Substituted Ureas DCMU		35,312	1,283,353		38,922	1,414,562
Substituted Triazines						
Simazine		15,097	243,444		9,338	168,559
Atrazine		22,507	395,941		33,305	678,189
Unclassified	602	425	34,384	661	544	35,533
			4,757,846			4,753,869

Table XXII. Importation of Major Herbicides, 1955 - 1965

YEAR	Inorganic Chemicals		Hormone type		Aliphatic acid Derivatives		Substituted phenols	Substituted Ureas	Substituted Triazines	
	Sodium Chlorate Kg.	Sodium Arsenite Kg.	2,4-D; 2,4,5-T MCPA Imp. Gall.	2,4-D; 2,4,5-T MCPA Kg.	T C A Kg.	Dalapon Kg.	P. C. P. Imp. Gall.	D.C.M.U. Kg.	Simazine Kg.	Atrazine Kg.
1955	81,494	—	49,706	5,600	254,300	—	3,448	—	—	—
1956	92,780	124	48,333	6,125	181,700	—	3,460	—	—	—
1957	107,961	80	36,142	645	163,278	—	1,824	—	—	—
1958	128,835	4,000	43,150	565	167,096	—	3,528	—	—	—
1959	173,383	—	60,261	72	264,389	—	1,534	—	—	—
1960	304,851	7,050	76,629	—	377,063	400	2,641	12,500	568	—
1961	214,301	6,000	59,272	—	363,716	9,553	1,403	30,000	1,812	—
1962	272,937	8,000	54,507	—	335,595	21,933	1,010	38,279	21,432	—
1963	276,502	—	45,825	—	339,981	5,070	969	39,915	26,833	2,377
1964	398,053	—	48,249	—	389,449	6,670	595	35,312	15,097	22,507
1965	272,823	—	45,330	—	309,746	2,261	100	38,922	9,338	33,305

XXIII. List of crosses(*1*) made in 1965 and sown in November

Parental Combinations		No. of Tassels	No. of seedlings potted
B.41227	x 51NG 140	4	0
58 B 38	x M.220/56	2	0
CP 36-105	x D.109	2	0
Mapou Perlée	x 28 NG 101	2	2
,, ,,	x Sdlg. (Chalain x 57 NG 208) ...	2	16
,, ,,	x Sdlg. (M.109/26 x 57 NG 208) ...	2	20
,, ,,	x US 48-34	4	5
M.134/32	x D.109	2	1
M.204/40	x S.S. Passoeroean	1	13
M.241/40	x Mol. 5904	3	2810
,,	x S.S. Kloet	2	54
,,	x S.S. Mandalay	2	240
,,	x S.S. Tabongo	2	0
M.377/41	x 51 NG 140	5	2
,,	x Sdlg (Chalain x 57 NG 208) ...	2	0
M.112/42	x S.S. Mandalay	2	60
,,	x Sdlg. (Chalain x 57 NG 208) ...	4	0
57 NG 208	selfed	1	2
P.O.J. 2364	x 57 NG 208	1	0
Sdlg. (Chalain x 57 NG 208)	x 57 NG 208	1	36
	Total	46	3,261

1. This list excludes the majority of crosses made in 1965 and stored in deep freeze

Table XXIV. Experimental crosses, 1965 — Study of inheritance to gumming disease

Cross		No. of Tassels	No. of seedlings potted
B.3337	x M.147/44	9	760
,,	x M.202/46	6	240
,,	x Ebène 50/47	3	2
Ebène 1/37	x Ebène 50/47	3	0
Ebène 50/47	x B.34104	2	2
M.134/32	x Ebène 50/47	9	2
,,	x M.147/44	11	98
M.202/46	x Ebène 50/47	3	9
,,	x M.147/44	5	210
M.202/46	selfed	4	4
	Total	55	1327

Table XXV. List of Approved Cane Varieties, 1966

M.134/32

M.134/32 white

M.134/32 striped

*M.112/34

*M.423/41

**M.147/44

M.31/45

M.202/46

M.93/48

***M.99/48

M.253/48

M.442/51

Ebène 1/37

Ebène 50/47

*B.H.10/12

**B.3337

**B.34104

B.37161

B.37172

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* *To be uprooted before 31st December, 1969*

** *To be uprooted before 31st December, 1970*

*** *Recommended for release, 12th February 1965*