MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE

ANNUAL REPORT 1967

Mauritius Sugar Industry Research Institute

ANNUAL REPORT 1967

Printed by
CLAUDE MARRIER d'UNIENVILLE
The Mauritius Printing Cy. Ltd.
37, Sir William Newton Street
Port Louis—Mauritius
1968

CONTENTS

STATISTICAL TABLES

* *Cover photograph : Sugar crystals from C-massecuite washed in saturated sucrose solution to remove mother liquor and dried in volatile hydrocarbon solvent × 140 (Crystals prepared by S. Marie-Jeanne, photograph by L. S. de Réland).*

MEMBERS EXECUTIVE BOARD

Mr. Jean Espitalier-Noël, *Chairman, representing the Chamber of Agriculture*

Mr. M. D. ffrench-Mullen, C.B.E., *representing Government, January to November*

Dr. A. Darné, *representing Government, December*

Mr. L. H. Garthwaite
Mr. F. North Coombes — *representing factory owners*
Mr. Y. Rouillard

Mr. L. Desvaux de Marigny, *representing large planters*

Mr. S. Gaya — *representing small planters*
Mr. S. Bunjun

MEMBERS RESEARCH ADVISORY COMMITTEE

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

Mr. M. D. ffrench-Mullen, C.B.E., *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 — *representing the Société de Technologie Agricole et Sucrière*
Mr. René Noël

and the senior staff of the Research Institute.

STAFF LIST (as at 31st December 1967)

Director	P. O. Wiehe, C.B.E., D.Sc. (Lond.), A.R.C.S.
Chief Agriculturist	G. Rouillard, Dip. Agr. (Maur.)
Senior Field Officers	G. Mazery, Dip. Agr. (Maur.)
	F. Mayer, Dip. Agr. (Maur.)
	M. Hardy, Dip. Agr. (Maur.), *i/c Réduit Expt. Stn & Irrigation.*
	R. Béchet, Dip. Agr. (Maur.), *i/c Belle Rive Expt. Stn*
Field Officers	R. Ng Ying Sheung, Dip. Agr. (Maur.), *i/c Union Park Expt. Stn*
	L. Thatcher, Dip. Agr. (Maur.), *i/c Pamplemousses Expt. Stn*
	G. Mc. Intyre, Dip. Agr. (Maur.)
Consulting Agronomist ...	P. Halais, Dip. Agr. (Maur.)
Chemist	Y. Wong You Cheong, Ph.D. (Q.U.B.), A.R.I.C.
Asst. Chemists	L. Ross, Dip. Agr. (Maur.)
	P. Y. Chan, B.Sc. (Lond.)
	L. C. Figon
Laboratory Assistants ...	C. Cavalot
	H. Maurice
Chief Entomologist	J. R. Williams, M.Sc. (Bristol), D.I.C., M.I. Biol.
Laboratory Assistant	M. A. Rajabalee
Chief Plant Pathologist ...	R. Antoine, B.Sc. (Lond.), A.R.C.S., Dip. Agr. Sc. (Cantab.), Dip. Agr. (Maur.), *i/c Plant Breeding & Pathology Divisions.*
Plant Pathologist	C. Ricaud, Ph.D. (Lond.), D.I.C.
Laboratory Assistant	S. Sullivan
Plant Breeder	L. P. Noël, Dip. Agr. (Maur.)
Biometrician	J. A. Lalouette, Dip. Agr. (Maur.)
Associate Plant Breeder ...	P. R. Hermelin, Dip. Agr. (Maur.)
Assistant Plant Breeder ...	H. R. Julien, B.Sc. (Reading).
Field Assistant	S. de Villecourt
Plant Physiologist	C. Mongelard, M.Sc. (Lond.), D.I.C., M.I. Biol.
Laboratory Assistant	J. Pitchen
Chief Sugar Technologist ...	J. D. de R. de Saint Antoine, B.S. (L.S.U.), Dip. Agr. (Maur.)
Chemist	E. C. Vignes, M.Sc. (Lond.), A.R.I.C., Dip. Agr. (Maur.)
Associate Sugar Technologist ...	E. Piat, B.Sc. (Glasgow), Dip. Agr. (Maur.)
Instrument Engineer	F. Le Guen, M.Sc. (Lond.), D.N.C.L.
Senior Asst. Sug. Technologist ...	M. Randabel, Dip. Agr. (Maur.)
Assistant Sugar Technologist ...	S. Marie-Jeanne, Dip. Agr. (Maur.)
Laboratory Assistants ...	L. Le Guen
	M. Abel
Temporary Sugar Technologist ...	A. Bérenger

Secretary Accountant ...	... P. G. du Mée
Asst. Secretary Accountant	... J. Desjardins
Librarian	... Miss M. Ly-Tio-Fane, B.A. (Lond.)
Draughtsman-Photographer	... L. S. de Réland, Grad. N.Y.I.P.
Clerks	... Mrs. A. Baissac
	Mrs. M. T. Rae
	Mrs. J. R. Williams
	Mrs. M. Le Guen

THE MAURITIUS HERBARIUM

Curator	... R. E. Vaughan, O.B.E., D.Sc. (Lond.), F.R.I.C.
Herbarium Assistant ...	... J. Guého

REPORT OF THE CHAIRMAN

EXECUTIVE BOARD 1967

LAST year the first lines of my report were congratulations for Mr. D. ffrench-Mullen on his appointment as a Commander of the Most Excellent Order of the British Empire. This time I wish to express our regrets at Mr. ffrench-Mullen's departure, as he has resigned from Government service, and to place on record our appreciation of the invaluable services he has rendered to the Institute, and in particular to the Board, on which he has served since 1961.

The changes on the Board for 1967 were the replacement of Messrs. R. de Chazal and Hamid Lallmahomed by Messrs. Yves Rouillard and S. Bunjun, and also that of Mr. ffrench-Mullen by Dr. A. Darné for the last two meetings.

The Board held 15 meetings during the year, two of which jointly with the Research Advisory Committee.

ESTABLISHMENT

For the first time in many years there were no resignations and consequently no new appointments during the year.

The Board has much pleasure in congratulating Mr. Y. Wong You Cheong who has been awarded a Ph.D. by the Faculty of Agriculture, Queen's University, Belfast, and Mr. F. Le Guen who has been granted an M.Sc., by the Faculty of Technology, University of Manchester, and made an Associate of the Institute of Science and Technology of the same University in Chemical Engineering.

FINANCE

In my previous report, I laid stress on the inadequate income which the Institute derives from the statutory levy on sugar exports and the very serious consequences resulting from insufficient revenue.

On account of various unavoidable increases in expenditure which have taken place during the year under review, the Institute had once again to modify and restrain the programme of work which had been planned in order to balance its budget. It is in fact apparent from the published accounts that the financial position of the Institute has deteriorated by comparison with the preceeding year.

In order to improve the situation, the Board, after ca·eful consideration, has made a request to Government for altering the Ordinance governing the Institute and applying, as from 1968, the statutory levy to the total tonnage of sugar produced in any calendar year, instead of to the amount of sugar exported, as is the case at present. This would result in an immediate increase in revenue and would render less urgent the very real need for an increase in the cess itself.

I have every reason to believe that this request has been well received and I sincerely hope that it will meet with the approval of Government.

AIME DE SORNAY SCHOLARSHIP

The scholarship was awarded in 1967 to Mr. K. D. C. Ruhee who came out third, with 71% of the marks, at the entrance examinations of the University of Mauritius, in April.

Mr. M. Goolam Hossen, who had been awarded the scholarship jointly with Mr. G. Gallet in 1965, accepted a Government scholarship and, in accordance with the regulations of the College of Agriculture, relinquished the Aimé de Sornay scholarship.

GENERAL

Visit of Mr. Gavin Ross

Mr. Gavin Ross, of the Statistics Department, Rothamsted Experimental Station, spent two months, in March and April, mainly in the Plant Breeding and Biometry Sections of the Research Institute. The visit was arranged through the kind services of Mr. D. Rhind of the Ministry of Overseas Development. Mr. Ross has submitted a draft report on the statistical problems he has studied. The report, which is now being finalised, should prove of great value in breeding and selection work. I should like to express my gratitude to Mr. Rhind and also to Dr. F. Yates for permission to second Mr. Ross for the visit.

University of Mauritius

After discussions with the Registrar of the University, it was agreed that the Senior Staff of the Institute would be responsible for all the lectures connected with sugar and sugar cane, and the conditions under which these lectures would be given were also established.

Trade Union Agreement

An agreement governing the wages and conditions of service of workers over the next three years was signed with the Plantation Workers' Union represented by the Hon. S. Jagdambi.

Burmese Agronomists

At the request of the Burmese Government, the Institute accommodated two Burmese agronomists to study methods of experimentation in sugar cane. Messrs. Saw Win Kyi and Tin Myint spent four months at the Institute working in the various divisions.

PERSONALIA

During 1967, the Institute had the pleasure of welcoming some distinguished visitors : Mr. Alfred Morris and Mr. John Farr, members of the House of Commons; Professor R. Chaminade of the *Centre National de la Recherche Agronomique*, an international authority on plant nutrition; and Mr. M. Delmas, Director, *Centre de Recherches Agronomiques du Sud-Ouest*, Bordeaux. The Institute also had the pleasure of entertaining the Hon. V. Ringadoo, Minister of Agriculture and Natural Resources, and Mr. A. Beejadhur, Governor of the Bank of Mauritius, who visited the various divisions and showed a keen interest in the work carried out.

ACKNOWLEDGEMENTS

I wish to record my grateful thanks to my colleagues of the Executive Board, to our Director and his Staff for their co-operation, help, and support throughout the year. I am especially indebted to Mr. Robert Antoine for his valuable assistance during the four-month period when he replaced the Director.

Chairman

20th February 1968

REVENUE AND EXPENDITURE ACCOUNT

YEAR ENDED 31st DECEMBER, 1967

Running & Administrative Expenses	...	1,899,001.76	Cess on Sugar Exported ...	...	1,805,167.90
Herbarium Expenses ...	...	6,466.25	Miscellaneous Receipts ...	...	69,418.71
Interest Paid	...	42,737.77	Excess of Expenditure over Revenue		326,038.22
Leave and Missions Fund ...	...	125,000.—			
Depreciation	...	127,419.05			
	Rs.	2,200,624.83		Rs.	2,200,624.83

BALANCE SHEET

AS AT 31st DECEMBER, 1967

ACCUMULATED FUNDS ...	...	1,126,058.70	FIXED ASSETS (at cost less Depreciation and Amounts written off)		
REVENUE FUNDS ...	...	106,885.82	Land & Buildings ...	1,357,788.51	
			Equipment	42,722.90	
AIMÉ DE SORNAY FOUNDATION ...		25,000.—	Agricultural Machinery and Vehicles	32,184.—	
					1,432,695.41
GOVERNMENT OF MAURITIUS (Purchase of Buildings) ...	...	89,403.65			
			CURRENT ASSETS		
SUNDRY CREDITORS ...	...	10,038.67	Sundry Debtors	118,979.61	
			Aimé de Sornay Foundation Account	25,000.—	
BANK OVERDRAFT ...	...	255,539.20	Cash at Banks & in hand ...	36,251.02	
					180,230.63
	Rs.	1,612,926.04		Rs.	1,612,926.04

(sd) JEAN ESPITALIER-NOEL } *Board Members*
(sd) L. H. GARTHWAITE }
(sd) P. O. WIEHE *Director*

AUDITORS' REPORT

We have examined the Books and Accounts of the Institute for the year ended 31st December 1967, 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 1967, according to the best of our information and the explanations given to us and as shown by the Books and Accounts of the Institute.

(sd) J. G. BOUIC, A.C.A.

DE CHAZAL DU MÉE & Co.

Chartered Accountants

Port Louis,
Mauritius,
16th February, 1968.

INTRODUCTION

THE 1967 SUGAR CROP

As a background to the research activities of the M.S.I.R.I., it has been customary to review briefly conditions under which the sugar crop, in any current year, has been realised. The same procedure is followed for 1967 which has unfortunately proved to be unfavourable to sugar production in many respects.

At the current rate of progress in sugar yield per acre, which is of the order of 1.5% per annum, production in 1967 should have been around 720,000 metric tons, instead of which 638,000 tons were produced. Negative influences have exerted themselves in the form of a moderately severe cyclone in January, shortfall of rain in February and May, and extremely unfavourable conditions for maturation throughout the harvest period from July to November. In addition, cane supply to factories was below average, while an added number of public holidays further slowed down harvesting progress.

In this connection, the following figures are of interest :

(a) effect of 6 additional public holidays on sugar production – 5400 tons sugar ;

(b) effect of crushing 19 hrs/day instead of 20 in 1966 = – 4500 tons sugar.

If factories had operated 23 hours per day and 6 days per week – a normal target –, sugar production in 1967 would have been 660,000 tons, leaving a debit balance of approximately 60,000 tons to adverse climatic factors.

The poor quality of the cane in 1967, particularly in the northern sector, is being ascribed in some quarters to new varieties. Admittedly sucrose content of the cane is not at the peak it attained in 1956 and 1957, and there has been a gradual decrease in sugar recovered % cane from 12.2% to an average of about 11.6% at present.

However, an analysis of factors at play, published in the *Climate and Cultivation* section of this report, shows conclusively the determining influence of climate on cane quality.

It should also be stressed that average sugar yields per arpent have steadily increased in spite of the fact that the additional acreage brought under cultivation in recent years is located mainly in an environment of lower intrinsic potential.

The more important data concerning the 1967 campaign are given below in comparison with the 1966 results:

	1967	*1966*
Area cultivated, arpents	204,000	206,000
Area harvested, ,,		
Estates	100,506	100,990
Planters	91,228	94,746
Total	191,734	195,736
Weight of canes, metric tons	5,814,468	4,842,915
Tons cane per arpent :		
Estates	35.3	29.5
Planters	24.9	19.7
Average, Island ...	30.3	24.7
Commercial sugar recovered % cane	10.98*	11.60**

* Equivalent to 9.1 tons of cane per ton of sugar.

** Equivalent to 8.6 tons of cane per ton of sugar.

	1967	1966
Tons sugar per arpent		
Estates	3.88	3.42
Planters	2.73	2.28
Island	3.33	2.87
Duration of harvest, days	168	139
Tons cane per hour ...	101.9	97.3
Tons cane crushed weekly	242,600	244,400
Sucrose % cane ...	12.46	13.20
Fibre % cane... ...	13.13	13.46
Molasses % cane ...	2.66	2.75
Filter cake % cane ...	3.09	3.37
Purity mixed juice ...	87.5	87.7
Reduced mill extraction	96.1	96.1
Pol % bagasse ...	1.89	2.05
Reduced boiling house recovery	88.5	88.4
Reduced overall recovery	85.0	85.0
Total sucrose losses % cane	1.62	1.73
Tons sugar 98.8 pol metric tons ...	638,300	561,800
Rainfall deficit Nov.-June (av. 15″)	11.1	23.7
Rainfall excesses July-Nov. (av. 2.5″)	10.8	0.0

Essential information concerning climatic factors, cane and sugar yields, sucrose content and varietal replacement is shown in figs 1-8.

THE CANE VARIETY SITUATION

In considering the present situation of commercial cane varieties in Mauritius, three main factors have to be borne in mind :

(i) the long ratooning cycle;

(ii) the recent outbreak of gumming disease;

(iii) the steady flow of more productive varieties released in recent years.

Because of the first factor, varietal changes are relatively slow since only 12% of the cultivated area is replanted annually. Concerning the second, it is evident that the outbreak of gummosis in 1964 has hastened varietal replacement (*cf.* fig. 8). Finally, it may be useful to recapitulate the sequence of release of varieties since 1956, which is as follows:

1956 : M.147/44; M.31/45
1959 : M.202/46; M.93/48
1962 : M.253/48; Ebène 50/47
1964 : M.442/51
1965 : M.99/48
1966 : M.409/51; M.13/53; M.13/56; N: Co. 376
1967 : M.377/56

Because of the factors outlined above, considerable changes have taken place in the composition of the sugar cane crop (*vide* Statistical Table XI). Thus during the last ten years, the area under M.134/32 has decreased from 55% to 3%, that under Ebène 1/37 has shrunk by 60%, while four Barbados varieties which occupied a peak of 23% of cultivated land in 1962 now account for 11% only. In 1964 M.147/44 reached its maximum (31%), precisely when gumming disease was first observed; its area is declining rapidly and it is probable that by 1970 there will be few plantations left. On the other hand, M.202/46 and M.93/48 have been considerably extended since 1963 and are responsible for a major contribution to the current crop as evidenced by their high yields (fig. 6). Similarly M.442/51 is fast reaching the status of an important commercial cane, although its extension beyond 20% of the cultivated area is unlikely because of its late maturity and its inadaptability to high rainfall areas.

Of the varieties released in 1966 and 1967, confirmation was obtained during the year of the high sugar potential of M.13/53, M.13/56 and M.377/56, the latter, in particular, showing a wide range of adaptation. M.409/51, on the other hand, requires exacting environmental conditions, while N:Co.376 is an excellent early maturing variety in regions of high rainfall. Although this is not a matter for complacency, it may be safely stated that the present varietal situation is far better than it was a few years ago : gumming - susceptible varieties are being rapidly replaced by resistant ones; at least three commercial canes (M.93/48, M.202/46, M.442/51) now occupying about 38%

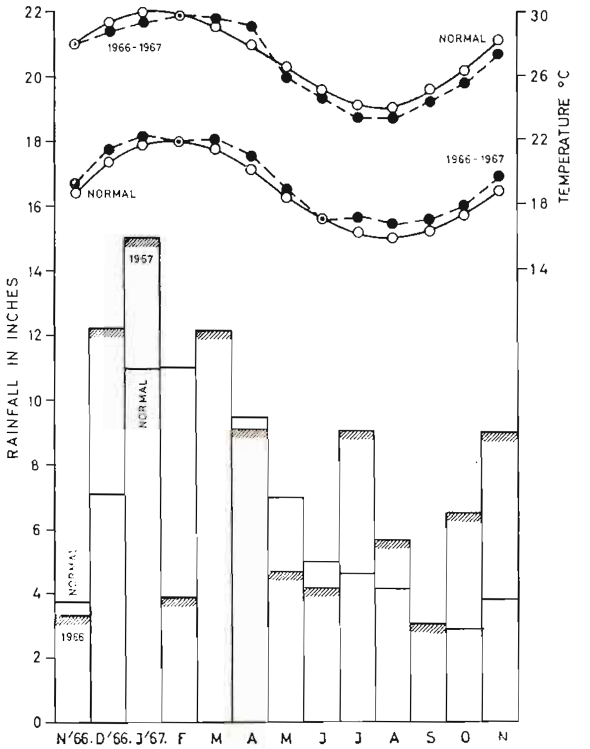


Fig. 1. Average rainfall, maximum and minimum temperatures over the cane area of Mauritius in 1967, compared to normal.

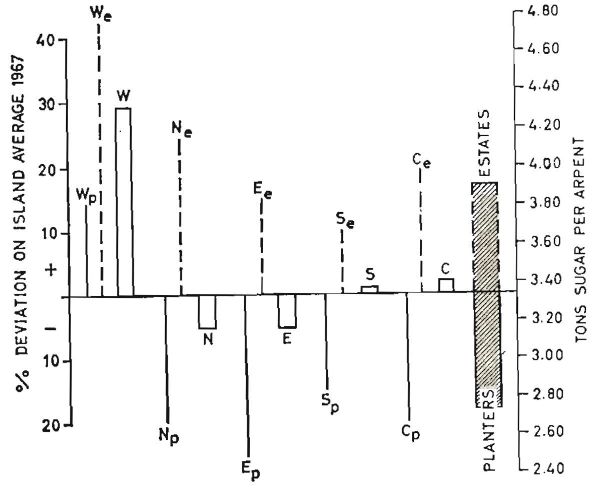


Fig. 2. Relative yields of sugar per arpent in different sectors. Average island yield 3.33 m. tons of 98.8 pol. sugar per arpent. Plain line : planters ; broken line : estates ; columns : sector average.

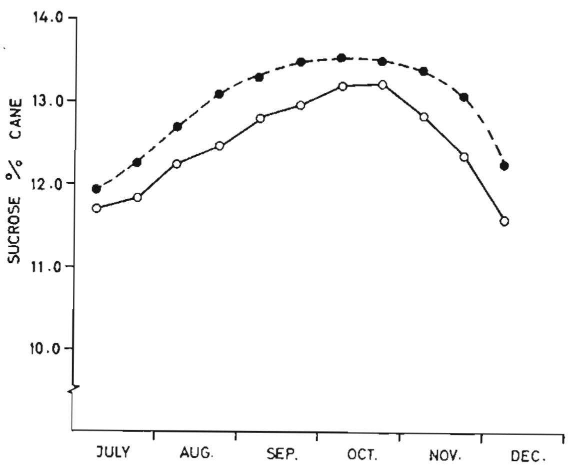


Fig. 3. Variation in sucrose % cane during the harvest season of 1967 (plain line) compared to the 1962-1966 average (broken line).

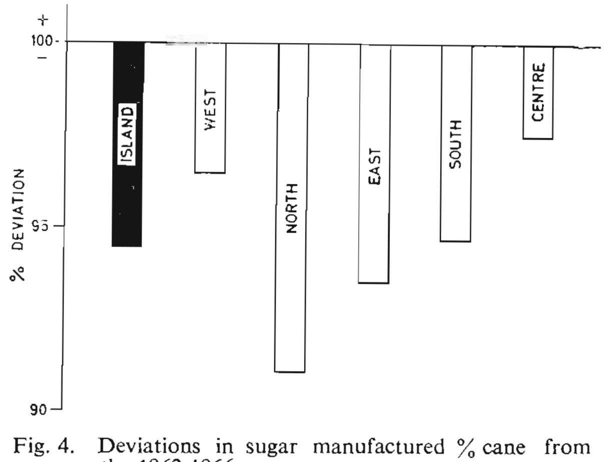


Fig. 4. Deviations in sugar manufactured % cane from the 1962-1966 average.

of the cultivated area have a high potential of production ; while varieties released in 1966 and 1967 cover the full range of environmental conditions under which sugar cane is grown in Mauritius.

In view of these satisfactory conditions, it is surprising to note that 15% of the 1967 plantations were made with unreleased varieties (*cf.* fig. 7). It should be stated once more in this connection that, in the research programme of the Institute a considerable amount of work is devoted to the production of new cane varieties, and no avenues of progress are left unexplored in the related studies. More than 20% of the financial resources of the Institute are devoted to this subject. Consequently, the large-scale cultivation of unproven varieties, which have not undergone the whole range of testing, does not serve the interests of the sugar industry.

Specific notes on the performance of newly released and promising varieties are given in the *Cane Breeding* section (pp. 43-45), but it is useful to summarize here the cane varietal situation as seen by the Institute at the end of 1967.

Environmental Conditions	*Varieties*	
	Proven	*Unreleased**
Sub-Humid	M.442/51 M.13/56 M.377/56	M.305/51 M.260/55 M.145/56 S.17
Humid and Irrigated	M.31/45 M.202/46 M.93/48 M.409/51 M.13/53 M.13/56 M.377/56 Ebène 50/47	M.428/51 M.356/53 M.260/55 M.144/56 CB.38/22 S.17
Hydromorphic Soils	M.99/48	
Super-Humid	M.202/46** M.93/48 M.377/56 N:Co.376	M.356/53 M.75/55 M.144/56 S.17

* All with high sucrose content.

** M.202/46 does not perform equally well over the whole of the super-humid zone ; it is also susceptible to leaf scald.

CANE BREEDING AND SELECTION

The handling of all data relevant to crossing and selection work by the newly created Biometry section has helped considerably to rationalize the whole experimental procedure. Thus, as mentioned in last year's annual report, the data assembled on punched cards have facilitated the choice of desirable parents. Also selection criteria were more critically defined and a complete analysis of results for the various stages of selection conducted. By means of a rapid analysis and proper presentation of data it has been possible to apply a selection pressure on sucrose content whenever cane yields were acceptable.

Mention should be made of the visit of Mr. Gavin Ross, of the Statistics Department of Rothamsted Experimental Station, who spent two months at the Institute at the beginning of the year to discuss the ways in which the various problems encountered in breeding and selection were being dealt with and to advise whenever necessary. His suggestions on various aspects of the experimental work have proved most helpful.

As a result of several factors, 1967 was a bad year for crossing. The main breeding plot at Réduit having been replanted in 1966, flowering was low. In addition, strong winds which prevailed during most of the crossing season proved detrimental to the viability of the flowers. Furthermore, a critical choice of parents contributed to reduce the number of attempted crosses. On the whole, 397 crosses were carried out, involving 125 combinations. A total of 99 different parents were used, comprising 40 clones as females, 62 as males, and 3 as both male and female. Crosses for breeding purposes numbered 46.

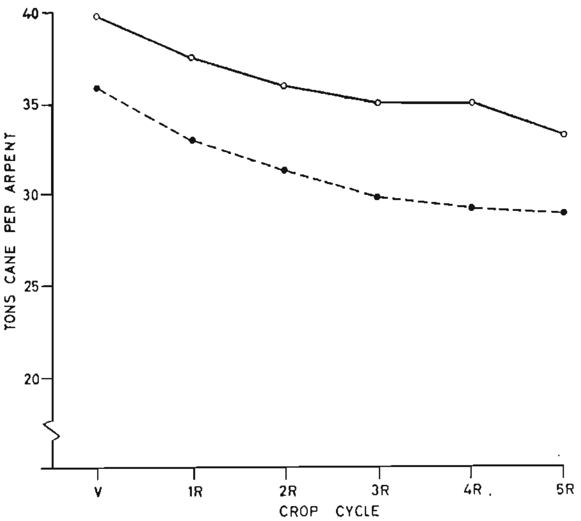


Fig. 5. Cane yields in virgins and ratoons in 1967 (plain line) compared to the 1962-1966 average (broken line).

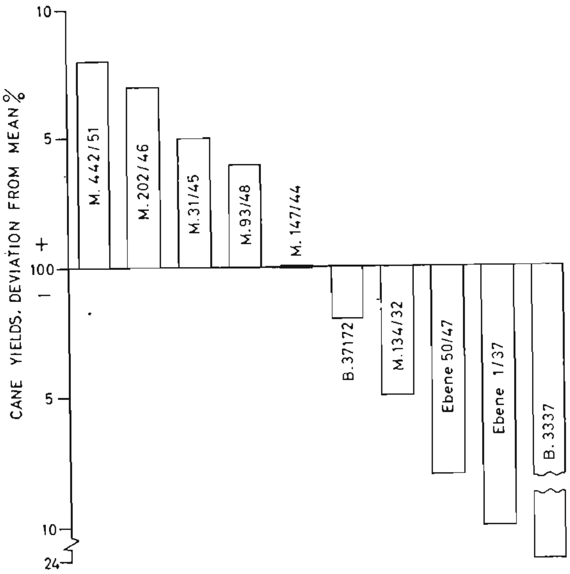


Fig. 6. Yields of different cane varieties on estates in 1967 in relation to the average (100 = 35.3 TCA). Varieties occupying less than 5% of the cultivated area have been excluded.

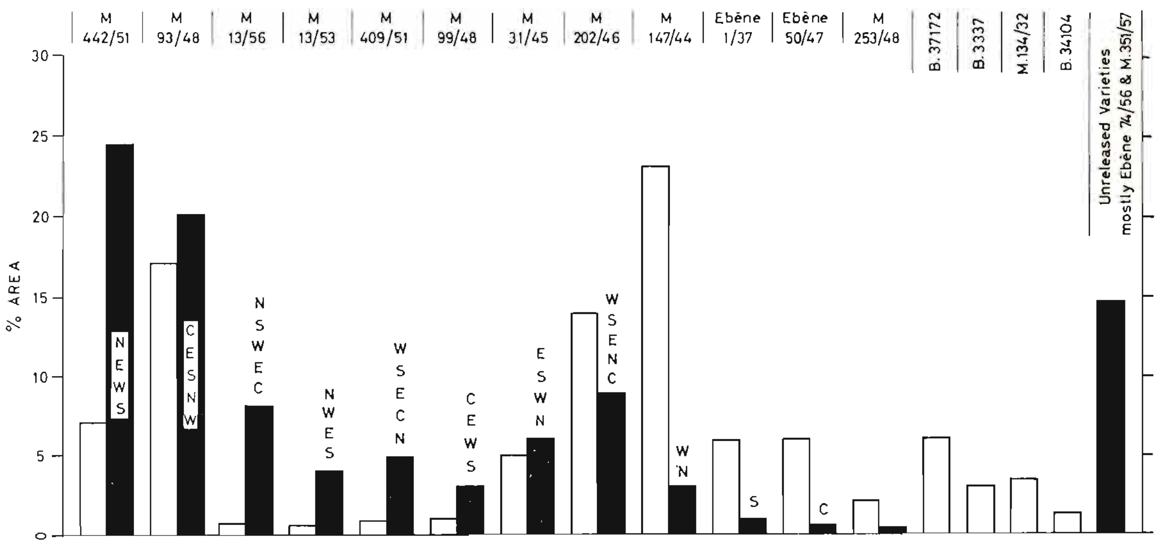


Fig. 7. Variety trend in 1967 as illustrated by area under cultivation (plain column) and area planted during the year (black column). Letters denote sectors arranged in descending order of magnitude of plantations.

Fuzz derived from crosses involving the same combination was grouped in the deep freeze together with those from the previous year. Fuzz derived from a group of at least 3 crosses per combination was sown early in Cctober, the balance being kept until bulked-up again for sowing the following year.

The poor germination experienced is attributed mainly to the bad conditions prevailing at crossing time which have affected adversely pollination and subsequent fertilization.

Selection, which started early in July in the Bunch Selection Plots, went on smoothly according to schedule. No selections were taken in First Selection Trials as such trials were, due to exceptional circumstances, selected in 1st ratoons instead of 2nd in 1966, and consequently all the trials standing in 1967 were in virgins or in 1st ratoons. The bulk of the selection work was conducted in the Propagation Plots in which more than 5,000 plots had to be brixed and weighed.

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

(a) Seedlings planted in March 1967 :

(i)	Commercial crosses	80,885
(ii)	Nobilization crosses	3,701

(b) Varieties in Bunch Selection Plots : (1964 series) ... 10,164

(c) Varieties in Propagation Plots : (1962-1964 series) ... 3,312

(d) Varieties in First Selection Trials : (1959-1962 series) ... 803

(e) Varieties in Multiplication Plots : Nil

(f) Varieties in Trials on estates 243

Investigations on the physiology of flowering. Experimental work conducted in 1966 having led to some interesting findings, further experiments were therefore laid down in 1967 to confirm these observations and investigate more fully some aspects of flowering. The main conclusions derived from these experiments are summarized here :

(i) Different varieties of sugar cane may require different conditions for induction of flowering. Thus, variety U.S.48-34 was induced to flower when given fifteen or more cycles of a daylength of 12 hours 43 mins, while variety N:Co.310 was not.

(ii) Observations on the differentiation of a vegetative apex to a floral primordium and subsequent development (various phases are illustrated in Plates I & II) showed that the change from vegetative to floral primordium in the variety U.S.48-34, appears to take place under Mauritius conditions around the 16th of February.

(iii) In a leaf cutting experiment it was observed that the lopping of old leaves on the stalk resulted in earlier emergence compared to control, whilst lopping of young leaves resulted in delay. There is an indication therefore that flowering may be controlled by a balance between flowering inhibitors and promoters.

(iv) Experimentation on the effect of light on flowering was continued, and it was shown that an interruption of the night with red light was the most inhibitive to flowering; other wavelengths were decreasingly inhibitive in the following order : white, red + far red, far red and blue. An interruption during the induction period of four hours during the night with white light from 5w bulb retarded flowering in variety U.S.48-34, light of higher intensities inhibited flowering altogether. It also appeared that light plays an important role in the post-initiation stage of flowering; thus, an interrruption of the night after initiation of the inflorescence resulted in reversion in the young primordium and consequently non-emergence of the flower; shorter and longer days than normal resulted in delay and some inhibition of flowering.

(v) Attempts to induce flowering artificially, by giving up to 90 cycles of the daylength of 12 hrs 43 mins to variety Senneville failed.

(vi) Finally, investigations on the use of chemicals to delay flowering showed that "Cycocel" applied to variety N:Co.376 during the post-initiation stage of flowering resulted in a slight but significant delay. On the other hand, maleic hydrazide applied after initiation at a concentration of 0.5% failed to delay flowering in variety U.S.48-34. Phosphon applied as a soil drench failed as well.

CANE DISEASES

Gumming Disease. Conditions at the beginning of the year were not propitious to the dissemination of the pathogen, or to the development of systemic infection. However, later in the season, ideal conditions prevailed, with the result that although the distribution of the disease in commercial plantations was on the whole fairly restricted, systemic infection was locally severe, particularly in cane growing in the dark magnesium clays under spray irrigation. Although the effect on M.147/44, as shown by leaf chlorosis following systemic infection, was the worst observed since the outbreak of the new epidemic, yet, once again, no cases of mortality were noticed in mature canes, confirming that the disease is not generally as damaging in the vigorous hybrids cultivated at present as it used to be in the "noble canes" during epiphytotics in the past.

Leaf striping, without systemic infection, was observed on the newly released variety M.377/56 in a few variety trials conducted by Estate Agronomists, but the reaction of this variety has not been consistent, as it is still showing high resistance in gumming trials, in

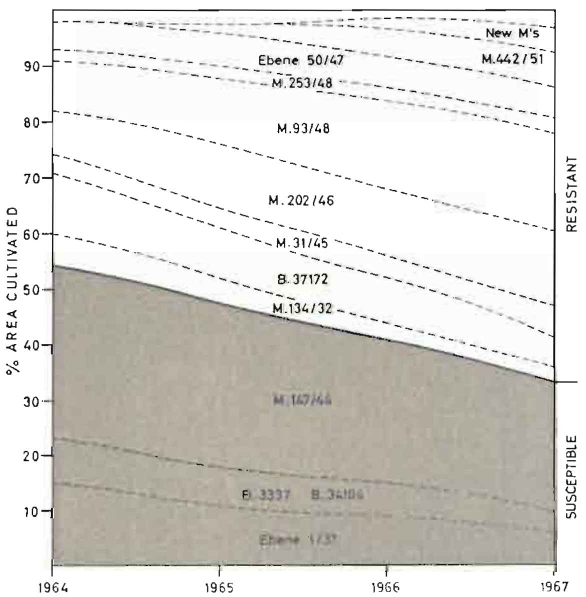


Fig. 8. Variety trend since the outbreak of gumming disease, susceptible varieties indicated by shaded area. Varieties are arranged in each group in order of their dates of release. New M's include 99/48, 409/51, 13/53, 13/56 and 377/56.

the majority of variety trials and in commercial plantations. This behaviour may indicate variability in the pathogenicity of the bacterium in different ecological areas or, more perturbing still, the presence of other strains of the organism differing in their degree of virulence. Studies on the problem are being continued.

Four resistance trials were conducted during the year, two involving the first testing after the Propagation Plot stage, with the new strain of the pathogen, and the other two involving the second testing of varieties from First Selection Trials with both old and new strains. All trials with the new strain had to be inoculated twice. Despite re-inoculation, the level of infection in one of the first-stage trials carried out in an area not very favourable to disease development was too low for a correct assessment of varietal reaction. In the other first-stage trial in which infection was heavy, out of 239 varieties, 14% showed high susceptibility and have been rejected, 31% were susceptible, 19% slightly susceptible, and 33% resistant. In the second-stage trials, 8 out of 42 varieties have shown high susceptibility. A new first-stage trial was established later in the year with 241 locally bred varieties and 58 imported ones.

The reactions of progenies from 4 different crosses involving combinations of resistant and susceptible parents were assessed. A wide variation in the percentage of resistant offsprings from different combinations was observed, being the lowest for the cross involving the two highly susceptible varieties B.3337 x M.147/44.

An experiment to study the effect of the disease on yield following systemic infection of young shoots at harvest was concluded. A highly significant reduction of 23.2% in sugar yield was observed, mainly due to a decrease in the number of millable stalks, through death of young tillers following knife inoculation.

Laboratory studies on the difference between old and new strains of the pathogen have shown that bacterial suspensions of the old strain have a higher viscosity than those of the new one.

Attention was again focussed on the bacterium causing a disease similar to gummosis on the broom bamboo (*Thysanolaena maxima*) which was heavily infected in 1967. Comparison of cultural characteristics of the pathogen with those of both old and new strains of the sugar cane gumming disease pathogen has again confirmed the inability of the former to hydrolyse starch, casein and gelatin, as opposed to both cane isolates.

Ratoon stunting disease. A new R.S.D. trial was established with 6 newly released varieties and 2 promising ones.

About 150 tons of cuttings were treated at the Central Hot-Water Treatment Plant to establish 40 arpents at the Central Nursery. The latter supplied 2,325 tons of planting material to planters during the year (2,715 in 1966) to establish 700 arpents of B nurseries. In addition, the Central Nursery supplied 900 tons to small and large planters for commercial plantations. One of the newly released varieties (M.13/56) appears to be vulnerable to the heat treatment, germination being rather seriously impaired.

Investigations were carried out on the possiblity of using single-bud setts instead of the usual 3-eyed ones in an attempt to reduce the treatment time and also to utilize treated planting material to a maximum. No difference between heat transmission inside one- and three-eyed cuttings was observed. Consequently, the time of treatment cannot be reduced and, furthermore, germination failures were higher in the case of one-eyed setts after treatment, probably through greater liability to invasion by the pineapple disease organism.

Other diseases. In spite of the climatic conditions which were unfavourable to the disease, a recrudescence of leaf scald, over the previous year, in commercial plantations of M.202/46, is attributed to less sustained vigilance in the rogueing of infected fields. The importance of rogueing, especially in nurseries and earlier ratoons of commercial plantations, is again stressed. The influence of climatic conditions on the distribution and development of the disease was again well illustrated this year. A heavily infected field under survey since 1966 has shown a considerable decrease in disease incidence. Also, infection failed to develop properly after inoculation in the resistance trial established last year ; the trial will have to be re-inoculated.

Chlorotic streak was severe, due to the wet season, affecting ratooning considerably in susceptible varieties in the high-rainfall area. Planters are again advised not to plant the highly susceptible M.442/51 in the wetter areas of the island. Experimentation on the transmission of the disease is continuing. The trial established in 1966 to study whether organic amendments could reduce the rate of re-infection has been ratooned. However, natural re-infection in the trial as a whole after harvest has so far been low.

Various experiments were carried out on the fungicidal control of pineapple disease. The rate of deterioration of mercurial fungicides in tanks during bulk treatment, after the short hot-water treatment against chlorotic streak, has been studied and it has been found that such treatment can be appreciably more expensive than the normal treatment in small containers at the planting site. Bulk treatment is thus not recommended unless the treatment plant is working at maximum capacity and large tonnages are handled daily.

A new fungicide combination, Hyamine + M.45, incorporated in the hot-water bath was tested on a laboratory scale.

On account of the rising price of mercury, the periodic screening of fungicides in the control of pineapple disease involved the testing of non-mercurial fungicides. Six such fungicides were compared to the standard organo-mercurial formulation at 4 concentrations. Two of the fungicides appear promising.

One of the problems of the super-humid zone is poor ratooning in certain varieties due partly to retarded re-growth after harvest during the cool season, and unspecific infection of buds and stumps. The effect of a fungicidal drench after harvest to promote ratooning was investigated. A slight beneficial effect was apparent with the fungicide Thiram as indicated by a greater number of germinating shoots. However, the early advantage was not reflected in the final yield.

Very few cases of *Fusarium* wilt were

observed during the year. A disease-control trial was established in a field which had shown severe infection; unfortunately, symptoms failed to develop in all plots. Plants derived from cuttings planted in infected soil in pots, as well as inoculated with pure cultures of the pathogen, failed to contract infection. Evidence is being accumulated indicating that infection by *F. moniliforme* follows a general weakening of the root system as a result of adverse soil conditions.

CANE PESTS

The breeding of *Diatraeophaga striatalis* Tns., the Javanese cane-borer parasite, was continued throughout the year at Pamplemousses Sugar Experiment Station. It left little time for other work on cane pests.

As recounted in last year's report, the object of breeding and releasing *Diatraeophaga* is to establish the parasite permanently in the island. If, on the other hand, the environment is adverse to this fly, so that it cannot be established or cannot flourish, then the releases should be of sufficient scope to demonstrate this.

Ten generations of the parasite were reared. The number of borers collected in the field and "inoculated" with the parasite's larvae was 88,861 and the number of adult parasites obtained therefrom was 37,512. The number of adults released was 23,894, including 12,974 females that had mated before release. Since this work began in February 1966, the totals up to December 1967 are 19 generations reared; 144,442 borers collected and inoculated; 64,811 adult parasites obtained and 46,061 adults released, the last figure including 22,716 mated females (fig. 9). It is proposed to continue breeding and releasing the parasite until the middle of 1968.

A few attempts were made in June and November to recover the parasite in the field in the vicinity of liberation sites. Five borers out of several hundred collected at Le Vallon for this purpose proved to be parasitized. However, releases at that site had been stopped only some weeks before and further attempts at recovery of the parasite in the field are needed before conclusions as to its establishment can be drawn.

Various data on the biology of *Diatraeophaga*, obtained during laboratory studies, are given in the body of this report.

Infestations of thrips, *Fulmekiola serrata*, on young cane, particularly young virgin cane of the variety M.442/51, were again conspicuous during the year, as they have been for several years. The insect, living in colonies in the rolled spindle leaves, scarifies the leaf epidermis and this injury, when severe, results in the leaves drying out along part of their length, particularly after they have unrolled. Less severe injury results in chlorotic patches in the form of streaks along the leaves, and this is more common in ratoon shoots. It seems possible that varietal susceptibility has resulted in greater thrips population than in former years, and it is intended to investigate the effect of thrips damage on cane growth in order to assess whether control measures would be justified.

Experimentation on the scale insect, *Aulacaspis tegalensis*, which remains troublesome at the Central Cane Nursery at Pointe-aux-Sables, could not be pursued during the year, but the East African Station of the Commonwealth Institute of Biological Control was

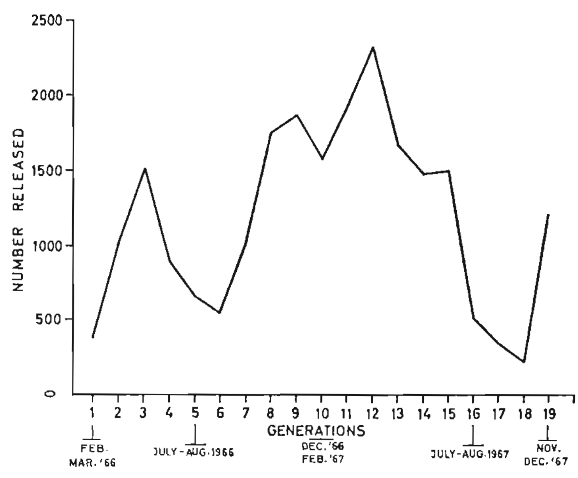


Fig. 9. Release of mated females of *Diatraeophaga striatalis* from March 1966 to December 1967.

requested to study its natural enemies in East and Central Africa with a view to introducing into Mauritius any species that seem promising.

A shipment of *Tytthus mundulus*, a predator of the eggs of *Perkinsiella saccharicida* and other leafhoppers, was made to South Africa in August at the request of the South African Sugar Experiment Station. The insect was required for tests against *Numicia viridis*. It may be recalled that *Tytthus* was purposely introduced into Mauritius in 1956-57 against cane leafhoppers, particularly *Perkinsiella saccharicida*, and it is worth recording that field observations over the years since then have shown the insect to be common, and often abundant, in the presence of leafhoppers on both sugar cane and maize. It has undoubtedly become a useful predator.

Soil samples taken intermittently over the last three years around sugar cane roots over the whole cane-growing area have revealed the presence of five, and possibly six, species of *Xiphinema*, all of which are root feeders. Thirty-five per cent of 89 samples contained one species or another, but two species, *X. ensiculiferum* and *X. elongatum*, were the commonest. The distribution of these two species was found to be distinct and closely correlated with environment : the former was recovered only from the Humic Ferruginous Latosols and Latosolic Brown Forest soils characteristic of the high rainfall area (> 100″ approx.), while the latter, although very widespread, was absent from that particular area. A third species seems to occur only in sandy soil.

NUTRITION AND SOILS

Nitrogen. The interest shown in other countries on the use of "slow release" nitrogen fertilizers has prompted the Institute to assess the value of such fertilizers under conditions where leaching of the nitrate ion may present a problem. However, the first results obtained from three trials have shown no response to nitrogen application, but the trials were carried out with virgin canes and first ratoons which generally give a poor response to nitrogen. It is hoped that some indication on the value of this fertilizer will be obtained during the next crop.

The relative efficacy of the ammonium and nitrate ions, particularly in respect of calcium ammonium nitrate fertilizer, are being compared in lysimeter studies. Information will thus be obtained on the leaching of nitrate ions in the presence of sugar cane roots and under different intensities of rainfall.

Phosphorus. The most significant trend in recent years is the increasing use of water-soluble phosphate fertilizers (fig. 10). These fertilizers have always been shown to be superior to water-insoluble phosphate fertilizers, especially in soils of higher pHs, in spite of the fact that there is rapid precipitation of the phosphate from solution in the soils of Mauritius. Precipitation from solution does not necessarily mean that the phosphate is rendered unavailable to the plant as there is evidence to show that "fixed" phosphate can be absorbed.

The effect of different soil constituents on the retention of phosphate by the soil has been

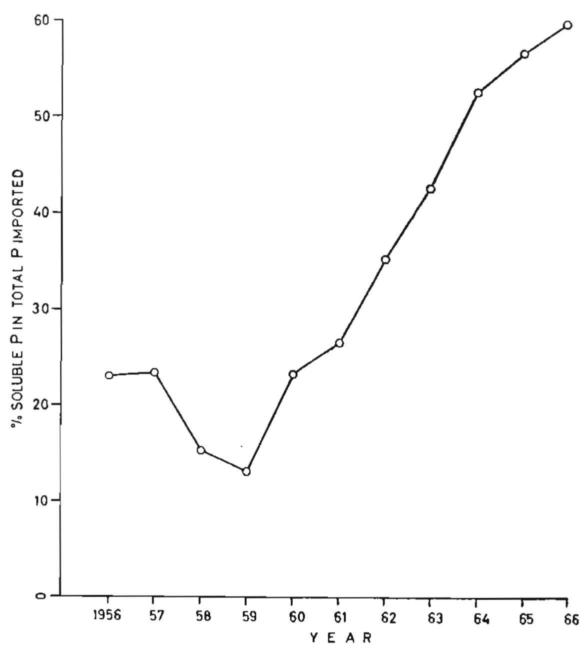


Fig. 10. Trend in the utilisation of soluble phosphate fertilizers.

studied. Results indicate the predominant influence of iron oxide in soils occurring in dry areas (Latosolic Reddish Prairie, Low Humic Latosol) and extractable aluminium in soils occurring in wetter areas (Humic Latosols, Humic Ferruginous Latosols, Latosolic Brown Forest). Other soil constituents, such as organic matter and clay contents, play a lesser role.

Indices of soil-available phosphate, such as exchangeable phosphate and labile phosphate which require the use of radioactive phosphate, and also phosphate potential were investigated. Although their use in non-basalt soils has met with some success in other countries, results obtained in Mauritius are conclusive in showing that these indices have limited value in basalt soils and are, in fact, inferior to indices of soil-available phosphate obtained by conventional extractants.

Field trials were continued on the effect of leaf spraying of phosphate on the ripening of sugar cane. Again, the timing of the spraying with regard to the age of the cane was shown to be an important factor as it could influence the sucrose level one way or the other. In view of the complex relationship between the different factors involved, no definite conclusions could be drawn at this stage.

Work is continuing on the distribution of labelled phosphate taken up by the sugar cane plant. The technique used is tedious, but no other method is satisfactory. Autoradiograms have been obtained, from which the following phosphate compounds have been identified : inorganic phosphate, hexose phosphate, phosphoglycerine acid, phosphatyl choline, adenosine di- and tri-phosphate, uridine diphosphoglucose and uridine monophosphate. Other autoradiograms reveal that there are more than twelve other metabolites which have to be identified.

Potassium. The only soils in which potassium nutrition presents difficulties in Mauritius are the Montmorillonitic Dark Magnesium Clays. A series of pot experiments have therefore been initiated to study the effect of soil moisture and other factors on potassium uptake in these soils.

Survey of soils low in silicon. Following the interesting results obtained in other countries on the use of calcium silicate slag in highly weathered soils, an intensive survey was carried out of soils which were thought to be capable of giving a response to the application of calcium silicate. Fields with the lowest values of extractable silicon, i.e. those of the Humic Ferruginous Latosol family were chosen for field trials in which two levels of calcium silicate slag from Japan (Mitsui product) at 3 and 6 tons per arpent, and coral sand at 4 tons per arpent were compared with a control. Pot experiments with these soils have shown a definite beneficial effect of calcium silicate on plant yields, with a decrease in plant Mn/SiO_2 ratio and soil-extractable aluminium.

Foliar diagnosis. Sheath sampling was carried out in all the permanent sampling units comprised in the Humic Ferruginous Latosols. This was done in order to assess the levels of Si, Ca, Mn of cane sheaths in this particular soil group.

Leaf sampling was carried out by estates and planters in all permanent sampling units, and a total of 616 samples were analysed for N P K.

Soil analysis. Chemists from 19 sugar estates worked in the Chemistry laboratories and carried out a total of about 1,000 analyses for available phosphorus and pHs.

SOIL-PLANT-WATER RELATIONS

Investigations on soil-plant-water relations are continuing along the lines already described. The consumptive use of water by the cane plant in relation to climatic and other environmental factors is being studied in the six lysimeters installed at Médine S.E. (Palmyre) in 1963. Third ratoons were harvested in November and the data obtained during the year confirmed generally the conclusions presented in last year's annual report.

The effect of different water régimes on cane growth was studied on two varieties growing under greenhouse and field conditions and some progress made in elucidating the factors affecting drought tolerance and susceptibility. The more important results obtained in this connection are outlined below.

Field scale measurements of the moisture index of the 4th-5th internode have shown that this method should be used more widely under Mauritius conditions to determine the optimum time for harvesting on irrigated estates. From data obtained during the year, it was found that varieties react differently to water stresses during the ripening stage. Thus M.202/46 responds well to drying off, while M.253/48 shows practically no improvement in sucrose content with progressive drying off, the reaction of M.147/44 being intermediate.

Through the courtesy of the *Centre d'Etudes Nucléaires*, a neutron probe was lent to the Institute and expert guidance given on its use by a visiting scientist, while two members of the staff spent a fortnight at the *Laboratoire de Radioisotopes de Tananarive* in Madagascar to become familiar with the use and maintenance of this instrument.

The visit of a soil physicist from F.A.O., mentioned in last year's report, was unfortunately postponed.

Effect of different soil-water régimes on growth. Greenhouse experiments to compare the effect of different soil-water potentials on cane growth were continued with the varieties Ebène 1/37 and M.147/44 along the same plan as the one used in 1966 when Ebène 1/37 was compared to M.442/51. The five water régimes selected consisted in allowing the soil-water potential at 15 cm. below the surface to reach predetermined values of –0.25, –0.5, –0.75, –3.0 and –9.0 atm., before the soil was restored to water saturation point.

Growth measurements were carried out at weekly intervals with the following results. During the first week, when soil moisture conditions were adequate, no difference in growth increment between the two varieties was observed. In the second week, the growth rate of Ebène 1/37 was affected by a decrease in soil moisture potential from –0.1 atm. to –0.25 atm., but M.147/44 did not suffer from the drying effect at this stage. On further drying when, in the third week, the soil suction had reached 0.5 atm., the growth of Ebène 1/37 became very slow and was completely checked when the soil suction reached 3 atm. in the 5th week. This was however not the case with the variety M.147/44 which continued to grow, but at a slower rate, until the soil suction was approximately 9 atm. when growth stopped. Further, resumption of growth activity, on re-watering in the driest treatment, was more rapid with M.147/44 than with Ebène 1/37.

The effects of the different treatments on total increment of dewlap height and shoot height during the experiment, which lasted nine weeks, have been recorded. These measurements clearly show that a differential response of the two varieties to equal increases in water stress measured at 15 cm. depth is an inherent varietal characteristic. Of the factors which could be the cause of this difference, the most likely ones are a different physiological tolerance to dry conditions and a different morphological development of the root system. Experiments on the effect of solute potential on growth in an attempt to find out some of the physiological characters responsible for drought resistance did not give any conclusive evidence. A field scale trial was carried out mainly to determine whether there was, or not, a morphological adaptability of the root system to drought conditions. This was carried out at Pamplemousses Experiment Station and consisted of a latin square design planned to comprise four different water régimes as treatments. Abnormal rainfall conditions during the experiment, however, did not permit the application of the two driest treatments, namely those which consisted in allowing the maximum soil-water suctions at 15 cm. depth to reach 0.6 atm. and 3.0 atm. before re-watering to field capacity. Only the two wettest treatments, in which maximum soil-water suctions allowed before re-watering were 0.2 atm. and 0.4 atm., could be applied. Soil humidity measurements were carried out with irrometers and a neutron probe. Since only the two wettest treatments were applicable, better information was obtained with the irrometers than with the neutron probe. Plant growth measurements were carried out at weekly intervals. The growth of both varieties was affected at a soil-water suction of 0.4 atm., and Ebène 1/37 was again found more susceptible than M.147/44 to the drying treatment.

A study of the development of the root system of both varieties showed that Ebène 1/37 is entirely dependent on its sett roots which explore only the top 15-20 cm. of soil during the first three months of growth, whereas M.147/44 produces shoot roots as early as two months after planting. These shoot roots grow rapidly in depth where humidity conditions are more favourable to plant growth than in the top soil layers, and they evidently help the sett roots in keeping a favourable plant - water balance under dry atmospheric conditions. The better location of the root system of M.147/44 in the deeper soil layers at an early age, which is an inherent character, seems to be one of the most important factors that contribute to the drought tolerance of this variety (*vide* Plate VII).

The use of Sinbar for a broad classification of drought-tolerant cane varieties. Experimental work with Sinbar (3-tert-butyl-5-chloro-6- methyl uracil) to determine tolerance or susceptibility of cane varieties to this herbicide has indicated that drought-resistant varieties were tolerant to Sinbar, while drought-susceptible varieties were usually affected, as shown by leaf chlorosis even at low dosage rates.

These findings, in parallel with the observation that the early development of the shoot-root system was one of the factors inherent to the drought-tolerant variety M.147/44, were the basic reasons for investigating whether Sinbar could be used to classify varieties into drought-tolerant and drought-susceptible groups.

An experiment was set up at Belle Rive Experiment Station, and the Chesterford logarithmic spraying machine was used to spray concentrations of Sinbar in decreasing dosage rates as from 3 lb. active ingredient per arpent on cane rows immediately after plantation. Eight varieties were tested, the drought-tolerant M.147/44, M.351/57, M.442/51, M.31/45 and the drought-susceptible Ebène 1/37, M.93/48, M.99/48 and B.3337.

The deleterious effect of Sinbar on the drought-susceptible varieties as shown by chlorosis of the leaves, contrasted with the tolerance of drought-resistant varieties.

This experiment indicates that a broad and rapid classification of newly developed varieties into categories as regards drought-tolerance is possible, and should the above results be confirmed with a larger number of varieties, this experimental approach may be of great help in the later stages of the cane selection programme.

WEED CONTROL

The screening of new herbicides and field trials with the more promising ones occupy a prominent place in the experimental programme.

Fifteen herbicides were included in a screening test using the Chesterford logarithmic spraying machine. Ten of them, BAS 2100, BAS 2552 Casoran 133, C 6313, C 6989, NPH 1357, WL 9385, Dacthal, Patoran and Tenoran were tested under humid conditions for the first time, and the results obtained were compared with two known herbicides, Atrazine and DCMU, and three others which had already been experimented with : Herban, Linuron and Sinbar. The rates of application varied between 6 lb. a.i. to 0.87 lb. a.i. per arpent, and the herbicides were sprayed in pre-emergence of virgin canes (variety M.31/45) and weeds. As expected, spectacular weed control was obtained with Sinbar at high dosage rates, but cane growth was severely affected. The herbicides Atrazine, DCMU, Herban and Linuron were more or less comparable in their effects on weed control and were not toxic to sugar cane. Of the ten new herbicides, only one, BAS 2100, could be classified in the above category. The other nine did not affect cane growth, but showed inferior herbicide activity, BAS 2552, C 6313, NPH 1357, Patoran being more effective, however, than Tenoran, WL 9385, C 6989, Dacthal and Casoran 133.

Small plot trials were laid down to compare the efficacy of DCMU, Atrazine, Cotoran, Herban, Fenac and Sinbar on weed control under different climatic conditions and their phytotoxicity to different sugar cane varieties. The experiments were carried out at five sites in the super-humid and humid zones. Herbicides were applied in pre-emergence of canes and weeds at 4 lb. a.i. per arpent, except Sinbar which was used at $\frac{3}{4}$, 1, $1\frac{1}{2}$ and 2 lb. a.i. per arpent. In the super-humid regions, the superiority of DCMU in weed control was evident. In the humid localities, Cotoran and Atrazine compared favourably with DCMU. Herban was found to be less effective than DCMU, Atrazine and Cotoran in both the humid and super-humid localities, its main drawback being its relative inefficacy on weeds of the family Compositae. Fenac did not give better weed control than the other herbicides tested and showed the disadvantage of affecting both cane germination and growth. For these reasons, it is not recommended for use in general practice. Sinbar is an excellent herbicide and is highly effective on weeds of the humid regions. Unfortunately, its high toxicity to several cane varieties precludes its present use until further information on varietal tolerance and rates of application becomes available.

Other experiments carried out in the super-humid and humid regions have confirmed that DCMU is the most profitable herbicide under conditions of high rainfall, while in humid localities the efficacy of Atrazine, Cotoran and DCMU is comparable at equivalent dosage rates of 4 lb. a.i. per arpent.

Special weed problems. Three herbicides BAS 2100, NPH 1357 at 4 lb. a.i. and gramoxone at $\frac{1}{4}$ lb. a.i. per arpent were included in a trial to study their effect on *Cyperus rotundus* and *Kyllinga monocephala* which are troublesome weeds in many parts of the island. Two weeks after application of the chemicals, it was observed that BAS 2100 had no effect on the established weeds, whereas NPH 1357 gave a 50% control of young plants and gramoxone a 90% weed kill. Three weeks later, the gramoxone plots were still the best. Pending the results of further trials with new chemicals, it is recommended that a first spray of $\frac{1}{2}$ lb. a.i. of gramoxone in 100 gallons of water per arpent should be made, followed by monthly applications of $\frac{1}{4}$ lb. a.i. in 60 gallons of water per arpent.

It should be mentioned that Sinbar is a promising herbicide for the control of *Cyperus* and *Kyllinga*, but extreme caution should be exercised in its use because of its high toxicity to several cane varieties.

Herbicide trials in sunflower*. One of the main problems encountered in the project of sunflower cultivation in the interrows of sugar cane, was the absence of data on herbicide applications that would not affect either of these crops under Mauritius conditions while giving a fair control of the weed population. The logarithmic spraying machine was used to evaluate the efficacy of fifteen herbicides in weed control in sunflower, and the chemicals were applied in pre-emergence of weeds and crop. The herbicides Atrazine, DCMU, Sinbar and BAS 2100 have proved highly toxic to sunflower at all rates of concentration from 6 lb. a.i. to 1.5 lb. a.i. per arpent. With the exception of Herban and Linuron, the other herbicides were either moderately toxic to sunflower, or their herbicidal properties were so inadequate that no further consideration was given to them in three subsequent trials based on a latin square design. In these trials, in addition to Herban and Linuron, two other herbicides Ametryne and Cotoran were included because they were not available at the time the logarithmic trial was laid down. The four herbicides were applied at 3 lb. a.i. per arpent in pre-emergence of sunflower and weeds in ratoon canes. The disadvantage of Herban, compared to other herbicides for general weed control in sugar cane plantations, namely, its low efficacy on certain weeds of the Compositae family, becomes an advantage in sunflower and sugar cane mixed plantations. The very slight ill-effect on sunflower plants of Herban at 3 lb. a.i. per arpent is the reason for the recommendation of its use in such plantations for the time being, until further work reveals a better herbicide. Linuron at 3 lb. a.i. per arpent may give equally good results but more experiments are necessary to assess fully its

* *Vide* Foodcrop Cultivation, p. 30

effect on sunflower. Cotoran and Ametryne at the rates experimented with were too toxic, and further work with lower dosage rates will be carried out during the next season. The object of further studies will be to find out the optimum rates of application of these herbicides that would not affect sunflower and give the best weed control at the most economic price.

FIELD EXPERIMENTATION

The programme of Field Experimentation covering the various disciplines of the Institute was pursued satisfactorily. A total of 233 field experiments were harvested, involving the weighing and sampling of 7056 plots. 41 new trials were laid down in 1967. A summary of field trials studied during the year is tabulated below:

	Estates	Stations
Variety		
Variety trials	85	—
Final variety trials ...	11	—
Special variety trials (with Estates' Agronomists) ...	3	—
Ratooning capacity ...	—	4
Fertilization and amendments		
Nitrogen	14	—
Phosphate	19	—
Calcium & phosphate ...	2	—
Potassium, calcium & magnesium	4	—
Basalt	5	—
Method of fertilizer application	2	—
Organic and mineral fertilization	—	4
Permanent fertilizer demonstration plots ...	—	4
Cultural Practice		
Spacing	10	—
Burning	3	4
Interline cultivation ...	3	—
Method of planting ...	5	—
Selective harvesting ...	6	—
Potato in cane interline ...	8	—
Sunflower in cane interline	12	—
Diseases	7	7
Herbicides	15	1

Of the 12 final variety trials laid down in 1966, one had to be abandoned, the remaining 11 were harvested in July, September and November in order to obtain yield data on twelve-month old canes at three harvest dates in 1968. Data on cane yields from these trials on virgin canes are unreliable because of the different planting dates, but useful information was obtained on the sucrose content of the varieties under test.

A selection of promising varieties, treated against ratoon stunting disease, was propagated at the Central Cane Nursery to provide planting material for the 1968 series of final variety/fertilizer trials.

The series of experiments on earthing up and interline cultivation was concluded and the results are reviewed in this report. There was no significant difference between treatments (control: 3.30 TSA; interline cultivation: 3.18; earthing up and interline cultivation : 3.20). Other aspects of cane cultivation including spacing, ridge v/s furrow cultivation, organic matter v/s mineral fertilization, and ridge v/s furrow planting are continuing.

Close contact was maintained between the Institute and sugar estates and planters, 1684 visits being made by members of the staff. The assistance given by the four agronomists employed by sugar estates is gratefully acknowledged; they co-operated fully with the staff and their help in connection with variety trials in particular is much appreciated.

Cane production on the four stations totalled 1607 tons : Réduit 427 tons; Pamplemousses 520 tons; Belle Rive 390 tons; Union Park 270 tons.

FOODCROP CULTIVATION

The success of any development in food crop production on estates must depend to a large extent on a well designed and executed experimental programme. The modest effort made in this connection in 1966 was continued in 1967, but it should be made clear at this stage that with the present staff structure of the Institute, a more ambitious programme would seriously impair the volume and quality of work now being carried out on sugar cane.

Trials to study the effect on cane and sugar yields of intercropping potato were harvested during the year and showed that the highest level of potato production was attained by planting two rows of potatoes on every cane interrow. There was no significant decrease in sugar yields, but a significant increase in potato yield at the higher density. Average results obtained were as follows :

	Tons	
	sugar/arp.	*potato/arp.*
Control (no potato) ...	4.13	—
1 line potato every alternate interrow	4.28	1.60
2 lines potato every alternate interrow	4.16	2.55
1 line potato every interrow	4.17	3.22
2 lines potato every interrow	4.17	5.14

Twelve trials were laid down to study the effect of sunflower cultivation on sugar production when interplanted in fields of ratoon cane. Sugar yields will not be obtained until 1968, but the results of sunflower yields are discussed in the Chapter *Cultivation* of this report.

Most sugar estates of the island established large scale observation plots of sunflower in ratoon fields. These provided an excellent opportunity to become acquainted with the problems facing the establishment of a new crop on a commercial scale. Of these it appears that the most critical ones are the date of planting and weed control*. Other factors of importance which were encountered included destruction of seeds after sowing by birds and rats, damage to seedlings and young plants by cutworms, hares, snails and stem boring insects, collar rots of various types, damage to the flower head by birds and insects, and improper drying.

In spite of these difficulties, there is reasonable hope that sunflower may become an important crop without reducing the overall sugar production. Yields of seeds were reasonable, and the oil content satisfactory, varying from 38 to 54% on seventeen samples dried at 70°C.

SUGAR MANUFACTURE

Raw Sugar Filterability. Much of the work of the Sugar Technology Division was once more devoted to problems relating to the production of raws of better filtering properties. As a result of various measures taken by the industry, average filterability was slightly better in 1967 than in 1966 in spite of a number of adverse factors, the most important of which were :

(*a*) very unfavourable climatic conditions, which led to a marked drop in sucrose content of cane and in juice purity;

(*b*) short crushing hours per day, which extended the crop unduly and resulted in greater deterioration of stored factory products.

The main practices adopted by the industry which were beneficial to the production of better filtering raws were :

(*a*) the enzymatic process of starch removal from juice, which was followed in 17 out of 23 factories;

(*b*) juice liming after final heating;

(*c*) a better understanding of boiling processes which led, in many cases, to the production of less B-sugars, or to the adoption of a two-boiling system in which only A-sugars were bagged;

(*d*) smaller grain size of shipment sugars.

* *Vide* Weed Control, p. 28

The most important aspect of the question, however, is not the average improvement achieved from one crop to the next, but the fact that spectacular results were obtained in certain factories where it was believed, in some quarters, that good filtering raws could not be produced because of inherent environmental conditions of soil and climate. From the experience gained during the last two years, it may now be concluded that the production of good filtering raws is a technological problem which may be solved, more or less easily, in any factory.

Other studies relating to raw sugar filterability which were conducted during the year are listed below :

(*a*) The testing of a commercial enzyme supplied by Messrs. Imperial Chemical Industries (S.A.) Limited, with the object of ascertaining whether it could be used economically on an industrial scale for further reducing the starch content of juices in those factories where the enzymatic process is followed. The results obtained, however, do not warrant the use of this enzyme.

(*b*) The boiling of a number of strikes in a small laboratory vacuum pan. This pan, built in 1966, was modified with the object of reducing the graining charge, and was fitted with a mechanical circulator and a cuitometer.

In addition to the vacuum pan, a single-effect evaporator and a small defecator have been commissioned late during the crop. With the help of this new equipment it will be possible to measure the filterability of raws produced from the juices of different varieties.

Apart from filterability studies, other research projects which received attention during the year are summarised hereunder:

(*a*) *Resistance heater*. A massecuite resistance heater was installed at the Mount factory for the reheating of final massecuite prior to curing in a continuous centrifugal. Tests were carried out to determine the amount of sucrose resolution taking place in the heater. It was found that when the massecuite was heated to 45°C, which is the normal practice when a continuous centrifuge is used for curing, the rise in purity of the molasses was 0.4 degree on the average.

The tests also revealed that this particular heater could not cope with more than about 50 cubic feet of massecuite per hour, whereas the continuous fugal could have cured at least 20 per cent more massecuite during the same interval. This is due to the conductivity values of the massecuites which were lower than those encountered in Australia where the resistance heater was designed. Further, the method of reheating used overhere is different from that used in Queensland where the massecuite is first heated in a conventional heater from 30° to 40°C before going through the resistance heater, whereas at the Mount the entire temperature rise was obtained in the latter.

(*b*) *Entrainment losses in vacuum pans.* The object of this study was to determine quantitatively the amount of sucrose lost in vacuum pans by entrainment, as it would appear that in certain factories this may account for a fair percentage of the undetermined losses.

An accurate method had to be used for measuring small amounts of sugar in the condenser water, and the one chosen was the citric acid method with the help of which it is possible to measure accurately as low a concentration as 2 mg. sucrose per litre.

The tests were carried out on an industrial vacuum pan equipped with its own barometric condenser. A rectangular weir was placed at the discharge of the seal tank of the condenser and its accuracy determined by comparison with the cooling water ratio. The latter was obtained by measuring the condensate and recording, at short intervals, condenser water inlet and outlet temperatures and boiling pressure.

The flow of condenser water thus obtained and the amount of sucrose contained therein measured by sampling and analysis, gave the sugar lost by entrainment for any period of time.

(*c*) *Exhaustibility of final molasses.* A practical method of judging the exhaustibility of final molasses is to determine the expected true purity as a function of the reducing sugars and ash content, and to compare this figure with the actual purity. In this connection, a study was carried out to recalculate the constants of the so-called Douwes-Dekker formula so as to bring them in line with the conditions prevailing in Mauritius. For this purpose, samples of average final molasses from each of the 21 factories producing defecation raws were analysed for reducing sugars and sulphated ash. The determination of true solids by drying in a Gardiner oven was kindly carried out by Messrs. Tate & Lyle at their research laboratories. All the results were then statistically analysed and a formula applicable to local conditions derived.

(*d*) *Calculation of true solids in molasses.* In sugar factory laboratories no equipment is available for determining true solids by drying under vacuum. The relationship between refractometric Brix and dry matter had therefore to be studied so as to enable factory chemists to calculate the expected purity of final molasses. An equation was derived by which true solids can be obtained from refractometric Brix by applying to the latter corrections based on reducing sugars and sulphated ash contents.

(*e*) *Densimetric v/s refractometric brix of final molasses.* When refractometric Brix was adopted for the chemical control of sugar factories in Mauritius several years ago, it was observed that the difference between refractometric and densimetric Brix of final molasses varied considerably between certain factories. In some of them the difference was small so that the purity calculated from the refractometric Brix was but slightly higher than that obtained from the densimetric Brix. In others, however, the difference was large and the rise in purity was consequently much greater. A study carried out to explain these differences has shown that difference in Brix is influenced mostly by the total ash content of the molasses, and not by the relative percentages of the individual ash constituents.

(*f*) *pH of sugar factory products.* In raw sugar manufacture it is the usual practice to measure the pH of most factory products at room temperature. In general, a sample of the hot liquor is brought to the laboratory and cooled before measurement. As pH varies with temperature, it is not possible to know its value under operating conditions. Since a low pH leads to inversion whilst a high pH causes destruction of reducing sugars and formation of coloured products, and since process control depends so much on pH, an investigation into the variations of pH with temperature for various factory products was carried out.

(*g*) *Juice liming after final heating.* During the 1967 crop a number of factories adopted liming of juice after the final heater, either just ahead of the flash tank, or between the flash tank and the clarifier. Under these conditions, particularly in the second case, the time interval available for correcting the pH with the help of the pH controller is very limited. On the other hand, the reaction between lime and juice is much faster than when cold or even hot liming (60°C) is resorted to. In order to obtain correct pH control, it is therefore necessary to know the reaction time at high temperature and a study was initiated to that end. Preliminary results were obtained and the study will be continued in 1968.

(*h*) *Yeasts.* The screening of osmophilic yeasts in raw sugars was continued during the crop and close contact in this respect was maintained with Messrs. Tate & Lyle Research Laboratories.

Miscellaneous. The activities of the Sugar Technology Division included also the analysis of 6510 samples of cane from the experimental plots of the Institute; the usual duties of the Instrumentation Section; and, various studies in connection with advisory work for a number of factories. The equipment inventories of the 23 sugar factories which had been prepared on the occasion of the ISSCT Congress held in Mauritius in 1962 were also brought up-to-date.

LIBRARY AND PUBLICATIONS

New accessions to the Library numbered 373 volumes in 1967 and the periodicals and reports received went up to 405 titles. The Institute is much indebted to the many institutions which send material in exchange. Special mention should be made of a complete collection of *Zeitschrift des Vereins der Deutschen Zuckerindustrie* received from the Institut für Zuckerindustrie in Berlin; much material has also been donated by the Library of the Experiment Station H.S.P.A., and the Institute for Agricultural Research, Ahmadu Bello University.

A catalogue of the prints on the History of the Sugar Industry in the collection of the Institute was completed during the year, and another of all the regional maps, including manuscripts in the Institute, was also started. It is to be hoped that the holdings in various Mauritius depositories will be communicated to the Librarian.

The year was marked by the publication of a full-length monograph *Weed Control in Sugar Cane : Research and Application*, by Dr. E. Rochecouste, formerly Botanist at the Institute.

Other publications released in 1967 were :

Annual Report 1966. 149, xxx p., 39 figs., 12 pl. French summary in *Revue agric. sucr. Ile Maurice* **46** (2) 1966 : 61-87.

Occasional Paper

No. 25 WILLIAMS, J. R. Observations on parasitic protozoa in plant–parasitic and free-living nematodes. (Originally appeared in *Nematologica* **13**, 1967 : 336-342)

Private Circulation Report (mimeographed)

No. 21 CHAN, P.Y. The radioisotope course in agriculture, Kinshasa, République Démocratique du Congo. 20 p., 2 figs.

Contrôle Mutuel Hebdomadaire. 25 issues.

Bulletin Hebdomadaire. Evolution Campagne Sucrière. 23 issues.

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

MAZERY, G. Recherche et exploitation de l'eau souterraine à l'Ile Maurice. **46** (1) 20-24.

Articles contributed to Foreign Journals & Symposia.

HALAIS. P. Normes du diagnostic foliaire pour les repousses de canne à sucre récoltables annuellement en régions tropicales. (Colloque sur la Fertilité des Sols Tropicaux, Tananarive, 19-25 novembre 1967).

LALOUETTE, J. A. Growth of pollen tube in *Saccharum* sp. and *Erianthus* sp. exhibited by callose fluorochrome reaction. *Grana palynol.* **7** (2) 1967.

Papers prepared for XIIIth Congress, I.S.S.C.T. Taiwan, 1968.

Agriculture Section

HALAIS, P. Silicon, calcium and manganese contents of cane leaf sheaths collected on ten great soil groups in Mauritius.

MONGELARD, J. C. The effect of different water régimes on the growth of two sugar cane varieties.

WONG YOU CHEONG, Y. & D. H. PARISH. Phosphate in the latosolic soils and latosols of Mauritius and its availability to plants.

I Relationship between phosphate retention and soil constituents.

II Relationship between soil available phosphates and phosphate uptake by plants grown in pots.

Breeding Section

JULIEN, R. The role of leaves in the perception and inhibition of the flowering stimulus in sugar cane.

LALOUETTE, J.A. Cane breeding and selection in Mauritius.

Pathology Section

ANTOINE, R. & *ors.* Cane diseases and their world distribution. (Prepared by Members of the Standing Committee on Cane Diseases.)

ANTOINE, R. The two gumming diseases.

RICAUD, C. Investigations on the systemic infection of gumming disease.

Processing Section

SAINT ANTOINE, J. D. de R. de. Measures adopted in Mauritius to improve raw sugar filterability.

VIGNES, E. C. The determination of phosphates in clarified juice.

In addition, two short notes were prepared by P.O. Wiehe at the request of the General Secretary Treasurer: (a) The XIth Congress of the Society, Mauritius 1962; (b) The Mauritius Sugar Industry Research Institute.

Theses

LE GUEN, F. The simulation of a single-effect concentrating evaporator.
M.Sc. Thesis, Faculty of Technology, University of Manchester, 1967.

WONG YOU CHEONG, Y. Phosphates in the latosolic soils and latosols of Mauritius, particularly in relation to the nutrition of the sugar cane.
Ph.D. Thesis, Faculty of Agriculture, Queen's University, Belfast, 1967.

GENERAL

The Research Advisory Committee held two meetings in January and March to review the current research programme of the Institute. Two other meetings were held in May and August with the Executive Board.

Lectures given at the Bonâme Hall are listed below.

14th March — P.O. WIEHE. Revue des travaux du M.S.I.R.I. en 1966.

18th April — G. ROSS. (Rothamsted Experimental Station). The problems encountered in the selection of sugar cane varieties.

16th May — L. P. NOEL. (i) Les variétés de cannes récemment homologuées pour la grande culture.(1)
R. ANTOINE. (ii) Multiplication rapide des variétés de cannes.(1)

26th May — M. WHITE (U. K. A. E. A.). Critical Path Finding (2)

13th June — C. RICAUD. (i) Le "Wilt" de la canne à sucre et quelques problèmes associés.(1)
S. MOREIRA (Director, Citrus Dept., Instituto Agronomico, Campinas, Sao Paulo, Brazil). (ii) The aspects of citrus growing in Brazil compared to those in Mauritius.(1)

20th June — C. CRABTREE (International Computers & Tabulators). Talk on Computers, followed by a film entitled "Your Obedient Servant".

18th July — P. CHAN & L. ROSS. Quelques aspects de la fertilisation de la canne à sucre à Maurice à la lueur des connaissances actuelles.(1)

31st July, 14th August, 4th & 11th September. — R. RAFFRAY (Comité de Pilotage de l'Expérience Tournesol). Problèmes de l'apiculture.

22nd August — C. MONGELARD. (i) Comportement des variétés de cannes en relation avec l'eau.
(ii) Court exposé sur l'efficacité des nouveaux herbicides.(1)

18th September — A. JOHNSTON (I.C.I., South Africa Ltd.). Boiler feed water treatment and analysis.(3)

20th September — Captain H. KOHLER, Chief Scientist, T. AITKEN *and* Colleagues, (Lamont Geological Observatory of Columbia

University, Palisades, N.Y.). Marine geophysical investigations and navigation by satellite.(4)

26th September — J. R. WILLIAMS. Plant parasitic nematodes.(1)

20th October — M. BRYAN (I. C. T., East Africa) — Presentation of a film on Computer 1901.(3)

24th October — R. ANTOINE. La situation variétale en fonction d'observations récentes sur la gommose.(1)

25th October — P. O. WIEHE. Promenade botanique dans le Sud-Ouest de Madagascar.5

22nd November — J. M. VINSON. Les oiseaux des Mascareignes.(5)

28th November — R. ANTOINE *and* G. KOENIG. Multiplication rapide des variétés de canne à sucre. (Meeting held at Bel Ombre S.E.).(1)

29th November — R. CHAMINADE (Directeur de Recherche, C.N.R.A.). L'homme et le Sol.

12th December — 3 films.

(i) Mechanical discharge of rock phosphate from ships.

(ii) Mechanical discharge of ships in Northern Africa.

(iii) Flour mills.(3)

27th December — M. LECOUFLE. La culture des orchidées.(6)

---

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

2. Meeting under the auspices of the Professional Engineers' Association of Mauritius.

3. Meeting under the auspices of the *Société de Technologie Agricole et Sucrière de Maurice.*

4. Meeting under the auspices of the *Société de Technologie Agricole et Sucrière de Maurice* and Professional Engineers' Association of Mauritius.

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

6. Meeting under the auspices of the Royal Society of Arts & Sciences of Mauritius and *Société de Technologie Agricole et Sucrière de Maurice.*

Staff Movements. Messrs. L. Le Guen, F. Mayer, G. Mc Intyre, M. Randabel, G. Mazery, P.G. du Mée and Dr. Wiehe, went on overseas leave during the year. Mr. R. Antoine spent a few weeks in London in September-October for medical treatment. Following the established policy of the Institute, these officers visited various research centres and submitted reports on problems of interest connected with the research programme.

At the request of Kilombero Sugar Co. and the C.D.C., Dr. Ricaud paid three visits to Tanzania in February, May and October, to investigate and advise on "yellow wilt" of sugar cane. His last visit was extended to the cane area of Malawi and Sena S.E. in Mozambique.

Under the auspices of the *Comité de Collaboration Agricole*, Mr. Antoine visited Madagasikara in March to see and discuss Fiji disease control work. Messrs. Lalouette, Randabel and Piat visited Réunion in May, August and November, to study cane varieties, rum production, and the performance of the Buckau Wolff continuous centrifugal respectively.

In April, Messrs. F. Le Guen and C. Cavalot spent a fortnight at the *Centre d'Etudes Nucléaires* in Tananarive to be trained in the use and maintenance of the neutron probe.

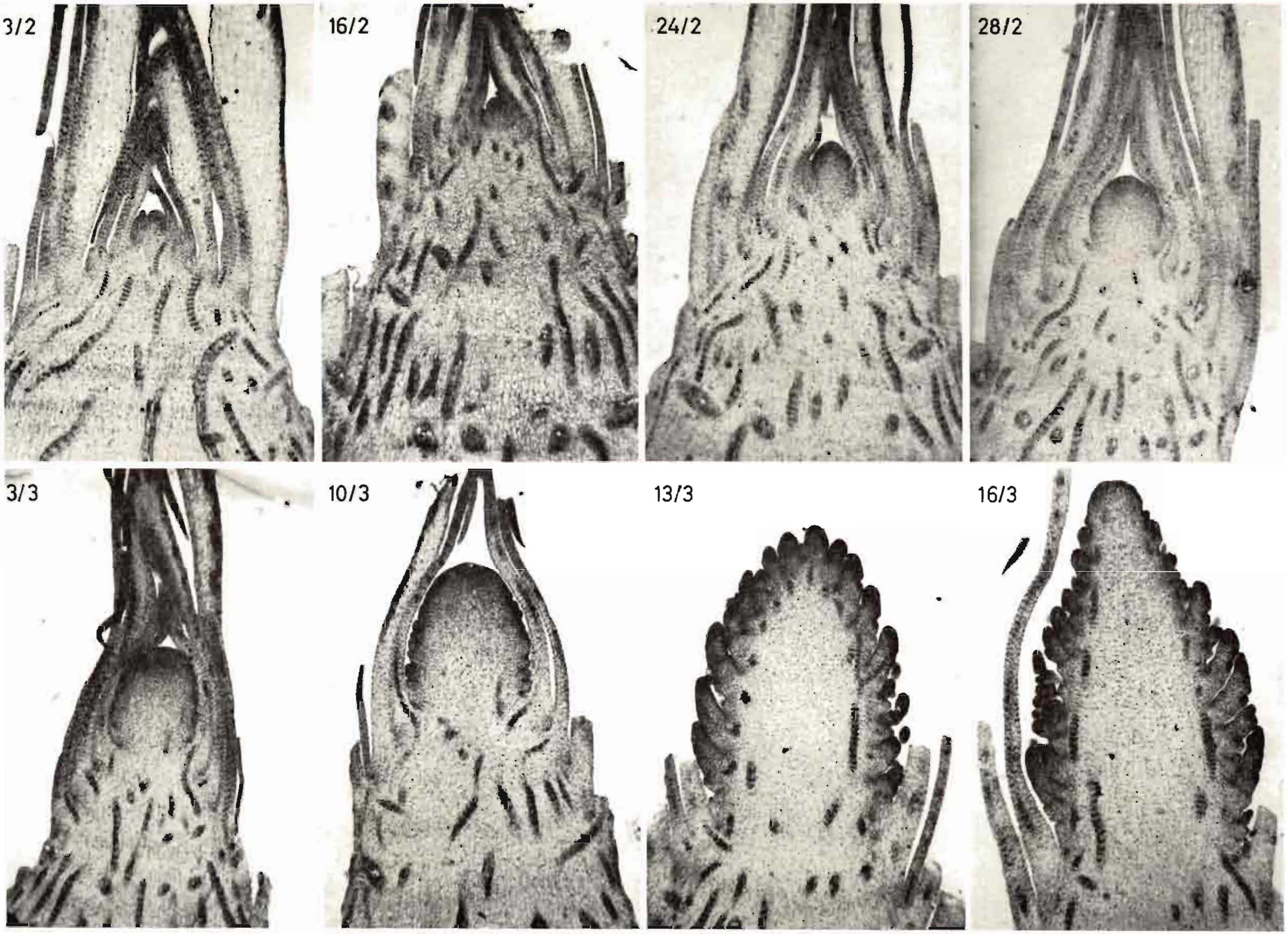
In October, Mr. L. Ross attended the "*Colloque sur la fertilité des sols tropicaux*" held in Tananárive and organized by I.R.A.T.

The 16th meeting of the *Comité de Collaboration Agricole* was held in Réunion from the 4th to 11th November, the Institute being represented by the Director and Mr. Antoine.

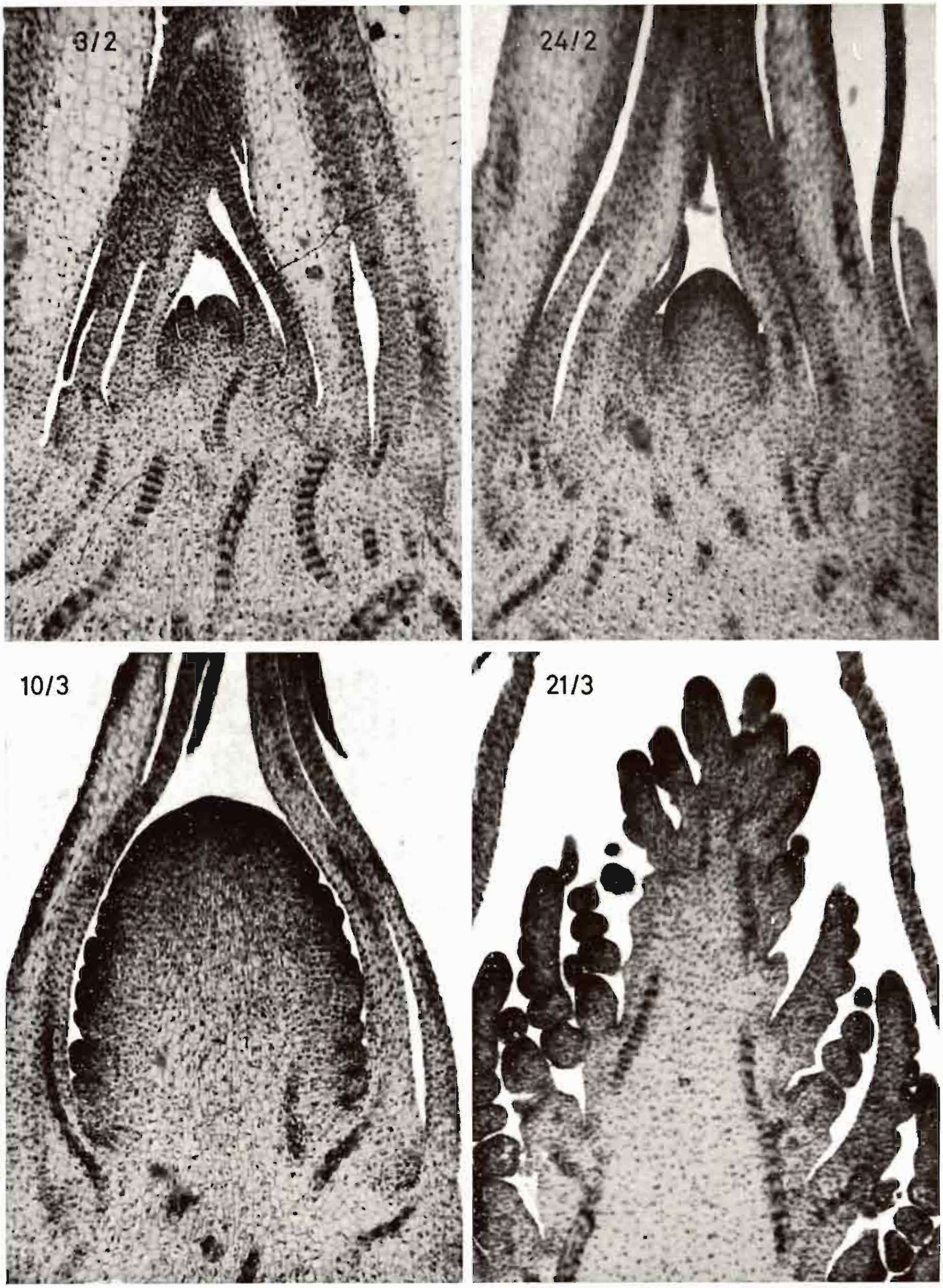
As usual, Estate Managers and their personnel offered many facilities to the Institute, and their assistance is gratefully acknowledged. I should also like to express my thanks to the Director of Agriculture and his staff for their collaboration. Finally, I am most grateful to the staff of the Institute, in particular to Mr. Robert Antoine who acted for me from March to July, for their loyal support during the year.

Director

29th January, 1968



Stages in development of the flower primordium in variety U.S. 48-34 between 3rd February and 16th March (x 26)



Stages in development of the flower primordium in variety U.S. 48-34 (x63)

CANE BREEDING AND VARIETIES

1. THE BREEDING PROGRAMME

J. A. LALOUETTE

Data-Processing

The automation of data-processing, started in 1966, was pursued during 1967. As experience with the system was being gained, the need for other machines to complete the equipment already available became strongly felt. Thus, towards the end of the year orders were placed for an electronic calculator and another automatic interpreter punch. The calculator will be in operation early in January 1968, and the interpreter punch in the first quarter of the new year. A second assistant was also appointed in December 1967.

Special efforts were devoted during the year to an assessment of selection criteria at every stage of the screening process. The great number of varieties in the earlier stages of selection, referred to in previous reports, have necessitated a higher selection pressure to be applied in later stages. The guiding principle, therefore, has been to try and apply a uniform pressure at all stages through a more thorough analysis of available data made possible by automation in data-processing.

The method of selection is briefly outlined.

Bunch Selection Plots

Screening of varieties at this stage hitherto consisted in a comparison of Brix and visual appearance at the time of selection with interspersed control stools. It was therefore not possible to assess the variability induced by the section of field under selection and, as a consequence, selection for Brix tended to be too lenient in some sections and too drastic in others. In 1967 as all control stools were measured for Brix just prior to selection, it was therefore possible to analyse the data and decide upon the pressure to be adopted throughout before selecting. The coefficient of variability per stool for Brix in the control variety M.147/44 averaged between 3 and 5%. Working in the upper tail area of the distribution, at a probability of 75%, the overall rate of selection was approximately 10%.

Propagation Plots

Selections from Bunch Selection Plots are planted in Propagation Plots in which each plot consists of a single line of 15 feet. Control rows are included every sixth line. Each variety being tested is normally planted simultaneously in the humid and super-humid zones. Whole plot weight, Brix and number of canes and flowers are assessed in plant cane and first ratoon. Selection at this stage had hitherto consisted in a visual comparison of varieties with controls and an integration of weight and Brix for the two years under consideration. This process was a slow and tedious one, inevitably influenced by personal bias to some extent. If reasonable selection could thus be achieved when dealing with a small number of varieties, it was evident that other means would have to be found when dealing with the 2,565 varieties awaiting selection in 1967 in two environments. It was therefore decided to investigate the possibility of using the equipment available, namely tabulator and calculator, to operate an automatic selection based on a model which would use the data recorded to the fullest benefit. The selection criterion which appeared most suitable was the product weight by Brix for each plot, hereafter called Kilo-Brix for convenience. After a preliminary analysis of results, obtainable, it was decided to calculate Kilo-Brix values for virgin and 1st ratoon results as well as for their cumulative values. Varieties reaching the acceptable level on the results of either 1st ratoon alone, or the cumulative value for virgin and 1st ratoon, were planted in the next stage.

The selection zone was defined as the upper tail area of the distribution at a probability of 85%. However, a number of varieties were also selected in the range 75 to 80% and 80 to 85% probability.

The co-efficients of variability per plot for the character Kilo-Brix in control plots are given in Table 1. It is unfortunate that only 1st ratoon results were available for the super-humid region.

Table 1. Coefficients of variability per plot for character Kilo-Brix in control plots

	Humid	*Super-humid*
Virgin + 1st ratoon results	15 to 20%	
1st ratoon results only	17 to 23%	10 to 37%
Virgin results only	20 to 29%	

The overall rate of selection was approximately 8%, and of the varieties thus carried over to the next stage, about 10% only were selected in both regions.

Variety Trials

The series of trials planted in 1963, with almost every variety replicated in each of the four main climatic zones. namely sub-humid, irrigated, humid and super-humid, reached the 3rd ratoon in 1967. The following characters were calculated for each of the three ratoon crops for which results were available, and also for the cumulative values over the three crop cycles :

(a) industrial recoverable sucrose % cane (I.R.S.C.);

(b) weight of sugar per arpent;

(c) weight of profitable sugar per arpent*.

The layout was analysed for the three characters above, as well as for weight of cane.

The co-efficients of variability per plot for each of the four characters mentioned on the cumulative results of 1st, 2nd and 3rd ratoons are presented below.

Table 2. Coefficients of variability in variety trials

Character	*Climatic zones* *Sub-humid*	*Irrigated*	*Humid*	*Super-humid*†
Weight of cane	8 — 15%	8 — 15%	10 — 15%	8 — 13.5%
I.R.S.C.	2.6 — 3.8%	2.7 — 4.7%	2.5 — 3.8%	4%
Weight of sugar	9 — 16%	8 — 14%	11 — 16%	10 — 13%
Weight of profitable sugar ...	8 — 16%	9 — 14%	10 — 17%	12 — 15%

An analysis of results obtained has indicated that a few varieties, adapted to the various climatic zones, are promising. However, these results will have to be supplemented by additional data before their release is contemplated.

* $(c) = \text{wt. of cane} \times \frac{(a) - 4}{100}$

† Six trials are included per zone, except for the super-humid zone where complete results were available for analysis in two trials only.

2. INVESTIGATIONS ON THE PHYSIOLOGY OF FLOWERING

R. JULIEN

Research on the control of flowering has been intensified in 1967; some interesting results have been obtained and are summarized below.

(a) The role of leaves in perceiving the flowering stimulus and in producing flowering inhibitors.

Plants of the variety U.S. 48-34 were given various defoliation treatments on the 16th of January, and again on the 24th of February. The dates of emergence, percentage emergence and percentage initiation were recorded for each treatment, and are presented in Table 3.

It appears from Table 3 that the removal of mature leaves, 3 and 4 from the plants results in earlier flowering compared to the undefoliated control. Furthermore, the removal of the spindle or leaf 1 or leaf 2 resulted in delay and reduced intensity of emergence of inflorescences. It is also apparent that there is a greater delay and inhibition of flowering when leaves 3 and 4 are left together on the plant compared to the presence of leaf 3 or 4 alone. The above results can best be interpreted by assuming that the lower leaves produce flowering inhibitors.

(b) Induction of flowering

An experiment conducted to determine the number of photoperiodic cycles necessary for induction of flowering showed that variety N : Co.376 failed to be induced to flower when subjected to a maximum of 15 cycles of a photoperiod of 12 hrs 43 mins. On the other hand, variety U.S. 48-34 was induced by 15 cycles of the same photoperiod, but flowering did not take place when only seven cycles were given to that variety. It thus appears that clones of sugar cane have different photoperiodic requirements.

(c) Artificial induction of flowering

Plants of the "noble" variety Senneville were subjected to a photoperiod of 12 hrs 43 mins during one, two and three months (February to April). These treatments failed to induce flowering although the minimum temperature was above 65°F during that period.

Table 3. Effect of leaf-cutting treatments on date of emergence and on % initiation and emergence

Treatment (*Leaves left on plant*)	*Mean no. of days to emergence*†	*Per cent initiation*	*Per cent emergence*
Nil	19	67	46*
Spindle	15**	91	85
1st	13***	100	100
2nd	16**	91	88
3rd	19	79	61*
4th	23	76	42**
3rd + 4th	35***	69	20***
2nd + 3rd + 4th	18*	70	40**
1st + 2nd + 3rd + 4th	20	100	100
S + 1st + 2nd + 3rd + 4th (Control)	21	96	93

† Reckoned from 1st April

* Significant at P 0.05
** ,, ,, P 0.01
*** ,, ,, P 0.001

(*d*) *Development of floral buds in sugar cane*

(i) From the beginning of February onwards, samples of at least six canes were taken at random from a 60 ft row of U.S. 48-34. Sections were prepared by the paraffin wax method and stained in ferric chloride and tannic acid. These were examined and are shown in Pl. I & II. It was apparent that up to the 16th of February the apex was still vegetative, whereas from 21st of February an inflorescence primordium had started developing. The primordium gradually increased in size at first, and later lateral primordia started to give rise to branches which would eventually subtend the florets. From the 24th of February onwards, samples were taken from the same row of cane and the length of the inflorescence measured. The growth pattern of the inflorescence is shown in fig. 11. It is of interest to note the different stages of growth, namely :

Stage *a* main axis of inflorescence enlarging;
,, *b* branching of inflorescence primordium;
,, *c* primordia of florets forming.

(ii) The growth pattern of the inflorescence of varieties N. 55-176, R.397, M.12/49 and N. 50-211 were followed from the 30th of March to emergence. The results are presented in fig. 12. It may be concluded from the data recorded that later emergence of variety M.12/49 compared to N.50-211 and R.397 may be attributed partly to slower growth of the inflorescence primordium.

(e) *Use of chemicals*

(i) *Maleic hydrazide* applied after initiation of an inflorescence at concentrations of 0.22% and 0.44% did not inhibit or delay flowering in variety U.S.48-34.

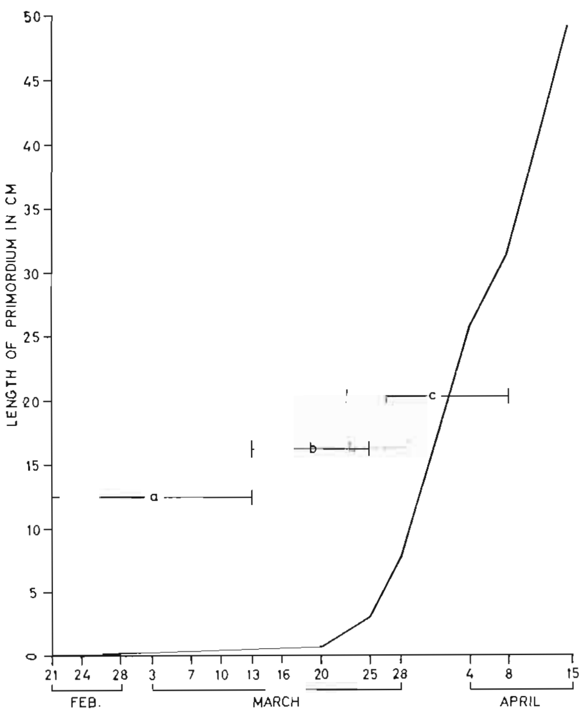


Fig. 11. Growth of inflorescence primordium in variety U.S. 48-34. (For explanations see text).

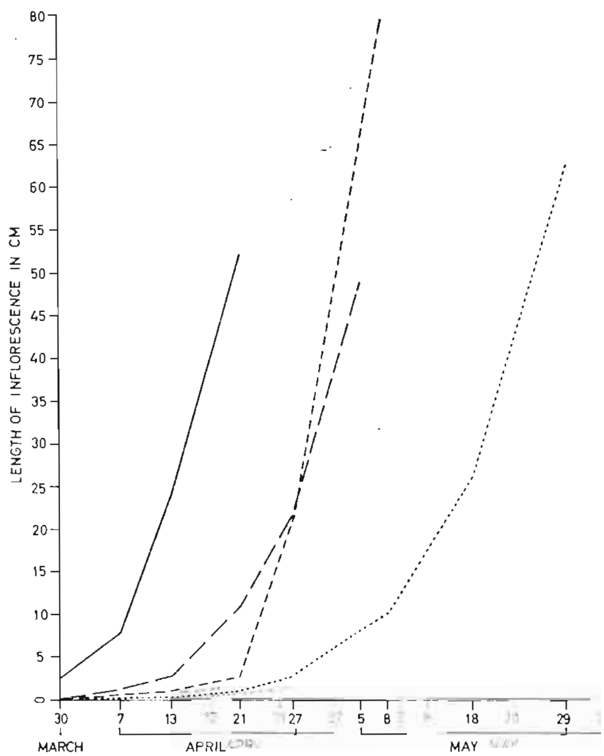


Fig. 12. Length of inflorescence in cm. at the different sampling dates for varieties M.12/49 (dotted), N 50-211 (long dashes), R.397 (short dashes), N.55-176 (plain).

(ii) *CCC** applied as a spray at concentrations of 0.1, 0.5 and 1% on three occasions at fortnightly intervals, during the post initiation stage of flowering, delayed emergence for about a week in the variety N:Co.376. When this chemical was applied on two occasions, delay occurred only at the highest concentration. Finally when a single and late application was made, there was no delay in emergence.

(iii) *Phosphon*** applied as soil drench during the induction period at rates of 2, 4, 6 and 8 g./pot did not inhibit flowering in varieties N : Co.310, U.S. 48-34 and *S. spontaneum* var. Mandalay.

(*f*) *Role of light before initiation*

(i) *Light of different wavelengths and flowering*. Interruption of the night from 10 p.m. to 2 a.m. with light of different wavelengths from the 15th of January to the 15th of March, showed that red light was most inhibitory to initiation and emergence. Blue and far red had relatively the least effect, whereas white and a mixture of red and far red gave intermediate response.

* 2-Chloroethyltrimethylammonium chloride
** 2,4-dichlorobenzyltributylphosphonium chloride

(ii) *Interruption given at different times during the night and flowering*. An interruption of two hours given at any time during the night, from the 15th of January to the 15th of March suppressed completely initiation and emergence in variety U.S. 48-34. Interruption of two hours given at the beginning or end of the night suppressed initiation and emergence in variety C.P. 36-13, whereas interruption at the middle of the night considerably reduced initiation though not completely. Continuous light throughout the night suppressed initiation and emergence in variety U.S. 48-34, but not in variety C.P. 36-13 where per cent initiation and emergence was similar to control.

(*g*) *Role of light after initiation*

Plants of variety N:Co.310 were given an interruption of the night with 4 hours white light during the early stage of development of the inflorescence primordium; this inhibited emergence and may have caused reversion of some primordia to the vegetative stage. Long day (12 hrs 43 mins) or short day (8 hrs) photoperiod given at the same stage as above delayed emergence, reduced somewhat the intensity of flowering, but caused no reversion in variety N:Co.310.

3. CROSSING AND SELECTION

L. P. NOEL, P. R. HERMELIN & R. JULIEN

Crossing

As a result of several factors, 1967 was not a good year for crossing. The main breeding plot at Réduit was replanted in 1966, and arrowing in virgins was on the low side. Furthermore, the strong winds which prevailed during most of the crossing season affected adversely the viability of the flowers. Also a more critical choice of parents restricted to a certain extent the number of possible combinations.

On the whole, 397 crosses were made involving 125 combinations in which entered 99 parents, of which 40 were females, 62 males, and 3 male and female. Crosses for breeding purposes numbered 46.

A summary of crossing work is given in Table 4. One improvement in the greenhouse worth mentioning is that heating is no longer by means of electrical elements but by water piping heated by diesel oil. The advantages of the new system are twofold : temperature control inside the greenhouse is smoother, and also much less expensive.

Sowing started early in October following the method outlined in last year's annual report. Thus, all crosses derived from the same combination were grouped together with those which had been kept under storage in the deep freeze. Fuzz derived from all combinations represented by at least 3 crosses each were sown. Germination was on the low side. As a result of this, the majority of seedlings were singly-potted. Sowing effected in 1967 is given in Table 5.

Table 4. Crossing work in 1967

Station	*No. of crosses made* Greenhouse Bi-parental	Fields Bi-parental	*Total*
Réduit	376	—	376
Pamplemousses	—	21	21
Total	376	21	397

Table 5. Sowing in 1967

Crosses	*Year of crossing*	*No. of crosses not germinated*	*No. of crosses germinated*	*No. of sdlgs obtained*	*No. of combinations*
Involving nobilizations	1967	24	39	2,191	24
Commercials	1965, 1966, 1967	170	271	15,463	91

Selection

Bunch Selection Plots. Selection started at the beginning of July with brixing of controls. The results were analysed, the variability of the fields assessed, and an even selection pressure applied throughout. Only varieties with a Brix significantly above the standard were selected. Out of the 13,242 varieties in Bunch Selection Plots at Pamplemousses and Minissy, 1,292 were selected and planted in Propagation Plots at Minissy and replicated partly at Belle Rive and the rest at Union Park.

Propagation Plots (Ratoons). The bulk of the work in 1967 consisted in the selection of Propagation Plots in ratoons. 2,565 varieties, replicated in two regions, were brixed, weighed and selected. Electro-mechanical machines were used for the first time to analyse the results. Data for Brix and weight were punched on cards, results analysed and selections made accordingly.

At Minissy, results in virgins, as these were available, were used together with those in ratoon for selection. At Belle Rive and Union Park results in ratoons alone were used. 225 varieties were thus selected and sent to the First Selection Trial stage.

Propagation Plots (Virgins.) These were brixed early in the season (beginning of July) and once more at the end of September. All plots were also weighed. Results were then registered on punch cards for use in 1968, together with those to be obtained in ratoons.

First Selection Trials. As selections had been conducted in 1966 on the combined data obtained in virgins and first ratoons, for reasons given in last year's annual report, no selections were therefore made in 1967. However all varieties in virgins and 1st ratoons were brixed and weighed.

A summary of selection work conducted in 1967 is given in Table 6.

Table 6. Selection work in 1967

Station	*Stalks planted in B.S.P.*	*Varieties planted in Prop. Plots*	*Varieties planted in 1st Sel. Tr.*	*Selections made in 1st Sel. Tr.*
Réduit ...	—	—	113	—
Pamplemousses	—	—	—	—
Belle Rive ...	—	834	88	—
Union Park ...	—	458	61	—
FUEL-Union ...	—	—	—	—
Minissy ...	—	1,292	—	—
	—	2,584	262*	—

The breeding plot at Pamplemousses was replanted during the year.

* From this number, 37 varieties (20 M and 17 Foreign) are planted in 2 regions making a total of 225 different varieties.

4. VARIETY TRIALS

R. ANTOINE & G. ROUILLARD

In 1967, 43 varieties were planted in trials on estates. These varieties were distributed in three replicated series. Each series comprises four trials distributed in the four main climatic zones. The same three controls, M.147/44, M.93/48 and M.377/56, were planted in all the trials.

One series has been laid out as a 4×5 triple rectangular lattice and therefore accommodates 17 varieties and the controls, and two series as 4×4 partially balanced triple lattices each accommodating 13 varieties and the controls.

The performance of 243 varieties is being assessed in 85 trials, (Tables 7 and 8).

Table 7. Varieties tested in trials on estates

M/46 series	1
M/49 ,, ...	1
M/51 ,, ...	4
M/52 ,, ...	2
M/53 ,, ...	6
M/54 ,, ...	14
M/55 ,, ...	31
M/56 ,, ...	37
M/57 ,, ...	50
M/58 ,, ...	17
M/59 ,, ...	38
M/60 ,, ...	20
Sub-total M's... ...	221
Ebène varieties ...	10
Imported varieties ...	12
Total	243

Table 8. Distribution of trials on estates in 1967

Year of planting	*Sub-humid*	*Humid*	*Super-humid*	*Irrigated*	*Total*
1963	6	5	5	6	22
1964	4	5	5	5	19
1965	5	5	5	5	20
1966	3	3	3	3	12
1967	3	3	3	3	12
	21	21	21	22	85

The performance of the most promising varieties is given below. Additional data are needed before any one of them is considered for release for commercial cultivation.

M.305/51 (B.34104 × M.63/39) is promising for the humid and sub-humid localities; yields being comparable with those of M.13/56.

M.428/51 (M.77/41 × M.213/40). The high sucrose content of the variety has been confirmed but its range of adaptability to extreme climatic conditions has yet to be determined.

M.356/53 (E.1/37 × Co.290). A rich cane particularly suited to conditions where water is not the limiting factor.

M.75/55 (E.1/37 × M.213/40). A rich variety; has performed well in one experiment under super-humid conditions.

M.260/55 (B.34104 × M.63/39). Although it seems to be adapted to the sub-humid zone, results are rather erratic and more data are required.

M.144/56 (M.241/40 × M.147/44). A fair yielder, with good sucrose content, shows promise under conditions where water is not the limiting factor.

M.145/56 (M.241/40 × M.147/44). Is being further tested to confirm its adaptability to sub-humid conditions.

M.84/57 (B.34104 × M.213/40). Is a good yielder, particularly adapted to the sub-humid zone; there are indications that its sucrose content may be rather disappointing at the beginning of the crop. The variety is moderately susceptible to yellow spot.

M.351/57 (N :Co.310 × M.99/34) has maintained its high yielding capacity, particularly in the super-humid zone but its main weakness is a low sucrose content. More precise data should be obtained on that variety which is susceptible to chlorotic streak.

Ebène 74/56 (Ebène 1/37 × M.147/44). In spite of being a good yielder in the super-humid zone, this variety has a low sucrose content, and more information is needed on its maturity behaviour, particularly at the end of the crop season. Susceptibility to eye spot and chlorotic streak has been observed.

Saïpan 17 (P.O.J.2725 × F.28). One of the richest varieties now under trial; results have been obtained in virgins only so far. Slight susceptibility to smut has been observed.

C.B.38-22 (C.P.27/139 × P.O.J.2878). A rich cane and a fair yielder which seems to have a wide range of adaptation. More precise data are required.

5. THE RECOVERABLE SUCROSE CONTENT OF COMMERCIAL AND PROMISING CANE VARIETIES

P. HALAIS, R. ANTOINE & G. ROUILLARD

In any breeding and selection programme, the major objective is to obtain varieties producing the maximum sugar output per unit area. Such output being a function of cane yield and sucrose content, it is evident that in order to obtain the best economic returns, the search for varieties possessing, amongst other desirable characteristics, high recoverable sucrose content is bound to remain one of the permanent objectives of an organization responsible for agricultural progress in the sugar industry.

An analysis of the recoverable sucrose content of commercial canes — those grown on a very limited scale being excluded — and of the promising varieties in the latest stage of selection is discussed in this chapter.

Table 9 gives the differences in recoverable sucrose content % cane that can be attributed to various factors. The data refer to the period 1961-1967.

Data collected to-date on the recoverable sucrose content for commercial varieties and a selection of promising ones were compiled and expressed as deviations from two controls : M.147/44 adapted to low to moderate elevations and rainfall areas, and M.93/48 adapted to higher elevations and rainfall. Results are given in figs 13 and 14. Figures in parentheses give the number of annual crops, virgins and ratoons which have been compared to the standard varieties in field trials. In general, there are 4 to 5 replicate plots in each trial.

Amongst seventeen varieties cultivated on a commercial scale at the present time in the island, there is an intrinsic difference of nearly 1.5 units in recoverable sucrose content % cane between Ebène 50/47, the richest, and M.253/48 or B.3337, the poorest. Furthermore, amongst twelve promising varieties in the latest stage of selection, the intrinsic difference is even bigger, 2.5 units between S.17, the richest, and Ebène 74/56 the poorest.

Table 10 gives a broad classification of commercial and promising varieties in three categories : rich, average and poor.

Table 9. Differences in recoverable sucrose content % cane as influenced by various factors

	Difference in recoverable sucrose content % cane	*Lowest content*	*Highest content*
Between sugar sectors	0.7	South (windward)	West (Leeward)
From year to year	0.9	1967 (harvest season wet)	1963 (harvest season dry)
Within harvest season (of normal length)	1.5	early July	end October
Between 17 commercial varieties ...	1.5	B.3337 or M.253/48	Ebène 50/47
Between 12 promising varieties ...	2.5	Ebène 74/56	S.17

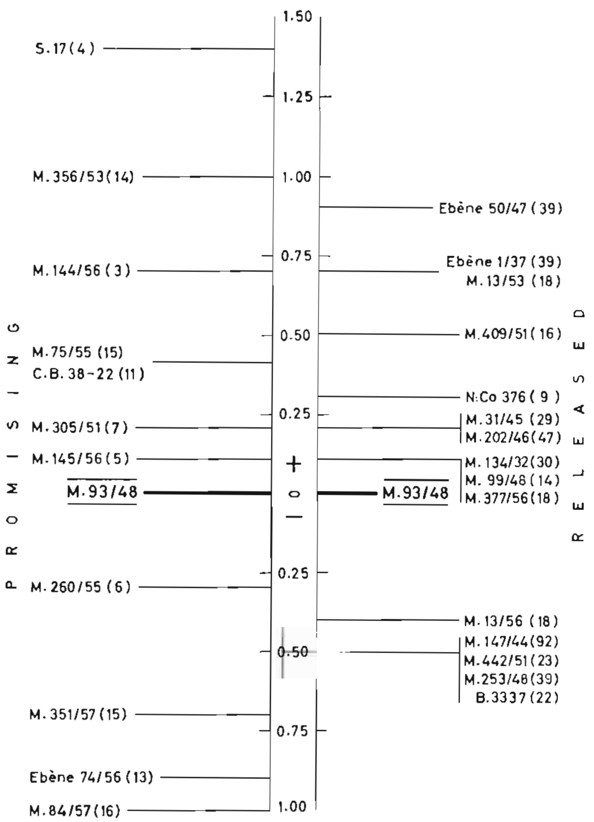


Fig. 13. Recoverable sucrose content of commercial and promising varieties expressed as differences from M.93/48. (Figures in brackets denote number of comparisons).

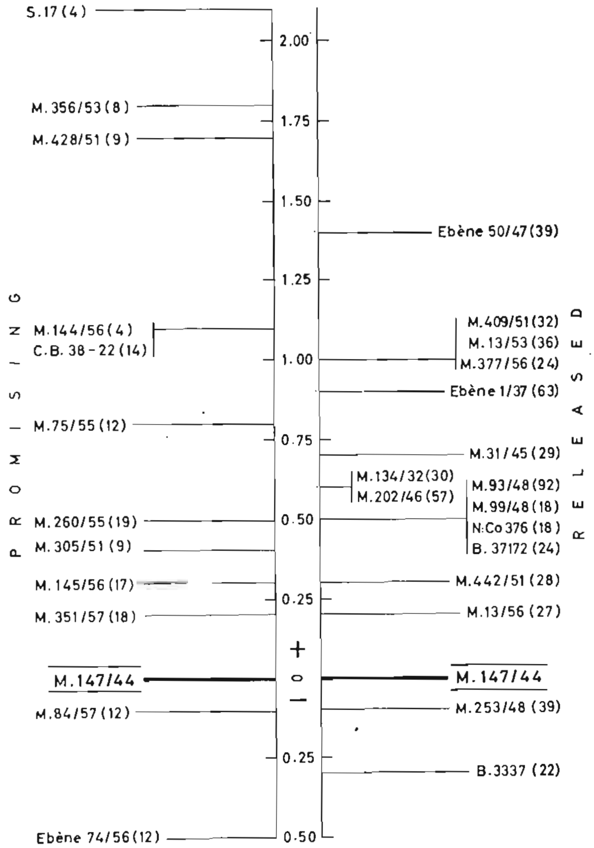


Fig. 14. Recoverable sucrose content of commercial and promising varieties expressed as differences from M.147/44. (Figures in brackets denote number of comparisons).

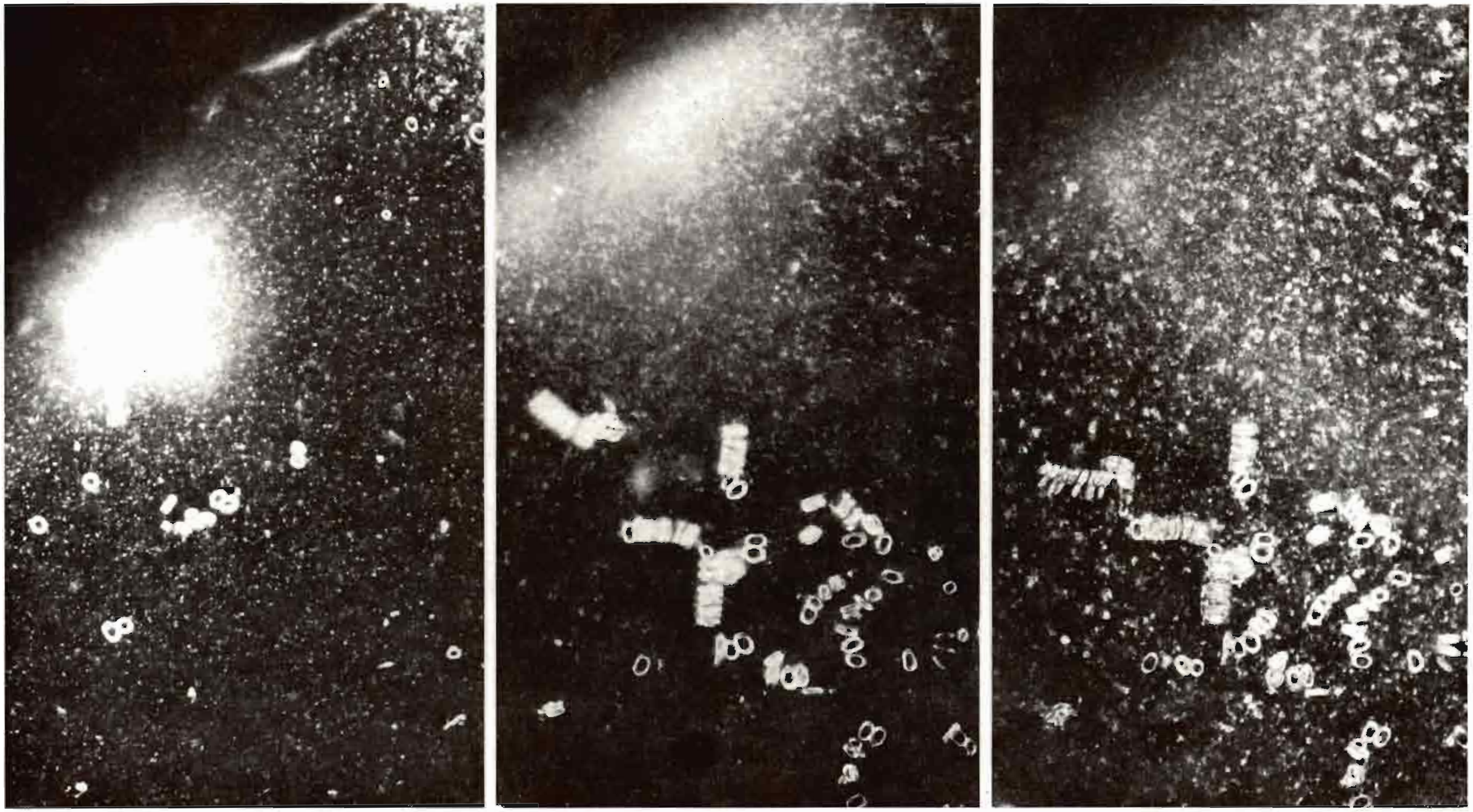
Table 10. Commercial and promising varieties classified as to recoverable sucrose content

Recoverable sucrose Class	*Commercial varieties*	*Promising varieties*
Rich	Ebène 50/47 Ebène 1/37 M.13/53 M.409/51	S.17 M.356/53 M.144/56 M.428/51
Average	M.377/56 M.31/45 M.202/46 M.134/32 N:Co.376 M.99/48 M.93/48 B.37172	C.B.38-22 M.75/55 M.305/51 M.145/56 M.260/55
Poor	M.442/51 M.13/56 M.147/44 M.253/48 B.3337	M.351/57 M.84/57 Ebène 74/56

As the classification of the varieties has been based on averages of data collected throughout the harvesting season, it follows that some varieties when reaped at the proper time would have a higher sucrose content. Thus, M.442/51 shows a low recoverable sucrose at the beginning of the crop, and quite an acceptable one at the end.

During the 1967 crushing campaign, millers' canes were composed as follows : rich canes 13%, average 53%, and poor 34%. Plantations of released varieties made during the same year consisted of : 9.2% rich, 39.8% average, 35.5% poor, and 15.5% of unreleased varieties which would fall in the poor group.

Systemic infection in "broom bamboo" (*Thysanolaena maxima*) caused by a bacterium related to *Xanthomonas vasculorum* causing gumming disease in sugar cane : *left*, systemic stripes ; *right*, gum pockets in stalks



Gum exudation from vessel of leaf of *T. maxima* showing large number of bacteria oozing out together with xylem rings due to breakdown of vessels (x 100)

CANE DISEASES

1. THE VARIETAL SITUATION IN RELATION TO CANE DISEASES

ROBERT ANTOINE

TWENTY-TWO varieties are included in the list of canes approved for commercial cultivation (*vide* Statistical Table XXIV). Of these, four are no longer planted and occupy an insignificant proportion of the total area under cane. They are M.112/34, M.423/41 and B.H. 10/12 (which will all have to be uprooted by the end of 1969) and B.37161. As for M.134/32, the area under this variety has decreased from 55% to 3% during the last ten years.

Three varieties which are doomed, owing to their high susceptibility to the new strain of the gumming disease bacterium, B.3337, B.34104 and M.147/44, will have to be uprooted, the first two by the end of 1970, and the other by the end of 1973.

The merits and defects of the 14 varieties left are discussed in relation to their adaptability to the various climatic zones of the island and their reactions to diseases. Notes are also included on promising varieties in the latest stage of selection.

It is thought convenient to separate the canes according to their zones of adaptation and further divide them into three groups: those released before 1964, year in which the new epidemic of gumming disease broke out; those released in, or after, 1964 and those which are showing promise and may stand a chance of being released for commercial cultivation (fig. 15).

1. Varieties adapted to super-humid zone

(a) Released before 1964

Ebène 1/37, released in 1951, a rich cane well-adapted to the super-humid zone, occupied up to 26% of the cultivated area. However its high susceptibility to wind damage and chlorotic streak are the two major factors which have led to its downfall. The variety is not replanted anymore and now occupies only 6% of the area under cane.

M.202/46. Although this variety is best adapted to the humid zone, it is profitably grown in certain areas of the super-humid zone. It is susceptible to leaf scald, but it has been shown that the life of the variety can be extended provided early rogueing of diseased plants, knife sterilization, and proper selection

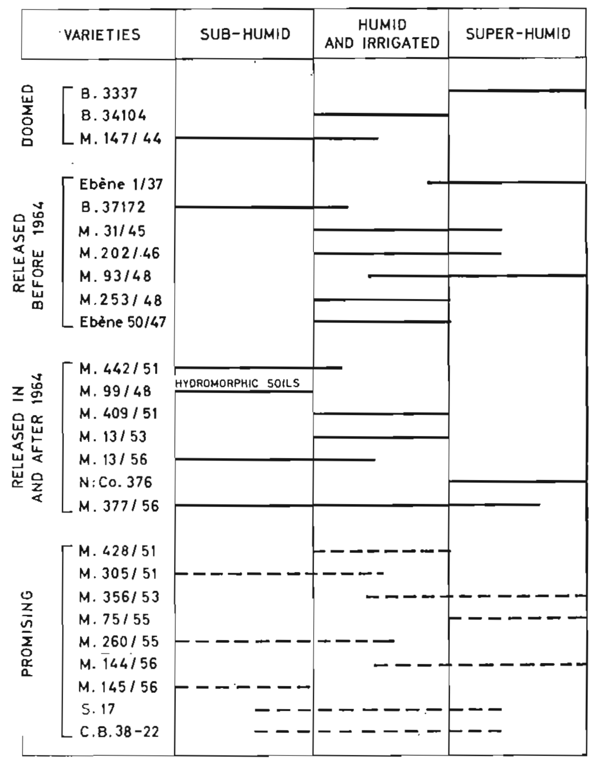


Fig. 15. Zones to which commercial varieties are, and promising ones appear to be, better adapted.

of planting material are practised. The variety is slightly susceptible to rust. However, attacks of *Fusarium* wilt have caused local damage.

M.93/48 is at present the leading variety of the high-rainfall area. It is a good yielder of average sucrose content. Resistant or tolerant to the major diseases, it should not however be harvested too late in the season as ratooning may be somewhat impaired.

(*b*) *Released after 1964*

N :Co.376 is proving a good substitute for B.3337 on the poorer slopes of the super-humid zone. It flowers abundantly and should be harvested early in the season, a desirable requirement in the area where it should be grown. The large number of relatively thin shoots produced per stool should not be a deterrent to planters.

M.377/56, a vigorous and rich cane, has a wide range of adaptation. However, its performance under the extreme conditions of the high-rainfall area has still to be determined.

(*c*) *Promising*

In addition, three varieties have shown promise in the high-rainfall area; these are : M.356/53, M.75/55 and M.144/56. They have a good sucrose content, particularly M.356/53, and are either resistant, or only slightly susceptible, to the new strain of the gumming disease bacterium, and resistant to the old.

2. Varieties adapted to the sub-humid zone

(*a*) *Released before 1964*

B.37172 has lost ground considerably, particularly on account of a gradual deterioration of its ratooning capacity, and is no longer replanted. However, it is still performing relatively well in restricted areas.

(*b*) *Released in, or after, 1964*

M.442/51 has proved to be the best replacement for M.147/44. However, the variety is a late maturer and consequently should not be harvested during the first half of the crop season. Its high susceptibility to chlorotic streak sets no problem in the zone to which it is adapted. However, in spite of its vigour, the variety should not be cultivated in the hydromorphic soils of the sub-humid zone, or in the wetter areas where the disease may cause heavy damage. It is resistant to both gummosis and leaf scald, and attacks of rust and thrips early in the season have not resulted in loss in yield.

M.99/48. That vigorous and late maturing variety was released primarily to replace B.3337 in the poorer soils of the super-humid area, but it is susceptible to yellow spot, a major limiting factor under very wet conditions. It now shows adaptation to the hydromorphic soils of the sub-humid zone.

M.13/56, a relatively thin-stalked, vigorous cane, adapted to a fairly wide range of environmental conditions including dry ones. The variety sets no disease problem, although it should be mentioned that a bronzing of the foliage has been observed but not yet identified. Of average sucrose content, the cane has a higher sugar potential than M.147/44 and should play a part in the replacement of that variety.

M.377/56, a thick-stemmed, vigorous and rich variety which has shown good adaptation to a wide range of soil and climate. It has been shown to possess drought-resistant properties and yet is a good yielder even in regions of high rainfall. As stated, its performance under the extreme conditions of the super-humid zone has yet to be determined. The variety is somewhat susceptible to yellow spot, and although it has shown resistance so far in gumming disease resistance trials, in the majority of variety trials and in commercial plantations, leaf striping due to gummosis, without systemic infection, has been observed in a few variety trials. The question is discussed in another chapter of this report. The variety has been rapidly multiplied, through the splitting of stools at an early stage of vegetation, and on one estate 15 ½ arpents were established in 12 months, starting with 75 stalks.

(*c*) *Promising*

The following varieties have shown promise in dry areas: M.305/51, M.260/55 and M.145/56. They are all resistant to the old gummosis, and resistant, or only slightly susceptible, to the new one.

3. Varieties adapted to the humid and irrigated zones

There is, as would be expected, a wider range of varieties adapted to the zones with environmental conditions more favourable to cane growth.

(*a*) *Released before 1964*

M.31/45, highly resistant to diseases, the variety has been extended since the new outbreak of gummosis. However, as the cane has a rather restricted period of harvest, the area under the variety will tend to be limited.

M.202/46, at present the leading cane in the area; its susceptibility to diseases has been outlined.

M.253/48, a good yielder under irrigation; the major defect of the variety is its low sucrose content.

Ebène 50/47, rapidly on its decline. A rich cane but, unfortunately, an erratic yielder. The variety is susceptible to yellow spot, *Fusarium* wilt and, at times, severe attacks of pokkahbœng.

(*b*) *Released after 1964*

M.409/51, a variety with a good sucrose content, but will not be cultivated on a large scale as it requires exacting environmental conditions for good performance. It is susceptible to chlorotic streak.

M.13/53, a moderate yielder but with good potential due to its high sucrose content. It has shown slight susceptibility to yellow spot.

M.377/56, as mentioned, is adapted to a wide range of conditions and performs exceptionally well in the area.

(*c*) *Promising*

M.428/51, with a high sucrose content, is showing good promise for the humid and irrigated zones. It is slightly susceptible to the new gummosis.

It should be noted, and this is shown in fig. 15, that although emphasis has been placed on adaptation to the two more unfavourable zones for cane production, the sub- and super-humid, several varieties can be profitably grown in the other two.

Two imported varieties, S.17 and C.B.38-22, are particularly interesting as they both have a high sucrose content, particularly the former. They have so far shown resistance to the major cane diseases, except that S.17 is slightly susceptible to smut.

On the debit side, it should be mentioned that a few very promising canes had to be discarded due to their susceptibility to diseases. Thus, M.296/55, a rich cane, which seemed well-adapted to the super-humid zone, has succumbed to the new gummosis. The same applies to Q.70 which had performed well in the humid and sub-humid zones. M.130/57 is another cane with high sucrose content for the high rainfall area; however, as a few cases of leaf scald have been observed in this variety, additional experimentation is under way to assess disease reaction. Furthermore, M.351/57 and Ebène 74/56, two high yielders, have a low sucrose content and their release for commercial plantations is not contemplated as yet.

It follows from the foregoing that the varietal problem which had arisen as a result of the outbreak of the new epidemics of gummosis and leaf scald in 1964 is now well in hand. Resistant varieties, old-standing and newly-released ones, now cover the full range of environmental conditions encountered in the sugar cane lands of Mauritius. Also, a few varieties, with high sucrose content, have shown promise in the various climatic zones, a good encouragement for the years ahead.

2. GUMMING DISEASE

C. RICAUD

The disease situation

The distribution of the disease in commercial plantations has again declined as a result of unfavourable climatic conditions for the dissemination of the pathogen and development of infection at the beginning of the year. However, conditions during the cool maturing season were ideal for the disease, with the result that heavy infection occurred, but in localized areas only, particularly on the dark magnesium clays and under spray irrigation, where gummosis was observed to be at its worst in M.147/44 ever since the new epidemic started in 1964. In one field, a survey revealed that all stalks showed foliar infection and all stools had at least one stalk with systemic infection and leaf chlorosis. Yet, once again, no death of mature stalks was observed, confirming that the disease is not as damaging in the vigorously growing hybrids at present under cultivation, as it used to be in the "noble" canes during epiphytotics in the past.

Resistance trials

Four resistance trials were concluded in 1967. Two involved the second-stage replicate testing with old and new strains of the pathogen in two localities, the old strain at Réduit and the new one at Ferney, each including 45 varieties coming out of First Selection Trials. The other two trials involved the first-stage testing with the new strain, including 338 and 239 varieties respectively.

Again, as a result of unfavourable conditions for development of infection early in the year, the contaminating rows of B.34104 in all trials with the new strain had to be inoculated twice, in an attempt to obtain an acceptable level of infection. Despite re-inoculation, that level in the larger first-stage trial, carried out in a locality where conditions have not proved favourable for disease development, remained low. The control plots of M.147/44 showed slight susceptibility only, and not more than 12% of the varieties contracted infection. The results of this trial will not be considered and, in future, all resistance trials with the new strain will be carried out in the south-eastern part of the island where conditions are ideal for disease development.

On the other hand, the level of infection in all other trials was very high. The proportion of resistant and susceptible varieties in the smaller first-stage trial is shown in Table 11.

Table 11. Reaction of varieties to the new strain in the first-stage gumming resistance trial

*Rating**		*No. of varieties*	*% of total tested†*
Resistant	1 ...	7	2.9
	2 ...	68	28.5
Susceptible	3 ...	124	51.8
Highly Susceptible	4 ...	30	12.5
	5 ...	3	1.3
	6 ...	0	0

* Numbers correspond to the following ratings :

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

† 3% failed to be established.

The highly susceptible varieties have been discarded. Of the susceptible ones (rating 3), 47 (19.2% of the total tested) have shown slight susceptibility only, and may later be re-rated and a decision taken if they reach the second-stage trial. Thus, on the whole, about 50% of the varieties tested at this stage have failed to show an acceptable level of resistance.

The final assessment of resistance in the second-stage trials is based on results obtained with both old and new strains. These results are summarized in Table 12.

Table 12. Reactions of varieties to gumming disease at the second-stage testing in 1967

	No. of varieties	*% of total tested*
Highly Resistant	11	24.4
Resistant	4	8.9
Slightly Susceptible ...	11	24.4
Susceptible	11	24.4
Highly Susceptible ...	8	17.8

At the second stage, when a more precise assessment of reaction can be made, varieties considered highly resistant are those which do not contract foliar infection at all, or which show very short stripes indicating that infection has occurred, but has been rapidly checked. Resistant varieties are those which may show moderate foliar infection under heavy bombardment by the pathogen. The slightly susceptible ones are those which bear a few long foliar stripes, and thus need re-testing or further observations in variety trials to confirm their status. Classification as susceptible or highly susceptible is also based mainly on foliar infection. Such varieties are rejected even if they fail to show systemic infection.

Of the promising varieties which have been re-tested, M.220/56 and Ebène 74/56 were rated as susceptible; M.260/55 and M.145/56 as slightly susceptible; M.75/55 and M.393/57, as resistant; and M.84/57 as highly resistant.

Reaction of progenies from resistant and susceptible parents

Gummosis, being a major limiting disease factor in the breeding programme which has led to the elimination of a few promising varieties, it was considered desirable to start a preliminary investigation on the reactions of seedlings issued from selected crosses involving susceptible and resistant parents. The current testing of varieties at definite stages during selection cannot give a correct picture, as a large number of seedlings never reach these stages. The new strain of the bacterium was used in the test, and the crosses involved the following parents : M.134/32, M.147/44, M.202/46 and B.3337 as shown in Table 13.

The seedlings from each cross were grouped into randomized plots consisting of one row of 30 ft with 15 seedlings each, planted singly. As usual, contaminating rows of B.34104 separated every two rows of seedlings, and plots along a line were separated by 5 feet of the cane providing infection. The following controls were included : M.147/44 (highly susceptible), M.31/45 and M.442/51 (resistant). The trial was conducted in an area favourable to disease development and the reaction of M.147/44 indicated a high level of infection.

The proportion of resistant and susceptible progenies from the different crosses is illustrated in fig. 16. The high proportion of susceptible seedlings from the cross involving two highly susceptible parents (50%) is interesting and further investigations have been planned.

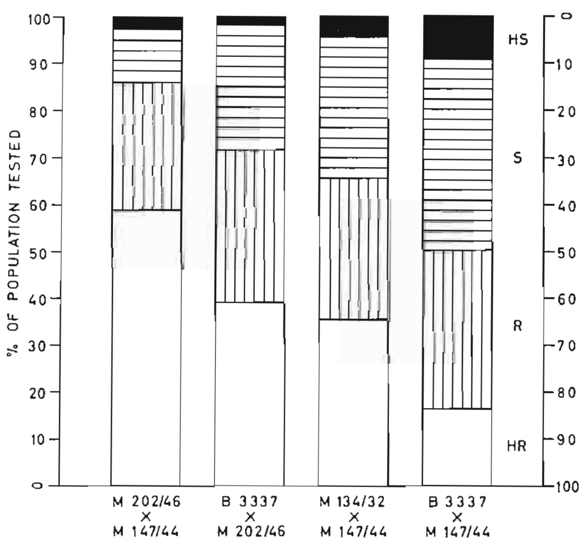


Fig. 16. Proportion of resistant and susceptible seedling progenies from four crosses involving resistant and susceptible parents. (HS = highly susceptible; S = susceptible; R = resistant and HR = highly resistant).

Table 13. Number of seedlings, issued from various crosses, tested for reaction to gumming disease

Cross		*No. of seedlings tested*
M.202/46 (resistant)	× M.147/44 (highly susceptible)	120
B.3337 (highly susceptible)	× M.202/46	143
M.134/32 (resistant)	× M.147/44	46
B.3337	× M.147/44	245

Effect of systemic infection on yield

It was pointed out in the Annual Report for 1965 that a fair amount of systemic infection occurs at harvest, through inoculation by contaminated knives, especially when young suckers are cut above their growing point. The shoots with chlorotic leaves which develop may be numerous and can persist until the next harvest under certain conditions. An experiment to study the effect of such infection by knives on yield in M.147/44 was concluded during the year. Plots of artificially inoculated stools were compared to non-inoculated ones. Each plot consisted of 4 rows of 20 ft and there were six replicates for each treatment. Inoculation was performed at harvest by pouring a dilute suspension of a pure culture of the new strain of the bacterium over the freshly cut surfaces of stumps and of young suckers cut above their growing point. The control plots were cut in the same way but not inoculated.

There was a good development of systemic infection as shown in Table 14.

The canes were harvested at ten months and, as usual, records were taken in the two middle rows of each plot only. As shown in Table 15, inoculation caused a highly significant drop of 23.2% in sugar yield, due mainly to a reduction in the number of millable stalks.

Labourers should therefore avoid cutting young suckers at harvest, in the susceptible varieties still under cultivation.

Studies on strain variation in *Xanthomonas vasculorum*

In order to obtain information on the distribution of the old and new strains in plantations, with the view of a better understanding of the problem of strain variation in the pathogen causing gumming disease, various isolates from different sources were grown on a medium containing 0.005% tri-phenyl tetrazolium chloride, which allows differentiation between the two strains (*cf. Annual Report 1964* p. 53).

Four isolates were obtained from varieties which had contracted infection in the resistance trial to the old strain at Réduit, including the control 55-1182, and five others from naturally infected varieties in different regions. The isolates were purified by the dilution plate method and three separate cultures of each, derived from single-cell colonies, were used for the tests. Slants of the tetrazolium medium were inoculated by stabbing with a needle dipped in suspensions of the bacterial cultures. There were 30 slants for each isolate, i.e. 10 for each of the three cultures derived from single-cell colonies. The flow of the bacterial cultures down the slants was measured after 5 weeks.

The results presented in fig. 17 indicate clearly the existence of two distinct populations of the pathogen. All isolates from varieties in the resistance trial to the old strain gave the typical reaction of that strain of the bacterium,

Table 14. Development and disappearance of chlorotic leaf symptoms in plots inoculated with gumming disease

Week after harvest		*6th*	*10th*	*14th*	*18th*
Shoots with chlorotic leaves/plot†	Average no.	30	27	8	0
	% of total	15.8	15.0	3.9	0

Table 15. Effect of gumming disease on yield in M.147/44, following infection by knives

	Inoculated	*Control*	*Reduction*
No. of millable stalks/plot	113	143	21*
Length of stalks (in.)	70.8	76.4	7.3*
Wt. of canes/plot (kg)	114.3	141.8	19.4*
I.R.S.C.	9.5	10.0	N.S.
T.S.A.	2.16	2.84	23.2**

† Counts reckoned on the two middle rows only

* Significant at P 0.05

** „ „ P 0.01

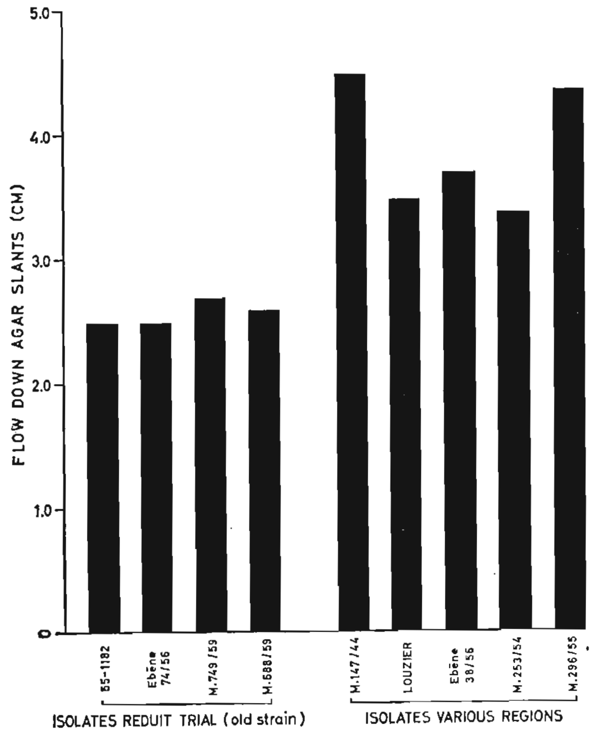


Fig. 17. Different growth of two strains of the gumming disease bacterium on a medium containing tri-phenyl tetrazolium chloride.

as measured by flow down the slope, although all these varieties are susceptible to both strains of the disease organism. All isolates from other sources reacted as the new strain, even the one obtained from the variety Louzier* which is highly susceptible to the old strain, but was being grown for experimental purposes in an area where the new epidemic prevailed.

Investigations are being pursued to determine the viscosity of the bacterial slime associated with old and new strains. Preliminary results, obtained with suspensions containing equal amounts of fresh weight of bacterial cells, using Cannon-Fenske viscometers, have indicated that suspensions of the new strain were less viscous than those of the old strain (Table 16). Turbidity values for the same suspensions were, on the other hand, lower for the old strain. Further and more precise experimentation will be on a comparison of suspensions containing equal numbers of bacterial cells.

Table 16. Relative viscosity and turbidity of bacterial suspensions of old and new strains

Conc. of suspension (fresh wt./vol.)	*Relative Viscosity*		*Turbidity*	
	Old strain	*New strain*	*Old strain*	*New strain*
1%	1.392	1.270	0.65	2.10
0.5%	1.207	1.143	0.30	1.05
0.25%	1.108	1.072	0.25	0.55

Leaf striping, without systemic infection, was observed on the newly-released variety M.377/56 in a few variety trials conducted by estate agronomists. Yet, the reaction of the variety has not been consistent as it has always been rated highly resistant in resistance trials, including the one in which it was being re-tested this year. Also, it has shown resistance in the majority of variety trials and in commercial plantations. This behaviour may indicate variability in the pathogenicity of the bacterium in different ecological areas, or probably and more perturbing still, the possible evolution of other strains of the organism differing in host reaction. Studies on this problem are being pursued.

The broom bamboo (*Thysanolaena maxima*), believed to be a natural host of the pathogen causing gumming disease until evidence to the contrary was obtained, was badly infected this year with a disease very similar to gummosis. Severe systemic infection with gum pockets inside the stalks leading to death of the growing point, as well as leaf chlorosis, were observed (Plate III), indicating the similarity between the diseases of cane and the grass. Microscopic observation of gum exudation in water from foliar stripes, revealed the presence of annular elements of the xylem vessels in the exudation stream (Plate IV), indicating that disintegration of the vessels had taken place. Such an observation has never been recorded in the case of gumming disease of the sugar cane.

A comparison of the cultural characteristics of the pathogen isolated from broom bamboo, with those of the old and new strains of the sugar cane pathogen, has confirmed the inability of the former to hydrolyze starch, casein and gelatin, as opposed to both cane isolates. Furthermore, cultures of the new strain produced a slightly larger zone of hydrolysis than those of the old strain, indicating again their greater enzymatic activity.

* Lahaina, Bourbon, Otaheite, Cana Blanca, Caiana.

3. RATOON STUNTING DISEASE

C. RICAUD

A new R.S.D. trial was established in the super-humid region with planting material derived from the Central Nursery, including the following newly-released varieties : M.409/51, M.442/51, M.13/53, M.13/56, M.377/56, N:Co. 376, and the two unreleased varieties M.356/53 and M.351/57.

The total area under A and B nurseries at the Central Nursery covered 135 arpents. The nursery supplied 2,325 tons of canes to estates and planters for the establishment of 700 arpents of B nurseries and, in addition, 900 tons to small and large planters for their commercial plantations. About 150 tons of cuttings were treated at the Central Hot - Water Treatment Station to establish 40 arpents of A nurseries at the Central Nursery for next year's supply.

The newly released variety M.13/56 having shown impaired germination after the long heat treatment, investigations were conducted to find out whether it was preferable to use single-bud setts for treatment, with a view to utilizing planting material to a maximum, and also to try and reduce treatment time as a result of, possibly, better heat transmission inside the smaller cuttings.

Using needle thermocouples, heat transmission inside single- and 3-bud setts during hot - water treatment at 50°C was therefore determined. The times taken for the temperature to reach 50°C at the centre of setts of three different diameters are set out in Table 17.

Table 17. Time taken to reach 50°C at the centre of one-eyed and three-eyed setts of different diameters

Diameter (cm.)	*One-eyed setts* (mins.)	*Three-eyed setts* (mins.)
3.0	25	28
3.9	40	43
4.5	50	65

It follows from the results that the diameter of the setts is far more important than their length, for cuttings of an average size, indicating that the rate of heat transmission is governed mainly by the shortest distance from the exterior to the centre of the cutting and that the rind has little more insulating power than the pith. Only in the case of oversize cuttings (4.5 cm in diameter) are appreciable differences observed; but, such cuttings are seldom encountered at the heat treatment plant.

Germination studies indicated that the single-eyed setts were still more affected after heat treatment, than the three-budded ones, probably through greater vulnerability to the pineapple disease pathogen. Even when grown in bagasse, germination failures were high with the single-bud setts.

4. PINEAPPLE DISEASE

C. RICAUD

Fungicide tests

The routine screening of fungicides for the treatment of cuttings against pineapple disease was carried out during the year. On account of the rising price of mercury, the efficacy of certain non-mercurial fungicides in the control of the disease was studied this time. The following fungicides were compared to one of the standard organo-mercurials, Aretan, at four concentrations : Captan (50% WP), Difolatan

(80% WP), Dithane M.45, Thiram and two organo-tin formulations, Brestan and Du-ter.

The fungicides were used in the cold dip treatment. A split-plot design was adopted with the four concentrations (low, medium I, medium II and high), as whole plots, with the split on the fungicides. There were four replicates and each individual sub-plot consisted of 25 cuttings planted in a row of 15 ft.

Ample inoculum was provided by planting untreated setts with all buds damaged and watering with spore suspensions of the fungus obtained from bagasse cultures, prior to the establishment of the trial.

Percentage germination of cuttings, of individual buds, as well as shoot length, were determined three months after planting. The results are presented in Table 18. The appropriate angular transformation was performed on the percentages for statistical analysis. Differences between concentrations and between shoot lengths were not significant. With the exception of Captan, all the fungicides gave significant control. There were no significant differences between the other fungicides on the basis of % germination of cuttings. On percentage germination of buds, Aretan was significantly superior to the others, with the exception of Difolatan. On the whole, Difolatan and Du-ter have given the most promising results among the non-mercurials.

A new fungicide combination Hyamine Dithane M.45 was also tested, incorporated in the hot-water bath for the treatment against chlorotic streak at 52°C/20 minutes. The investigation was carried out in a small laboratory tank. The new formulation was used at a concentration of 0.2%. Germination was determined for samples taken at intervals during a long run of treatments lasting over a week. These preliminary experiments have indicated that a significant control of pineapple disease was obtained with the new fungicide. Under the conditions of the experiment, 1 lb of fungicide treated 1 ½ tons of cuttings. In view of the encouraging results, further experimentation is contemplated.

Table 18. Assessment of fungicides in the control of pineapple disease

Fungicides	*Conc. g/litre*	*% Germination Cuttings*	*% Germination Buds*	*Av. shoot length*
Aretan (6%)	1.5	78.9	45.4	21.6
	2.5	61.9	36.8	22.5
	5.0	86.8	45.8	20.3
	7.5	86.0	52.8	21.2
	Mean	*78.4*	*45.2*	*21.4*
Captan	1.5	73.6	37.4	19.6
	2.5	69.6	29.7	18.5
	5.0	77.5	34.5	22.2
	10.0	80.8	38.4	22.9
	Mean	*75.4*	*35.0*	*20.8*
Difolatan	1.5	83.4	36.7	21.2
	2.5	88.1	41.4	22.8
	5.0	88.1	45.1	21.7
	10.0	81.7	43.1	23.9
	Mean	*85.3*	*41.6*	*22.4*
Dithane M.45	1.5	76.9	35.5	20.9
	2.5	75.5	35.3	24.0
	5.0	86.9	44.5	21.5
	10.0	82.5	42.5	22.8
	Mean	*80.5*	*39.5*	*22.3*
Thiram	1.5	66.1	31.5	21.6
	2.5	84.0	35.4	22.1
	5.0	83.4	43.3	21.3
	10.0	92.1	44.5	23.9
	Mean	*81.4*	*38.7*	*22.2*
Brestan	2.5	80.9	34.8	22.2
	5.0	78.6	38.4	20.6
	10.0	76.0	36.0	23.0
	20.0	88.9	40.3	24.2
	Mean	*81.1*	*37.4*	*22.5*
Du-ter	2.5	84.1	38.0	21.6
	5.0	87.1	45.3	22.3
	10.0	85.8	36.1	20.0
	20.0	79.5	40.1	22.4
	Mean	*84.1*	*39.9*	*21.6*
Control	*Mean*	*69.5*	*32.5*	*20.9*

Economics of bulk fungicidal treatment after hot-water treatment

The bulk treatment of cuttings for pineapple disease control, by dipping the cane baskets in a large tank containing a solution of the fungicide immediately after the short hot-water treatment against chlorotic streak, is the usual practice on estates. The services of the pathology laboratory of the M.S.I.R.I. are usually sought for assessing the deterioration of fungicide solutions in these tanks and indicating the number of treatments that can be effected. An original fungicidal concentration equivalent to 0.03% Hg (i.e. 1 lb fungicide at 6% Hg/20 gallons) is recommended for these tanks, and the solution can be used until the concentration has dropped to half that amount. As a large initial quantity of fungicide is required for each treatment cycle, on an average, about 150 lb (at 6% Hg) for a treatment capacity of 3 tons of cane, efficient use is essential in order to avoid expensive wastage.

Investigations were therefore conducted at three treatment sites to study the economics of bulk treatment, as compared to manual dipping of cuttings in fungicide in small containers at planting site, the normal estate practice with untreated cuttings. Daily determinations of the mercury content of fungicide solutions were made for several cycles.

Fig. 18 shows the deterioration of fungicide (averaged for two determinations) for a tank treating 3 tons of cane and using an initial amount of 150 lb of fungicide at 6% Hg. Treating 30-40 tons daily in such a tank, 1 to 1.3 ton of canes can be treated per lb of fungicide, the higher ratio being obtained with the greater daily output, as deterioration is a function of tonnage treated and time. On an average, if the original concentration was 0.03% Hg, the solution could be used until the end of the week.

The deterioration of fungicide solutions when treating in small containers was also studied. Using 1 lb of fungicide at 6% Hg in 20 gallons for treating 4-5 tons of cane to plant one arpent per day, several determinations showed that the fungicide solutions were just spent at the end of the day's work.

The economics of both methods of treatment are set out in Table 19.

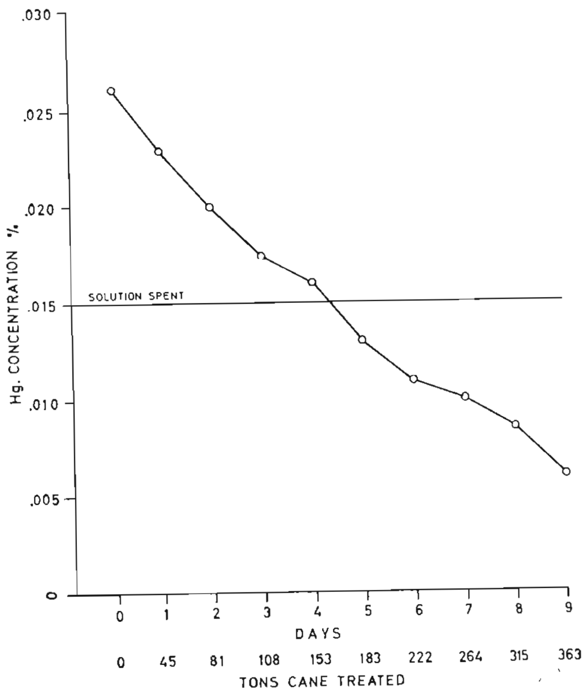


Fig. 18. Deterioration of an organo-mercurial fungicide during bulk treatment of cuttings against pineapple disease following short hot-water treatment.

The results show that bulk treatment of cuttings in the fungicide is at least three times more expensive than treatment at the planting site in small containers.

Considering that the additional labour cost for manual dipping of cuttings just before planting is insignificant, it follows that appreciable savings can be made by treating in small containers in the field. However, in order to ensure adequate control of pineapple disease, there should be no undue delay between heat treatment and fungicidal dip.

Table 19. Economics of bulk treatment compared to treatment in small containers for pineapple disease control

		Bulk treatment at H.W.T. plant	*Treatment in small containers at planting site*
Tonnage treated/1 lb fungicide	...	1 — 1.3	4
Amount of fungicide/arp.*	...	4 — 3 lb	1 lb
Cost/arp. (at Rs. 8/lb fungicide)	...	Rs. 32 — 24	Rs. 8

* 4 tons of cuttings planted per arpent.

5. AN ATTEMPT TO PROMOTE RATOONING BY FUNGICIDAL TREATMENT

C. RICAUD & R. BECHET

Poor ratooning is at times a problem in the super-humid zone with certain varieties. As, on occasion, diseases such as chlorotic streak and leaf scald can be discarded, the trouble could be due to infection of buds and stumps by various unspecific fungi, bacteria, or yeasts, especially when regrowth is retarded after harvest by cooler conditions or excessive soil moisture. The fungus *F. moniliforme* has been isolated from various buds which have failed to develop.

On the above assumptions, fungicidal treatment could perhaps be beneficial to ratooning, and its application incorporated with herbicide solutions should set no problem. An experiment was therefore designed, to test the efficacy of such treatment, and conducted in a ratoon field of M.93/48 with a homogeneous stand. The fungicides Thiram and Dithane M.45 were applied as a drench on the cane rows at the rate of 1 gm/5 litres of water/10 ft row of cane. A split-plot design was adopted with 4 replicates, with split on treatment and no-treatment. Each sub-plot consisted of 4 rows of 40 ft. A few weeks after harvest of the previous crop, all the young shoots were counted, then cut back completely and treated. Two more treatments were applied at two weeks intervals. Shoot counts were again made one month after the final treatment. At harvest, when the canes were 12 months old, yield, number of millable stalks and individual stalk length were assessed.

A slight beneficial effect was apparent in the plots treated with Thiram only when comparing stalk counts before and immediately after treatment (Table 20), but the results did not show significance in a co-variance analysis. Similarly, all other differences in stalk count, stalk length and yield were not significant.

Although it should be stressed that heterogenity in such trials is high, it would appear that the role played by fungal infection of the basal buds and stumps on ratooning capacity is probably a minor one.

Table 20. Differences and ratios* of shoot count after and before treatment with fungicide

Replicates	*THIRAM* Treated Difference	Treated Ratio	Non-Treated Difference	Non-Treated Ratio	*DITHANE M.45* Treated Difference	Treated Ratio	Non-Treated Difference	Non-Treated Ratio
I ...	699	3.6	295	1.8	456	2.1	403	2.5
II ...	496	2.3	250	1.8	156	1.5	194	1.6
III ...	375	2.0	395	2.0	331	2.1	188	1.6
IV ...	246	1.8	149	1.6	134	1.6	224	1.8

* Ratio $\frac{\text{No. of shoots after}}{\text{No. of shoots before}}$ is taken as an indication of the extent of branching of the rhizome.

6. MISCELLANEOUS DISEASES AND INVESTIGATIONS

C. RICAUD

Leaf scald

Conditions at the end of 1966 and through most of the 1967 crop were not favourable to the disease and yet a recrudescence of symptoms was observed in commercial plantations of M.202/46. This may be attributed to less sustained vigilance in the rogueing of infected fields. The importance of such rogueing in nurseries and earlier ratoons, at least up to the second, has to be once more stressed.

The leaf scald trial established in 1966 was inoculated at the beginning of the year, but symptoms failed to develop properly even in the rows of susceptible varieties planted to provide infection. After ratooning, at the end of the year, a few varieties showed symptoms in both inoculated and non-inoculated rows. They are the following : M.202/46, which is the highly susceptible standard; M.130/57, M.260/55 and M.124/59. The level of infection was too low for any definite conclusion to be made and the trial will have to be re-inoculated.

Chlorotic streak

Chlorotic streak was severe during the year, due no doubt to the wet season, and affected ratooning seriously in susceptible varieties growing in high rainfall areas. Severe reductions in yield were encountered in M.442/51 wherever it was being tried by planters in small plots in the wetter areas, or when planted in the dark magnesium clays of the sub-humid zone under irrigation. Planters are once more advised not to plant this variety which is highly susceptible to chlorotic streak under such environmental conditions. In marginal areas for the disease and under irrigation, the short hot-water treatment is essential for this variety.

Greenhouse experiments on the transmission of the disease are still progressing. Symptoms have started to appear, but it is too early to begin an assessment of results.

The trial established in 1966 to study the effect of soil organic amendments on the rate of re-infection was ratooned. Unfortunately, natural re-infection in the trial as a whole has so far been low.

Fusarium wilt

Very few cases of *Fusarium* wilt were seen in 1967, and wherever infection was observed, this was on a very restricted scale.

In a trial established in a field where infection had been severe, to study the effect of taking a short fallow after harvest on the possible reduction of disease incidence in the next crop, symptoms failed to develop in all plots. Similar failures were experienced when planting cuttings of the susceptible variety M.202/46 in heavily infected soil in pots, and also in soil inoculated with pure cultures of the pathogen. Inoculation at the base of mature plants also failed to reproduce the disease.

It is most likely that the strain of *F. moniliforme* observed associated with wilt under local conditions, is a mild pathogen, commonly occurring in sugar cane soils in the saprophytic phase, which infects the plant only after a general weakening of the root system by adverse soil conditions. The factors involved are under study.

Fiji disease in Madagascar

The level of infection in the resistance trials carried out on the east coast of Madagascar has been the lowest so far recorded since the trials were started in 1962, in M.134/32, the variety providing infection, with only 10% of the stools diseased. The Malagasy agricultural authorities are considering the desirability of constructing, as another co-operative effort by Réunion, Mauritius and Madagascar, a greenhouse in Tananarive in which disease reaction of varieties would be assessed.

In the trial planted in 1963, the varieties B.46364, B.49119, Cl.41223 and Q.58, now in third ratoon, have again confirmed their resistance. In the 1964 trial, three varieties rated resistant in first ratoon have now contracted infection : R.514, R.519 and R.520. In the 1965 trial, Ebène 88/56 and N:Co.293 have proved to be susceptible. No disease transmission has yet been observed in the 1966 trial in which M.409/51 is included. The following Mauritian varieties are undergoing quarantine in Madagascar to be tested at a later date : M.13/53, M.13/56, M.377/56, M.84/57 and M.351/57.

CANE PESTS

J. R. WILLIAMS

THE breeding and liberation of the cane borer parasite *Diatraeophaga striatalis* Tns., which is described fully below, left little time for other work on cane pests.

Infestations by the thrips *Fulmekiola serrata* (Kob.) were particularly conspicuous during 1967 on young canes, especially young virgin canes. The insect, living in colonies in the spindle leaves, scarifies the leaf epidermis and this injury, when severe, results in leaves drying out along part of their length, mostly after they unroll, or in large, irregular chlorotic patches or streaks on opened leaves. Desiccation is more a feature of attack in virgin cane, and leaf chlorosis in ratoon cane. The loss of photosynthetic area is often very considerable. Thrips injury seems to have increased in recent years, perhaps because of greater susceptibility of present commercial canes, and it is planned to investigate its effect on cane growth to assess the need for control measures.

The scale insect *Aulacaspis tegalensis* (Zehnt.) remains troublesome at the Central Cane Nursery. No experimental work was done during the year but the East African Station of the Commonwealth Institute of Biological Control was requested to make a survey of its natural enemies in East Africa with a view to the introduction into Mauritius of any that seem to hold promise.

A shipment of *Tytthus mundulus* Bredd., a predator of leafhopper eggs, was made to South Africa at the request of the Mount Edgecombe Sugar Experiment Station. The insect was required for tests against *Numicia viridis.* It may be recalled that *Tytthus* was purposely introduced into Mauritius in 1956-57 against cane leafhoppers, particularly *Perkinsiella saccharicida,* and it is worth noting that field observations over the years since then, and during searches for the insect for shipment to South Africa, have shown that it is common and often abundant in the presence of leafhoppers on both sugar cane and maize. It has undoubtedly become a useful predator.

Nematode studies were continued as time permitted. From soil samples taken intermittently in recent years, it has been determined that at least five species of *Xiphinema* occur about cane roots and the distribution of some is clearly linked with environment. Thus, two of the commonest, *X. ensiculiferum* and *X. elongatum,* have distributions that are distinct, the former occurring in Humic Ferruginous Latosols and Latosolic Brown Forest Soils characteristic of the high rainfall area (> 100″) and the latter in other soils of lower rainfall areas ; a third species seems present only in sandy soil.

LIBERATION OF THE MOTH-BORER PARASITE, *DIATRAEOPHAGA STRIATALIS*

Breeding and liberation. The breeding and liberation of the Javanese cane borer parasite, *Diatraeophaga striatalis* Tns., as described in last year's report, was continued throughout the year at the Pamplemousses Sugar Experiment Station. It may be recalled that the object of this work is to establish the parasite in the island as a biological control agent of the cane moth borer *Chilo sacchariphagus* (Boj.), which is also the natural host of the parasite in Java. If, on the other hand, environmental conditions in Mauritius are for some reason adverse to the parasite, so that it cannot be established or cannot flourish, then the liberations should be of sufficient scope to permit a conclusion to this effect.

Results of breeding. Ten generations were reared. The number of borers collected in the field and inoculated with first-instar parasite larvae was 88,861, giving 47,936 parasite pupae from which 37,512 adults emerged. The sex ratio is 1 : 1, and of the 19,044 female adults actually obtained, 15,892 were mated in the laboratory within two days of their emergence. The number of adults released amounted to 12,974 mated females and 10,920 other adults, the latter being mostly males but including a small, undetermined number of unmated females.

Table 21 shows the complete record of laboratory rearing since the work began in February, 1966. It will be seen that nearly 150,000 borers collected and inoculated have enabled almost 23,000 mated female parasites to be released.

The number of mated females released as a percentage of borers inoculated is a criterion of the efficiency of the breeding technique : it averages 15.7, but varies considerably per generation and, as discussed in the previous report, depends primarily on the size of the borers available. Thus, efficiency can be increased considerably by using only large borers, but supply of borers is never adequate owing to difficulties of collecting them and all that are at hand, except the very smallest, are invariably used for breeding. In other words, the number of large borers that can be collected is the key factor that determines both the efficiency of breeding routine and the size of each parasite generation reared.

Releases. Table 22 shows full details of liberations made during 1967, and is a continuation of Table 23 in the *Annual Report 1966*, which details the liberations of that year.

Most parasites were released at Le Vallon, where a total of 23,697 adults, including 11,763 mated females, were liberated between 22nd October 1966, and 27th May 1967. This locality had been selected for liberation of the parasite because of its topographical isolation and high rainfall, while streams with wooded banks and forested mountain slopes adjacent to sugar cane fields offered a varied environment. Unfortunately, and despite the presence of borer infested fields in October 1966, borers were not abundant in the area when most parasites were released.

Releases in other localities were over shorter periods and on a smaller scale. The presence of borer-infested fields was the main reason for these subsidiary liberations, combined with a desire to distribute the parasite fairly widely.

In December, Joli Bois was selected as a site for regular liberation of the parasite during the 1967-68 crop-growth period ; nearly 1000 mated females had been released there by the end of the year.

Recovery of the parasite. A few attempts to recover the parasite in the field were made by collection of borers at liberation sites and retaining them for emergence of parasites. Parasites emerged from five borers collected at Le Vallon on 12th-13th June, 16 days after the last liberation in that locality, showing at least that the parasite can reproduce itself in the field. No other recoveries were made. It is considered premature to determine whether or not the parasite is established as a result of liberations already made and more serious efforts at recovery cannot be made concurrently with the work of breeding the parasite, which it is intended to continue until June 1968.

Biology

Certain aspects of the biology of *Diatraeophaga* were studied in the laboratory.

Duration of life cycle. The insectary where breeding is conducted has no temperature or humidity control, and the duration of the life cycle accordingly varies with the seasons. The length of larval and pupal life was recorded accurately for a number of individuals of each generation reared between February and December. Results are shown in Tables 23 and 24 and in fig. 19.

Larval life (from inoculation of host to pupation of parasite larva) varied from 7 to 23 days, but the average length of larval life varied from 8.8 days in the hot season to 15.6 days in the cool season. Roughly speaking, a 1°C rise in daily temperatures may be said to decrease the duration of the larval stage by 1 day.

The pupal period varied from 10 to 22 days,

Table 21. **Laboratory-rearing of *Diatraeophaga striatalis*, February 1966 - December 1967**

Generation	*Date*	*Borers inoculated*	*Pupae obtained*		*Adults obtained*		*Females obtained*		*Females mated*		*Mated females released*		*Efficiency Index: (Mated females released × 100 / borers inoculated)*
			No.	*As % borers inoculated*	*No.*	*As % pupae*	*No.*	*As % adults*	*No.*	*As % females*	*No.*	*As % females mated*	
1	Feb-Ap. '66	4,205	1,345	32.0	1,165	86.6	600	51.5	495	82.5	361	72.9	8.6
2	March-May '66	6,760	3,501	51.8	3,118	89.0	1,517	48.7	1,252	82.5	1,042	83.2	15.4
3	Ap.-June '66	8,224	5,893	71.7	5,081	86.2	2,612	51.4	1,688	64.6	1,519	90.0	18.5
4	May-July '66	3,488	2,603	74.6	2,195	84.3	1,137	51.8	997	87.7	904	90.7	25.9
5	July-Aug. '66	3,152	2,122	67.3	1,692	79.7	822	48.6	769	93.6	672	84.7	21.3
6	Aug.-Sept. '66	3,107	1,952	62.8	1,691	86.6	837	49.5	749	89.5	571	76.2	18.4
7	Sept.-Nov. '66	6,754	3,612	53.5	2,884	79.8	1,425	49.4	1,314	92.2	1,039	79.1	15.4
8	Oct.-Dec. '66	11,324	5,226	46.2	4,365	83.4	2,274	52.1	2,061	90.6	1,757	85.2	15.5
9	Nov.-Jan '67	8,567	6,100	71.2	5,108	83.7	2,578	50.5	2,192	85.0	1,877	85.6	21.9
10	Dec.-Feb. '67	8,226	5,422	65.9	4,366	80.5	2,202	50.4	1,927	87.5	1,580	82.0	19.2
11	Jan.-Feb. 67	15,210	7,284	47.9	5,364	73.6	2,674	49.9	2,292	85.6	1,925	84.0	12.7
12	Feb.-March '67	10,191	6,983	68.5	5,949	85.2	3,062	51.5	2,551	83.3	2,355	92.3	23.1
13	March-Ap. '67	10,371	5,265	50.8	4,587	87.3	2,330	50.8	1,972	84.6	1,679	85.1	16.2
14	Ap.-June '67	9,548	4,508	47.2	3,539	78.5	1,842	52.0	1,662	90.2	1,472	88.6	15.4
15	May-July '67	11,766	6,546	55.6	4,679	71.5	2,411	51.5	2,058	85.4	1,509	73.3	12.8
16	July-Aug. '67	7,185	3,005	41.7	2,212	73.6	1,083	49.0	920	84.9	494	53.7	6.9
17	Aug.-Oct. '67	5,462	1,524	27.9	1,172	76.9	600	51.2	527	87.8	348	66.0	6.4
18	Oct.-Nov. '67	3,059	1,934	63.2	1,477	76.4	714	48.3	656	91.9	393	59.9	6.0
19	Nov.-Dec. '67	7,843	5,465	69.7	4,212	77.1	2,126	50.5	1,327	62.4	1,219	91.9	15.5
Totals		144,442	80,290	55.6	64,811	80.7	32,846	50.7	27,409	83.4	22,716	82.9	15.7

Table 22. Liberations of *Diatraeophaga* in 1968

Date	*Mated females*						*Total*	*Other flies (mostly males)*	*Grand totals*	*Locality*
	Days after mating									
	0	*1*	*2*	*3*	*4*	*5+*				
18/1/67		186	87	94			367	117	484	**Le Vallon**
20/1/67		145	212				357	298	655	
24/1/67								455	455	
27/1/67			68	98			166	400	566	
2/2/67		6	10	15	51		82	250	332	
13/2/67		131	100	66	7		304	222	526	
16/2/67		165	182	162			509	515	1024	
18/2/67		125	134				259	390	649	
21/2/67		146	160	138		14	458	360	818	
24/2/67		118	108	126			352	460	812	
27/2/67		3		36		4	43	97	140	
14/3/67		124	113				237	240	477	
17/3/67		142	135				277	377	654	
20/3/67		191	93				284	300	584	
23/3/67	110	103	188	112		17	530	355	885	
28/3/67	20	6	32	85	179		322	543	865	
12/4/67		98		164			262	110	372	
15/4/67		65	123				188	142	330	
19/4/67		149	123	47	35	8	362	215	577	
22/4/67		67	75	135		38	315	400	715	
25/4/67		48		40		24	112		112	
12/5/67			41	31	17		89	220	309	
15/5/67			126	105	58		289	270	559	
19/5/67	28		99	73	52	98	350	353	703	
23/5/67			52	61	88	111	312	250	562	
27/5/67			82	69	36	77	264	130	394	
Totals	158	2018	2343	1657	523	391	7090	7469	14559	
24/1/67					70		70		70	**Piton**
25/1/67					35		35		35	
26/1/67					46		46		46	
27/1/67					135		135		135	
28/1/67					56		56		56	
29/1/67					72		72		72	
30/1/67					56		56		56	
31/1/67					62		62		62	
1/2/67					67		67		67	
4/2/67						9	9		9	
Totals					599	9	608		608	
14/3/67				116	26		142		142	**Valetta**
17/3/67				127			127		127	
20/3/67			8	92		4	104		104	
22/3/67			94			19	113		113	
23/3/67		104					104		104	
26/3/67				101			101		101	
30/3/67						14	14		14	
12/4/67		47	158		58		263	100	363	
15/4/67				152			152	135	287	
Totals		151	260	588	84	37	1120	235	1355	

Date	*Mated females* *Days after mating* 0	1	2	3	4	5+	*Total*	*Other flies (mostly males)*	*Grand totals*	*Locality*
26/6/67				68	44	58	170	650	820	**Belle Vue**
29/6/67				72	89	90	251	320	571	
4/7/67						184	184	350	534	
7/7/67						161	161	260	421	
10/7/67						496	496	50	546	
14/8/67						53	53		53	
17/8/67						86	86		86	
21/8/67					64	217	281		281	
Totals				140	197	1345	1682	1630	3312	
29/ 4/67						25	25		25	**Pamplemousses**
14/ 7/67						9	9		9	
30/ 8/67						74	74		74	
2/10/67						43	43		43	
16/11/67						21	21		21	
23/12/67						46	46		46	
1/ 6/67				22		146	168	150	318	**La Chaumière**
13/ 7/67				22	14	202	238	80	318	**St. Antoine**
2/10/67					9	117	126		126	**Savinia**
2/10/67						126	126		126	**Labourdonnais**
10/11/67		52	32			144	228		228	
2/10/67						53	53		53	**Réduit**
6/11/67		16	27	34	33	34	144		144	**Colmar**
4/12/67		55	24	65	35		179		179	**Beau-Vallon**
Totals		123	83	143	91	1040	1480	230	1710	
6/12/67	40	32	62				134	79	213	**Joli Bois**
8/12/67	30	96	15				141	284	425	
11/12/67	80	93	51	10		3	237	232	469	
13/12/67	57	33	14			34	138	236	374	
15/12/67	82	76	13			10	181	225	406	
18/12/67	41	32	58			32	163	300	463	
Totals	330	362	213	10		79	994	1356	2350	
Grand Totals	**488**	**2654**	**2899**	**2538**	**1494**	**2901**	**12974**	**10920**	**23894**	

Table 23. Duration of larval life of *Diatraeophaga striatalis* at different seasons during laboratory rearing

Date of inoculations	*Mean length larval life (days)*	*Standard deviation (days)*	*Range (days)*	*No. of readings*	*Daily temperature °C Mean minimum*	*Mean maximum*
20/ 2/67 ...	8.8	1.0	7-13	649	25.0	31.3
20/ 3/67 ...	9.5	1.2	8-16	821	24.9	29.7
17/ 4/67 ...	10.3	1.1	9-14	332	23.0	28.3
22/ 5/67 ...	13.0	1.4	10-19	796	20.5	25.6
7/ 7/67 ...	15.1	1.4	13-20	181	19.8	24.0
22/ 8/67 ...	15.6	1.8	13-23	296	19.2	24.4
7/10/67 ...	12.4	1.3	10-17	348	20.6	26.0
10/11/67 ...	10.1	1.5	8-15	672	23.3	29.6
18/12/67 ...	9.0	1.4	7-15	547	24.5	31.0

Table 24. Duration of pupal life of *Diatraeophaga striatalis* at different seasons during laboratory rearing

Date of pupation		*Mean length pupal life (days)*	*Standard deviation (days)*	*Range (days)*	*No. of readings*	*Daily temperature °C Mean minimum*	*Mean maximum*
10/ 2/67	...	10.5	0.5	10-11	82	25.4	32.0
3/ 3/67	...	11.1	0.5	10-13	143	24.6	29.4
3/ 4/67	...	11.3	0.5	10-12	95	24.3	29.7
2/ 5/67	...	15.0	0.8	14-17	119	21.7	26.8
5/ 6/67	...	18.7	0.8	18-21	185	20.0	24.8
25/ 7/67	...	20.1	0.8	18-22	59	19.2	24.0
12/ 9/67	...	16.1	0.3	16-17	54	20.0	25.4
19/10/67	...	15.5	0.5	14-16	42	20.8	26.3
27/11/67	...	12.4	0.5	12-14	146	22.2	28.4
19/12/67	...	10.3	0.5	10-11	74	24.7	31.6

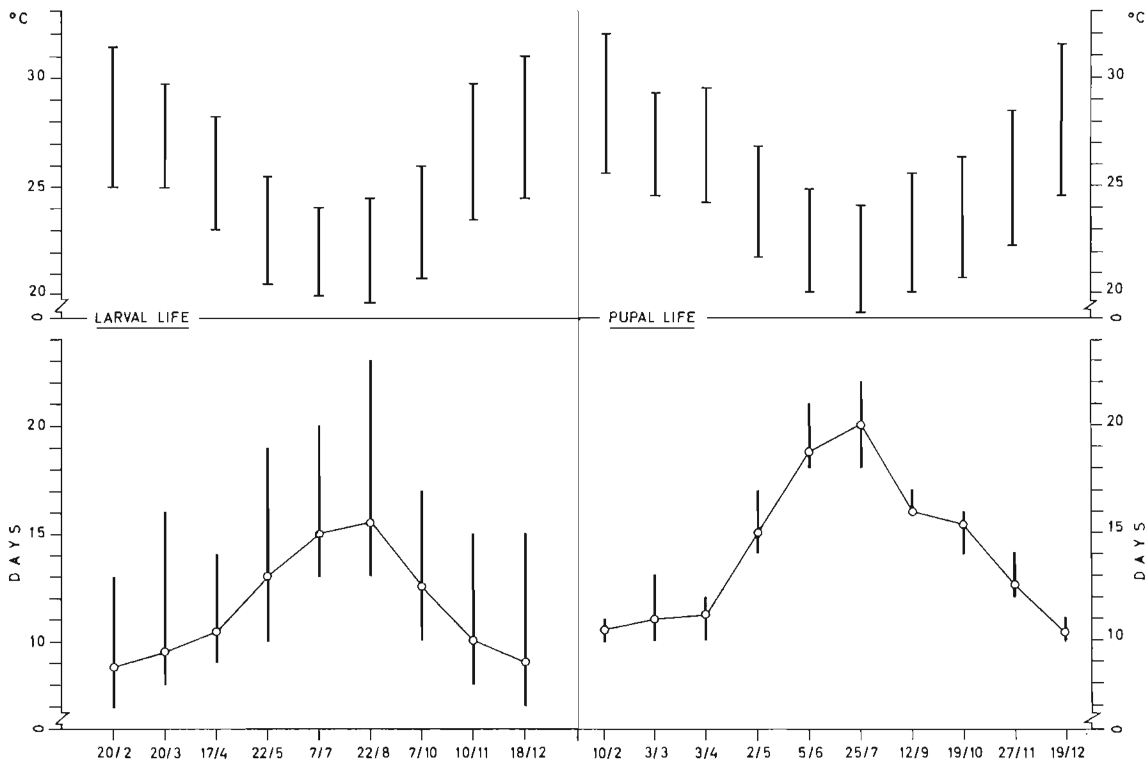


Fig. 19. Duration of larval and pupal stages of *Diatraeophaga striatalis* at different seasons during laboratory breeding in 1967. Abscissae show initial dates. Ordinates show range between average daily min. and max. temperatures, and mean and range of life stages respectively.

with averages ranging from 10.3 days in the hot season to 20.1 days in the cool season.

Allowing 5 to 7 days, according to season, for development of the egg in the uterus, the developmental period from fertilization of the egg to emergence of the adult thus averaged 24 days in the middle of the hot season, and 43 days in the middle of the cool season.

Reproduction in relation to age of adults. The effect of age on readiness of adults to mate, on their fertility, and on the fecundity of the females, was assessed.

Virgin adults, aged 0, 1, 2, 3, 4 and 5 days, that had been kept in a dark room, the sexes separate, and provided with water, sugar and honey, were used in the initial experiment. On 26th June at 9.30 a.m., 30 females and 40 males of each age category were put outdoors in organdie cages 18″ x 18″ x 18″, that is, there were six cages and adults of six ages, the adults in any one cage being of the same age, and all adults were virgin and had been kept under identical conditions beforehand. The cages were orientated in the same way (placed in a row), and the weather was overcast with sunny intervals, temperature 24°C. When adults mated, they were removed *in copula* from the cages.

The incidence of mating is shown in Table 25, from which it is to be concluded that mating, under the conditions given, occurred with equal facility irrespective of age, except that freshly emerged adults showed comparatively little inclination to mate.

Keeping the adults in darkness before the experiment may have influenced their readiness to mate. To determine if this was so, 20 virgin females and 30 virgin males were kept separately (a) in the darkroom, and (b) outside the darkroom until 4 days old. When the different sexes from the darkroom and those from outside the darkroom, respectively, were placed together on 3rd October and taken outdoors, as in the experiment described above, 17 (85%) females of the former mated within 45 mins. and 10 (50%) of the latter, indicating that retaining adults in darkness increased their readiness to mate.

Table 25. The mating of virgin adults of different ages (30 females and 40 males of each group caged separately)

	Females mated			
Age	*Within 30 mins*		*Within 90 mins*	
(days)	*No.*	*%*	*No.*	*%*
0	0	0	7	23
1	21	70	26	87
2	22	73	24	80
3	25	83	27	90
4	24	80	27	90
5	20	67	24	80

The fertility of females when mated at 1, 2, 3, 4 and 5 days of age, respectively, with males of their own age, was assessed by the state of the ovaries and uterus 10 days after mating. Results are shown in Table 26. Firstly, it is apparent that when flies were less than 3 days old at mating, the ovaries exhausted their egg-producing capacity so that they were empty, or virtually so, 10 days later ; when flies were older, descent of eggs from the ovaries was incomplete and these organs often remained large and conspicuous. Secondly, some eggs that descended into the uterus remained unfertilized and did not develop ; when adults were less than 3 days old at mating their number was normally small, but when adults were 3 days old or more at mating the number was large. To sum up, if adults were 3 days old or more when they mated, eggs did not descend normally from the ovaries and most that did descend were not fertilized.

To elucidate the reasons for infertility of virgin adults aged 3 days or more, data were sought on (a) the sex responsible for infertility, and (b) descent of eggs in virgin and mated females, respectively.

To determine the sex responsible for infertility of the older adults, 1-day-old virgin females were mated with 4-day-old virgin males, and *vice versa*. When the females were dissected 10 days later, results were as shown in Table 27, and from them it was concluded that females, but not males, lose fertility if unmated within 3 days of emergence.

Table 26. Fertility of females according to age when mated, as assessed by dissection 10 days later. All mated on 26.6.67 with virgin males of their own age, then retained with water, sugar and honey, until dissected

	1-day-old				*2-day-old*				*3-day-old*				*4-day-old*				*5-day-old*			
	Uterine eggs				*Uterine eggs*				*Uterine eggs*				*Uterine eggs*				*Uterine eggs*			
Female No.	*Developed*	*Undeveloped*	*Total*	*Ovarial eggs*	*Developed*	*Undeveloped*	*Total*	*Ovarial eggs*	*Developed*	*Undeveloped*	*Total*	*Ovarial eggs*	*Developed*	*Undeveloped*	*Total*	*Ovarial eggs*	*Developed*	*Undeveloped*	*Total*	*Ovarial eggs*
1	0	12	12	Many	310	102	412	Few	48	220	268	Many	0	9	9	Many	116	79	195	Many
2	416	14	430	None	214	30	244	None	3	215	218	Many	40	110	150	Many	0	90	90	Many
3	284	126	410	None	402	20	422	None	0	0	0	Many	52	261	313	Few	0	105	105	Many
4	232	20	252	None	27	231	258	Few	176	130	306	Few	0	212	212	Many	12	139	151	Many
5	0	38	38	Many	398	92	490	None	21	285	306	Many	15	126	141	Many	0	0	0	Many
6	282	51	333	None	144	42	186	None	0	102	102	Many	18	234	252	Many	84	99	183	Many
7	274	11	285	None	168	49	217	Few	0	0	0	Many	5	54	59	Many	20	87	107	Many
8	194	87	281	None	208	33	241	None	0	47	47	Many	0	196	196	Many	2	165	167	Many
9	0	0	0	Many	200	7	207	None	71	245	316	Many	14	154	168	Many	3	58	61	Many
10	259	42	301	None	237	66	303	Few	250	100	350	Few	0	58	58	Many	7	193	200	Many
$\bar{x}_1$	194	40	234		231	67	298		57	134	191		14	141	156		24	102	126	
$\bar{x}_2$	278	50	327		231	67	298		95	199	294		24	157	181		35	117	152	

$\bar{x}_1$ = General averages

$\bar{x}_2$ = Averages for females that have at least some developed eggs

Table 27. Fertility of females mated when 1-day-old with 4-day-old males, and when 4-day-old with 1-day-old males

Female No.	*Females 1-day-old when mated (with 4-day old males)* Uterine eggs: Developed	Un-developed	Total	Ovarial eggs	*Females 4-day-old when mated (with 1-day-old males)* Uterine eggs: Developed	Un-developed	Total	Ovarial eggs
1	260	44	304	None	180	158	338	Few
2	190	115	305	None	22	321	343	Few
3	237	38	275	None	111	232	343	Few
4	196	6	202	None	1	91	92	Many
5	0	192	192	Many	147	61	208	Many
6	285	8	293	None	165	135	300	Few
7	0	62	62	Many	19	65	84	Many
8	167	25	192	Few	0	7	7	Many
9	110	109	219	None	46	190	236	Many
10	207	15	222	None	6	106	112	Many
11	0	68	68	Many				
12	283	131	414	None				
$\bar{x}_1$	161	68	229		70	137	206	
$\bar{x}_2$	215	55	270		77	151	228	

$\bar{x}_1$ General averages

$\bar{x}_2$ =Averages for females that have at least some developed eggs

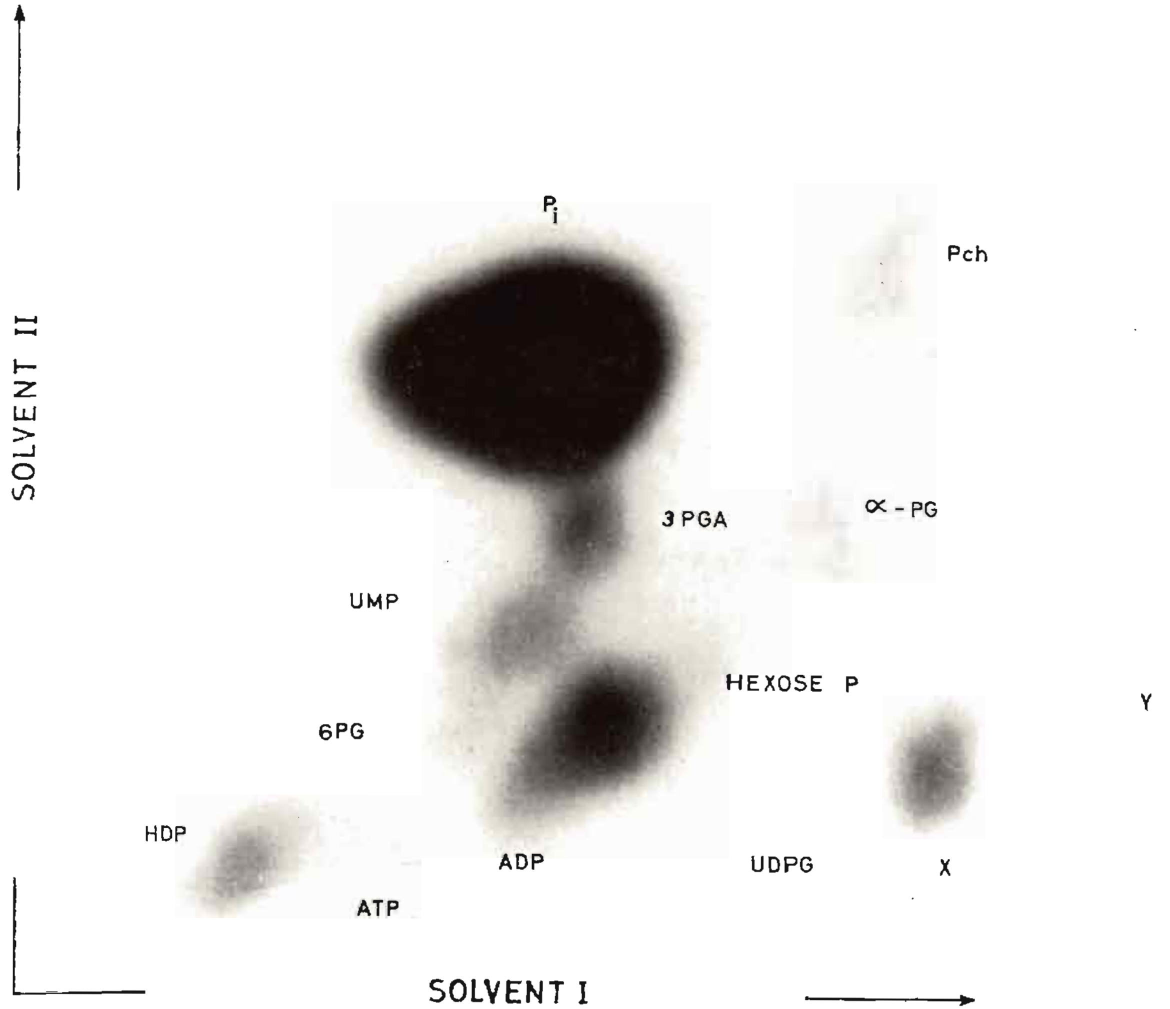
Dissection of many females showed that eggs do not normally descend into the uterus when females are virgin, particularly during the first few days of life, and that mating (copulation and/or impregnation ?) triggers their descent. Thus, the uterus of virgin females, whether freshly emerged or several days old, is usually empty, but within 24 hours of mating it contains about half, or more, of all the eggs that are to descend : thereafter, eggs continue to descend at a reduced rate until about the 3rd day after mating when all have descended and the ovaries are shrunken and empty. Descent of eggs before mating occurs was evidently not a cause of infertility in the older females : some other, unknown factors were responsible.

Fecundity. This may be defined as the number of young produced per female. It is indicated by the data for females 1 to 2 days old when mated, that is given in Tables 26 & 27. Excluding the six females that had apparently not been impregnated (no developed eggs in uterus), data become available for 26 females and the averages are as follows :

No. developed uterine eggs 10 days after mating (fecundity)	238
No. undeveloped uterine eggs 10 days after mating	58
Total uterine eggs 10 days after mating (potential fecundity) ...	296

There is much individual variation, depending on the size of a female, and this in turn depends on the size of the host in which it developed and whether that host contained more than one parasite. There is, therefore, no valid average obtainable from laboratory-bred females because methods of breeding affect their size and, if required, small or large individuals can be produced at will. In large females the number of uterine eggs is often 500-600.

Relative growth of sorghum in silicon-deficient soil (Belle Rive) treated with coral sand, calcium carbonate and silicates



Distribution of radioactive phosphate in the leaves of sugar cane whose roots were kept in radioactive phosphate solution for 24 hours.

NUTRITION AND SOILS

1. SOME ASPECTS OF PHOSPHATE NUTRITION OF THE SUGAR CANE

Y. WONG YOU CHEONG & P. Y. CHAN

WHEN soluble phosphate is added to soils, much of it normally passes out of solution fairly rapidly, i.e. becomes fixed by the soil. Part of this fixed phosphate may be rendered unavailable to crops and part may remain readily available, depending mainly upon the nature of the soil. The extent to which fixed phosphates are available to crop has been of great academic and practical interest for many years; it has been shown that certain phosphate minerals believed to be generally produced during soil/fertilizer reactions are available to plants. Some iron and aluminium phosphates were found to be relatively good sources of phosphorus (TAYLOR *et al*, 1960). Apart from the chemical nature of the reaction products between phosphate and the soil minerals, it would seem that physical properties, such as size of particle, also have a direct influence on the availability of these reaction products.

In the latosolic soils and latosols of Mauritius, iron oxide and extractable iron and aluminium are the main factors governing the fixation of applied soluble fertilizer phosphate. Whichever of these two factors is more important on a particular type of soil depends on the nature of the soil; unfortunately, little is known on the nature of the reaction products between phosphate and iron and aluminium in the soils of Mauritius. However, in soils of higher pHs, the main phosphate-precipitating agent appears to be free iron oxide, which occurs in a fine state in these soils, whilst in soils of lower pHs, extractable iron becomes the main phosphate-precipitating agent. The concentration of extractable aluminium does not become significant until low pHs are reached, but even then, it is doubtful whether aluminium plays a more important role than iron in the fixation of soluble phosphate in these soils.

There are usually only very small amounts of dissolved Al or Fe present in soil solutions. It would appear, therefore, that ionic precipitation of iron and aluminium phosphates would not occur to any great extent, except on very acid soils when aluminium ions would be present in appreciable quantities.

Excess soluble aluminium has been shown to be toxic to many plants, and phosphorus deficiency has been related to aluminium toxicity. It is therefore necessary to dissociate these two effects :

(i) a phosphate deficiency caused by the immobilisation of soil or fertilizer phosphorus either in the soil or in the roots due to the presence of large quantities of reactive aluminium or iron in the soil;

(ii) an aluminium toxicity *per se*, i.e. interference by the high levels of aluminium in the plant with normal metabolic processes.

The Latosolic Brown Forest soils of Mauritius contain high levels of soluble aluminium. It would seem that these levels of soluble aluminium would interfere with the phosphorus nutrition of sugar cane growing in these soils, but foliar diagnosis results indicate adequate leaf phosphorus levels, although no information is available on the distribution of phosphate-containing compounds present. Any toxic effect of excess aluminium in these soils could possibly be a direct effect of aluminium on the metabolic processes of the plant.

Mc. GEORGE (1924) stated that the poor growth of sugar cane kept in nutrient solutions containing high levels of aluminium was not due to phosphate deficiency. However, AYRES, HAGIHARA *and* STANFORD (1965) reported that aluminium levels in Hawaiian soils were not sufficiently high to repress the growth of sugar cane. In South Africa, BISHOP (1967) found that high levels of soluble aluminium in the soil were not toxic to sugar cane, although they were associated with poor growth.

That aluminium interferes with phosphate metabolism in other plants has been shown by many workers (RANDALL *and* VOSE, 1963, RORISON, 1965). This last author obtained a difference in % esterification and in the proportion of esterified fractions between aluminium-treated and control plants. More recently, CLARKSON (1966) suggested that aluminium decreased sugar phosphorylation and inhibited the formation of hexokinase.

Very little is known about the nature and distribution of phosphate-containing compounds in the sugar cane plant. As these compounds have such an important bearing on the synthetic reactions in the cell, on translocation processes (HARTT *et al*, 1963) and other equally vital metabolic processes, exploratory work was carried out to investigate the nature and distribution of these phosphate-containing compounds, particularly the phosphate esters and sugar phosphates.

A sugar cane plant was kept for 24 hours in nutritive solution containing P^{32} and at the end of the incubation period, the incorporation of P^{32} into the different phosphorus metabolites in the leaves was studied by the technique of BIELESKI *and* YOUNG (1963).

The distribution of the P^{32}-containing compounds is shown in Plate VI. The esters and sugar phosphates identified are P(inorganic), phosphoglyceric acid, adenosine triphosphate, 6-phosphoglyceric acid, uridine monophosphate, phosphatyl choline and hexose phosphate. The other compounds have not been identified. Most of the P^{32} transported to the aerial parts is in the form of inorganic phosphate, with some conversion into hexose phosphate and phosphoglyceric acid, which is in agreement with the work of LOUGHMAN *and* RUSSELL (1957) on barley plants.

REFERENCES

AYRES, A.S., HAGIHARA, H.H. *and* STANFORD, G. (1965). Significance of extractable aluminium in Hawaiian sugar cane soils, *Proc. Soil Soc. Am.* **29** : 387.

BIELESKI, R.L. *and* YOUNG, R.E. (1963). Extraction and separation of phosphate esters from plant tissues. *Analyt. Biochem.* **6** : 54-68.

BISHOP, R.T. (1967). Alumina and silica relationships in growth area failures. *Proc. S. Afr. Sug. Technol. Ass.* **41**: 190.

CLARKSON, D.T. (1966). Effect of Al on the uptake and metabolism of phosphorus by barley seedlings. *Pl. Physiol., Lancaster*, **41** : 165-172.

HARTT, C.E., KORTSCHAK, H.P., FORBES, A.J. *and* BURR, G.O. (1963). Translocation of C^{14} in sugar cane. *Pl. Physiol., Lancaster*, **38** : 305.

LOUGHMAN, B.C. *and* RUSSELL, R.S. (1957). The absorption and utilization of phosphate by young barley plants. *J. exptl. Bot.* **8** : 280.

Mc GEORGE, W.T. (1924). The influence of aluminium and iron salts upon the growth of sugar cane and their relation to the infertility of acid soils. *Bull. Hawaiian Sug. Plrs' Ass. Exp. Stn No.* 48.

RANDALL, P.J. *and* VOSE, P.B. (1963). Aluminium effect on phosphorus nutrition. *Pl. Physiol.,Lancaster*, **38**: 403.

RORISON, I.H. (1965). The effect of aluminium on the uptake and incorporation of phosphate by excised roots. *New. Phytol.* **64** : 23.

TAYLOR, A.W., GURNEY, E.L. *and* LINDSAY, W.L. (1960). An evaluation of some iron and aluminium phosphates as sources of phosphorus for plants. *Soil. Sci.* **90** : 25.

2. COMPARISON BETWEEN HAWAIIAN AND ORSTOM CLASSIFICATION OF MAURITIUS SOILS

P. HALAIS & C. CAVALOT

One of the first long-term projects agreed upon since the creation of the Mauritius Sugar Industry Research Institute (MSIRI) in 1953 was entitled : *"The soils of Mauritius and their classification according to the Hawaiian system"*.

This system of soil classification and nomenclature was established during the forties by CLINE and others of the Soil Survey staff of the United States Department of Agriculture (USDA) to suit the special conditions of parent rock, climate and topography of the group of volcanic islands forming the Territory of Hawaii, of which the analogy with Mauritius is an established fact. Furthermore, the general progress of sugar cane agriculture in the two territories asked for more fundamental information concerning soils than that previously required.

The publication of the soil maps of the Territory of Hawaii as a result of the detailed survey which started in 1939, and of the accompanying voluminous descriptions, was unfortunately delayed and appeared only in 1955.

Five years later in 1960, the soil survey staff of the USDA published an entirely different classification and nomenclature, *the "7th approximation"*, a comprehensive system to deal with soils on a broader universal scale. Up to the present, however, Cline's soil classification is still being used in Hawaii, at least by the research workers of the Sugar Experiment Station (HSPA).

The 1:100,000 Soil Map of Mauritius based on this earlier Hawaiian classification was printed in 1962 by the Directorate of Overseas Survey, Tolworth, England. The accompanying notes, prepared by D.H. PARISH *and* S.M. FEILLAFÉ, as Occasional Paper No. 22 of the MSIRI, appeared in 1965.

In the meantime, the Soil Map of Africa on a scale of 1 :5,000,000 was being prepared as a result of an international project headed by J. D'HOORE, Director of the Inter-African Pedological Services created in 1953, and Lecturer in Pedology at the Associated Co. of the University of Louvain in Belgium.

In the explanatory notes accompanying the Soil Map of Africa, D'HOORE referred to Mauritius as a complex of volcanic islands in the vicinity of Africa, too small to be included in the 1 :5,000,000 map.

The system finally selected as a result of numerous meetings between the soil experts of the participating countries, differed from both USDA classifications, the earlier one and the latest *"7th approximation"*. A new pedogenetic classification, the outcome of five successive approximations elaborated between 1958 and 1963, was finally adopted.

More recently, the French pedologists of the Office of Scientific & Technical Overseas Research (ORSTOM), headed by G. AUBERT, who were active participants in the Soil Map of Africa project, published in 1965 their world classification of soils to finalise the successive approximations based on pedogenetic principles. An amendment to the scheme was made a year later in 1966 by G. AUBERT and his co-worker P. SEGALEN to account for the present state of knowledge concerning the Ferrallitic soils (Latosols of earlier USDA classification) which are of very wide occurrence in the tropics.

As a result of all the above-mentioned progress, the earlier soil classification prepared for Hawaii, and used successfully by PARISH and FEILLAFÉ under Mauritius conditions, did not meet with full acceptance from the world sugar-growing countries. Consequently, it is now time, after some twenty-five years, to keep pace with world advances in soil classification. For example, such terms as "Prairie" or "Forest" used for the Soil Map of Mauritius do not refer to soil characteristics and should be avoided on present standards; others, like "ferruginous", may have been used abusively.

With this objective in mind, the Consulting Agronomist of the MSIRI, Pierre HALAIS, visited in July 1967, the Central Scientific Services at Bondy, near Paris, to discuss with P. SEGALEN the problem of correlation between the Hawaiian soil classification used earlier for the Soil Map of Mauritius and the latest soil classification of ORSTOM worked out progressively by AUBERT *and* SEGALEN. As a result of this interview, SEGALEN made suggections in writing which have been filed at the MSIRI, Réduit.

Some of the equivalences are uncertain, and all the necessary information to fix the position of the units in the new classification of ferrallitic soils is not available. Nevertheless, as a whole, the correspondence has been rather easily worked out.

The new 1965-1966 pedogenetic soil classification of ORSTOM consists of four higher categories : *class*, *sub-class*, *group* and *sub-group*. The soil *family* is based on the pedographic characteristics of the parent rock, or of the original material, *viz.* hardness and resistance to decomposition, cohesion, permeability, richness in bases... The *series* correspond to difference of detail in the profile : depth of the soil, of the accumulated or indurated horizon, thickness of certain main horizons, high content of coarse components and, where applicable, position in the "landscape". In some cases, the *series* are sub-divided into soil *types* according to definite characteristics in the texture of their upper horizons, and into *phases* corresponding to slight variations in the profiles due to temporary changes or short-term action, e.g. cultivation, erosion, etc.

This very complex soil classification should be completed by new sub-groups corresponding to soils which have been insufficiently studied, or which are not yet known.

Eleven classes have been recognized up to the present :

1. Raw mineral soils
2. Weakly developed soils
3. Calcomagnesimorphic soils
4. Vertisols and para-vertisols
5. Isohumic soils
6. "Mull" soils
7. Podzolic soils
8. Fersiallitic soils
9. Ferrallitic soils
10. Halomorphic soils
11. Hydromorphic soils

Only five of these have been observed in Mauritius. They are : 1. Raw mineral soils; 2. Weakly developed soils; 4. Vertisols & para-vertisols; 9. Ferrallitic soils; 11. Hydromorphic soils.

A code number is used by ORSTOM at Bondy to account for each pedogenetic unit; it consists of a group of three figures, except in the case of class 9, the Ferrallitic soils, for which four figures are used.

Concise definitions are given below for the classes, sub-classes, groups and sub-groups occurring, or likely to occur in Mauritius.

Class 1. *Raw mineral Soils*
Profile (A) C

Sub-class – Climatic origin (absent in Mauritius)
,, *Non climatic origin*
The pedoclimate is neither too dry nor too cold and allows for a start in the development of the soil.

Group 1.3 – Resulting from erosion or skeletal.

Sub-Group 1.31 – *Lithosols*, on rocks which do not allow root penetration.
,, **1.32** – *Regosols*, on mellow, friable or fragmentated rocks, allowing easy root penetration.

Group 1.4 – *on deposited materials*
Still in the process of being deposited.

Sub-Group 1.41 – *Alluvial*
,, **1.42** – *Marine*
,, **1.43** – *Aeolian*
,, **1.44** – *Colluvial*

Class 2. *Weakly developed soils.*
Profile A C

A horizon shallow and poor in organic matter. State of decomposition of the minerals in A not different from that in B horizon.

Sub-class – climatic origin (absent in Mauritius)
,, *Non climatic origin*
Young or rejuvenated soils — The pedoclimate favouring some development of the soil.

Group 2.4 – *resulting from erosion*
Shallow soils formed on slopes, with organic matter somewhat decomposed.

Sub-Group 2.41 – *Lithosolic* (solid rocks within first 30 cm.)
,, **2.42** – *Regosolic*
Group 2.5 – *on deposited materials*
Generally recent alluvium
Sub-Group 2.51 – *Modal*
,, **2.52** – *Hydromorphic* (with gley and pseudogley)
,, **2.53** – *Slightly saline or alkaline*
,, **2.54** – *Vertisolic* (with large prismatic structure at least in depth and relatively dark in colour)
Group 2.6 – *Andosol*
Soils rich in allophane. The limit between the andosols, the weakly developed soils, and ferrallitic soils is still uncertain.

Class 4. *Vertisols & Para-vertisols.*
Profile A (B) C, or A $(B)_a$ C, or $A(B)_g$ C

More or less homogenized or irregularly differentiated as a result of internal movements. Polyhedric to large prismatic structure at least in B horizon where the macroporosity is very weak, and cohesion as well as consistence very strong as soon as the soil is dry. Soil often very clayey with predominance of swelling clay, soil generally dark and unrelated to the content of organic matter. The base exchange complex is more often very rich in Mg.

Sub-class – *Topomorphic or topolithomorphic*
Group 4.1 – *Grumosolic*
Fine structure of the surface horizon of at least 20 cm.
,, **4.2** – *Non Grumosolic*
Large structure starting before the depth of 20 cm.
Sub-class – *Lithomorphic*
On more or less pronounced slopes and always rich in clay of a 2 : 1 type of lattice.
Group 4.3 – *Grumosolic*
,, **4.4** – *Non Grumosolic*
For each of the four groups **4.1**, **4.2**, **4.3**, and **4.4**, the following *sub-groups* are recognized

1. *Modal*
2. *With vertisolic characteristics moderately accentuated*
3. *With large concretions of hydromorphic origin*
4. *Early stage of saltiness*

Class 9. *Ferrallitic Soils*
Profile A (B) C, or A B C

Most often very thick, generally showing an advanced stage of decomposition of organic matter which is thoroughly bound to the mineral matter and a very strong decomposition of the weatherable minerals, resulting in the liberation of important quantities of sesquioxides of Fe, Mn and comparatively often of Al; elimination of a large proportion of silicon resulting in a molecular ratio $SiO_2 : Al_2O_3 \leq 2$; clay minerals in addition to the above-mentioned sesquioxides composed of kaolinite (1 : 1 type of lattice) and occasionally of traces of illite. Possible presence of residual and inherited minerals; parent material, C horizon, consisting of thoroughly decomposed minerals which collapse easily under the pressure of the fingers. A weak base exchange capacity; degree of base saturation often low or moderate, rarely high in B or (B) horizon. Variable structure in B, sometimes not very pronounced, but high friability of this horizon.

Three *sub-classes* have been defined, based on analytical data carried out on the B horizon at a depth where the organic matter content is relatively low. Less than 0.5% for sub-class 1 and less than 1.0% for the two others.

	Sub-Class 9.1 Weakly base unsaturated	*Sub-Class 9.2 Moderately base unsaturated*	*Sub-Class 9.3 Strongly base unsaturated*
Sum exchangeable bases (m. e. per 100 g)	2 — 8	1 — 3	<1
Degree of base saturation (%) ...	40 — 80	20 — 40	<20
$pH(H_2O)$	5.5 — 6.5	4.5 — 6.0	<5.5

Six groups have been defined :

Group 1 – *Typical* for sub-classes **9.1**, **9.2** and **9.3**. Profile formed of a succession of horizons of relatively constant texture on the entire depth of the soil. Comparatively low in organic matter which is well decomposed.

Group 2 – *Humiferous* for sub-classes **9.2** and **9.3**. Soils rich in well-decomposed organic matter, at least 7% in the first 20 cm. or more than 1% down to a depth of at least 100 cm. Soils poor in allophane even if they are formed on volcanic rocks. Crumb structure in the entire humiferous horizon.

Group 3 – Impoverished (absent in Mauritius)

Group 4 – Recast (absent in Mauritius)

Group 5 – Rejuvenated or almost developed (new term *penévolué*) For sub-classes **9.1**, **9.2** and **9.3**.
Soils having general characteristics of the ferrallitic class but relatively richer in weatherable minerals, particularly as a result of erosion and redifferentiation of the soil thus truncated.

Group 6 – Leached (absent in Mauritius)

Only three groups, namely *typical*, *humiferous* and *almost developed* (*penévolué*) have been observed in Mauritius.

Ten *sub-groups* have been defined

0. with humiferous A horizon, very deep (absent in Mauritius)
0. Podzolised raw humus (absent in Mauritius)
1. *Modal* (Groups **1**, **2**, **3** and **4**)
2. Yellow B horizon (absent in Mauritius)
3. Indurated B horizon (absent in Mauritius)
4. Hydromorphic (absent in Mauritius)
5. *Slightly rejuvenated or almost developed* (*penévolué*) Groups **1**, **4** & **6** relatively rich in weatherable materials.
6. Slightly recast (absent in Mauritius)
7. Eluviated (absent in Mauritius)
8. *Humic* – content of well developed organic matter above 3% in the first 20 cm. Group **1**
9. Very dark brown, strongly acid soil, rich in gibbsite (absent in Mauritius)

For the ferrallitic soils, the coding in use at ORSTOM in Bondy consists of four figures, the first one indicates the class; the second, the sub-class; the third, the group; and the fourth, the sub-group.

Class 11 – *Hydromorphic Soils.*

Soils whose evolution is dominated by the presence in their profile of an excessive amount of water, at least at certain periods of the year. This may be due to the water-table (gley), or simply to temporary water-logging of a deep or surface horizon (pseudogley)

Sub-classes – Hydromorphic organic soils (absent in Mauritius)
Hydromorphic soils with medium organic matter (absent in Mauritius).
Hydromorphic mineral or slightly organic soils.
Total organic matter inferior to approximately 10% on at least the first 20 cm. The hydromorphic nature is expressed by colour characteristics or by redistribution of elements capable of being dissolved : ferrous and manganese oxides, calcium carbonate, gypsum, etc. in the first metre approximately, or more intensively at depth between one and two metres.

Group 11.3 – *Weakly humiferous with gley*
Gley horizon resulting from reduction process.

Sub-Group **11.31** – *Gley on surface or entire soil*
,, **11.32** – *Gley at depth*
,, **11.33** – *Saline*
,, **11.34** – *Leached*

Group 11.4 – *Weakly ferruginous with pseudogley*
Characterised by pseudogley, dominance of reoxidation after reduction.

Sub-Group 11.41 – *with stains and concretions*
,, **11.42** – *with crust or cuirasse*

Group 11.5 – Weakly humiferous with redistribution of calcium carbonate and gypsum (absent in Mauritius)

Proposed correspondence between soil groups of the 1 : 100 000 soil map of Mauritius (1962) and the ORSTOM soil classification (1965 - 1966)

SOIL GROUPS (Hawaiian classification)	*PEDOGENETIC UNITS OF ORSTOM*				
	Class	*Sub-class*	*Group*	*Sub-group*	*Code Number*
Low Humic Latosols	Ferrallitic	Weakly base unsaturated	Typical	Modal or humic	9.111 or 9.118
Humic Latosols	,,	Moderately base unsaturated	Typical	Modal or humic	9.211 or 9.218
Humic Ferruginous Latosols	,,	Strongly base unsaturated	Humiferous	Modal	9.321
Latosolic Reddish Prairie Soils	,,	Weakly base unsaturated	Almost developed (*penévolué*)	Humic	9.158
Latosolic Brown Forest Soils	,,	Strongly base unsaturated	,,	Humiferous	9.358
Dark Magnesium Clays	Vertisol	Topolithomorphic	Grumosolic or non grumosolic	—	4.1 or 4.2
Ground Water Laterite	Raw mineral soil (on ferrallitic crust)	—	—	—	1.
Grey Hydromorphic Soils	Hydromorphic soil	Mineral	Weakly humiferous with pseudo gley	—	11.4
Low Humic Gley	,,	,,	Weakly humiferous with gley	—	11.3
Regosols	Weakly developed soils	Non climatic	Deposited (marine)	Regosolic	2.42
Lithosols	Raw mineral or weakly developed soils	Non climatic	Skeletal	Lithosols or Lithosolic	1.31 or 2.41

The following is a schematic representation of successive stages of development of a soil in Mauritius originating from a lava flow and forming a fully-developed ferrallitic soil, typical and modal.

Class	*Sub-class*	*Group*	*Sub-group*
Raw mineral	Non climatic origin	Skeletal	Lithosol
Weakly developed	Non climatic origin	Skeletal	Lithosolic
Ferrallitic soil	Various stages of base unsaturation	Almost developed (*penévolué*)	Humic
,, ,,	,,	Typical	Almost developed (*penévolué*)
,, ,,	,,	Typical	Modal

It appears that, in order to suit Mauritius conditions perfectly, the classification of ORSTOM could be completed by the creation of new categories to fill the gap between young weakly developed (*class*) and almost developed (*groups*) soils.

It seems possible that the use of the ORSTOM classification for ferrallitic soils, the most widespread in Mauritius, may permit rapid detailed mapping for special studies from morphological field observations completed by a few selected and characteristic determinations in the laboratory. Such characteristics may include SiO_2: Al_2O_3 molecular ratio of the clay fraction in doubtful cases, organic matter content of the whole profile, and sum of exchangeable bases and pH (H_2O) values on the low organic B horizon comparatively unaltered by cultivation.

REFERENCES

AUBERT, G. (1964). The classification of soils as used by French pedologists in tropical or arid areas. *Sols Africains/African soils.* **9** (1) : 107.

AUBERT, G. (1965). Classification des sols. Tableaux des classes, sous-classes, groupes et sous-groupes de sols utilisés par la Section de Pédologie de l'ORSTOM. *Cah. ORSTOM, sér. Pedol.* **3** (3) : 269.

AUBERT, G. *and* P. SEGALEN (1966). Projet de la classification des sols ferrallitiques. *Cah. ORSTOM, sér. Pedol.* **4** (4) : 97.

CLINE, M.G. *et al* (1955). Soil survey of the Territory of Hawaii. USDA series 1939, No. 25.

D'HOORE, J. (1964). Soil map of Africa at a scale of 1:5,000,000 (revised definitions). *Sols Africains/African Soils* **9** (1) : 65.

D'HOORE, J. (1964). La carte des sols d'Afrique; Mémoire explicatif. Commission de Co-opération Technique en Afrique. Pub. **93**. Lagos, 1964.

HALAIS, P. (1946). Données essentielles sur les sols de l'île Maurice. *Rev. agric. sucr. Maurice* **25** : 192.

PARISH, D.H. *and* S.M. FEILLAFE (1965). Notes on the 1 : 100,000 soil map of Mauritius. *Occ. Pap. Maurit. Sug. Ind. Res. Inst.* No. 22.

RIQUIER, J. (1960). Notices sur les cartes pédologiques de reconnaissance : Ile de la Réunion. *ORSTOM* (Madagascar), Section Pédologie.

SEGALEN, P. (1967). Private correspondence in the files of the MSIRI, Réduit.

SOIL SURVEY STAFF (1960). Soil classification, a comprehensive system : 7th approximation, USDA.

3. SILICON STATUS OF MAURITIUS SOILS

Y. WONG YOU CHEONG, L. ROSS & C. CAVALOT

With increasing rainfall and degree of laterisation, the soils of Mauritius (CRAIG, 1934; CRAIG & HALAIS, 1934) like those of Hawaii (AYRES, HAGIHARA & STANFORD, 1965) are characterized by a lowering of base status and silicon content accompanied by the accumulation of iron and aluminium oxides. The presence of these oxides, affects the availability of silicon in the soil. JONES & HANDRECK (1963) have shown that iron oxides and especially aluminium oxides were very effective in sorbing monosilicic acid and therefore, the solubility of silicon in soils of the same pH was influenced by the free sesquioxides present. As a result of investigations into the use of various calcium silicate slags in highly weathered soils of Hawaii, AYRES (1965) concluded that increases in sugar yields were expected with the application of reactive silicates to soils low in silica. Sugar yields increased when calcium silicate was applied to soils containing less than 200 lb Si per two-foot acre (50 ppm. Si). In Taiwan, SHIUE (1964) reported that soils of low silicon content gave low cane yields.

In view of the increasing importance of silicon in the soil, it was decided to carry out a general survey of the silicon status of local soils, particularly of those soil families which occur under conditions of intense weathering. The results are presented in Table 28.

Table 28. Mean values and inter-relationship of pH, Si and, Al status of local soils and Si, Mn content of sugar cane growing in them

Great Soil Groups	*Soil Si p.p.m.*		*MEAN VALUES*				
	Mean	*Range*	*Soil ext. Al p.p.m.*	*pH*	*Sheath Mn p.p.m.*	*Sheath SiO_2 %*	*Mn/ SiO_2*
Latosolic Reddish Prairie	210	(130-467)	21	6.5	62	3.60	17
Low Humic Latosol ...	114	(40-231)	40	5.9	97	3.29	29
Humic Latosol ...	59	(44-81)	71	5.3	110	3.11	35
Latosolic Brown Forest	52	(35-81)	411	5.2	114	2.93	39
Humic Ferruginous Latosol	34	(18-46)	203	5.0	125	2.65	47

Mean figures of all soil groups			*Correlation coefficients*
Extractable soil Si	v/s soil pH	...	0.989**
Sheath SiO_2	v/s soil Si	...	0.893*
Sheath SiO_2	v/s soil PH	...	0.924*
Sheath Mn/SiO_2	v/s soil pH	...	—0.974**
Sheath Mn	v/s extract. Si	...	—0.994**

Mean figures of all soil groups excluding Latosolic Brown Forest Soils

log (extract. Al) v/s log (sheath SiO_2) — 0.999**

* Significant at 5% level
** Significant at 1% level

Extractable silicon and soil pH. A highly significant correlation (r = 0.989**) is obtained between extractable silicon and pH when the mean figures for the Great Soil Groups are considered. When each soil group is considered individually, however, it is only the Low Humic Latosol which gives a significant correlation (r = 0.871**). A relationship would be expected between soil silica and rainfall, but in the soil families occurring under high rainfall (Latosolic Brown Forest and Humic Ferruginous Latosol), factors other than rainfall influence the soil silicon. These soils are high in extractable aluminium but there is wide variation between the levels of extractable aluminium of soils occurring within the same soil group. The aluminium oxides and the silicon probably combine to form clays, but what fraction of the silicon present in the clays is extractable, is not known.

On the other hand, the Latosolic Reddish Prairie and Latosolic Brown Forest Soils are of comparatively recent origin, and as they are usually shallow soils in close proximity to the parent rock, great variation would be expected in the silicon content of members of the same family. Generally, however, extractable silicon decreases with increasing acidity and degree of weathering.

It would appear that the Humic Ferruginous Latosols are the only soil family in which an application of silicate could prove beneficial to sugar cane growth as the values of soil silicon are low in these soils, in fact, lower than the threshold limit given by the Hawaiians.

Sheath silica and soil silicon. According to CLEMENTS (1965), response to calcium silicate slags would be expected on the very acid aluminous Humic Ferruginous Latosol when the sheath silica level of sugar cane was below 1.50%. It would appear from Table 28, that the sheath silica level of sugar cane growing in the Great Soil Groups presented was adequate. However, these figures are mean values for these soil groups (HALAIS, 1967) and individual figures could be lower than 1.50% in the more weathered soils of the Humic Ferruginous Latosols (Table 29). In fact, the more weathered phases are extremely low in both soil silicon and plant silicon.

SHIUE (1964) found that of all extractants, the acetate buffer (pH 4.0) was in closest relationship with the uptake by cane plant, and AYRES (1965) using ammonium acetate buffer (0.5 N, pH 4.8) obtained the same close relationship. Table 28 shows that in Mauritius too, a significant correlation (r 0.893*) is obtained between silica content of sugar cane sheath and soil silicon extracted by 0.5 N ammonium acetate, pH 4.8. This relationship implies that the plant uptake of silicon is governed by the concentration of silicon in the soil solution and if the concentration of monosilicic acid, although varying in soils of same pH, is being maintained at a steady level by soil reserves (JONES & HANDRECK, 1965), the highly weathered soils are bound to become severely depleted in silicon if continuously cropped with sugar cane. Table 29 shows furthermore that in the Humic Ferruginous Latosol Group, there are soils of extremely low silicon content. The amount of silicon removed from the soil by each crop of sugar cane is very high, about 356 kgs SiO_2 per arpent (FEILLAFÉ, 1949).

Sheath silica and soil pH. As there is such a strong relationship between soil pH and soil silicon and also between sheath silica and soil silicon, it is obvious that there would also be a relationship between sheath silica and soil pH ($r = 0.924$*).

Extractable aluminium and sheath silica. The accumulation of iron and aluminium oxides with increasing degree of weathering of soils and the ability of these sesquioxides, particularly those of aluminium, to sorb monosilicic acid have suggested the determination of the relationship between soil extractable aluminium and sheath silica. When the Great Soil Groups are considered (the LBF being excluded), there is an inverse highly significant relationship between extractable aluminium and sheath silica ($r = -0.999$**). The relationship between soil extractable aluminium and sheath silica is, therefore, exponential. Here again, the Low Humic Latosol is the only soil group showing a significant relationship between log (extractable soil aluminium) and log (extractable soil silicon) ($r = -0.888$**). When the Latosolic Brown Forest and Humic Ferruginous Latosol Soils are compared, it is found that although the soil extractable aluminium of the Latosolic Brown Forest is twice as high as that of the Humic Ferruginous Latosol group, yet the LBF soils have a higher silicon content. The presence of unaltered parent material in the soil profile of the LBF group must account for this. Therefore, plant roots must also be able to supply themselves with silicon directly from the unaltered parent material.

Mn/SiO_2 ratio and soil pH. There is a highly significant correlation ($r = -0.974$**) between Mn/SiO_2 ratio and soil pH. HALAIS & PARISH (1964) had stressed the importance of this ratio to the welfare of sugar cane, and CLEMENTS (1965), REYES SOTO & VELEZ RAMOS (1966) associated the increases in

Table 29. Humic Ferruginous Latosol (samples taken in poorly growing cane fields)

Soil Families	*Soil Si p.p.m.*	*Ext. soil Al p.p.m.*	*pH*	*Sheath SiO_2 %*	*Sheath Ca %*	*Sheath Mn p.p.m.*	*Mn/SiO_2*
F1 — Belle Rive ...	37	200	5.4	2.39	0.231	79	33
F2 — Sans Souci ...	29	231	5.5	2.18	0.212	125	57
F3 — Midlands ...	9	252	5.3	—	—	—	—
F4 — Chamarel ...	9	241	5.1	1.30	0.176	163	125

* Significant at 5% level

** Significant at 1% level

yields resulting from application of soluble silicates to the lowering of Mn/SiO_2 ratio in the sheath. According to CLEMENTS (1965), optimum growth conditions are obtained when this ratio lies in the 30-50 range. Mean figures of Mn/SiO_2 of the soil groups (Table 28), though showing an increase with increasing weathering of the soils, indicate that growth conditions are generally favourable. However, in the highly weathered Chamarel F4 soils of the HFL, a much higher Mn/SiO_2 ratio has been obtained (Table 29).

Soil silicon and plant manganese. As there is a correlation between soil and plant silicon, and sheath silicon has a great influence on sheath manganese (CLEMENTS, 1965), a relationship must exist between soil silicon and plant manganese. In fact, a highly significant negative correlation has been obtained between plant manganese and soil silicon ($r = -0.994$**). The level of soil silicon must determine to some extent the uptake of manganese, the lower the soil silicon, the higher the sheath manganese. WILLIAMS & VLAMIS (1957) have demonstrated a close connection between silica in leaves and manganese toxicity, and CLEMENTS (1965) has observed that silicate reduced leaf freckling (caused by undue accumulation of manganese) in sugar cane growing in highly weathered soils and explained that the effect of silicate was to reduce this Mn toxicity.

REFERENCES

AYRES, A.S. (1965). Calcium silicate slag as a growth stimulant for sugar cane on low silica soils. *Soil Sci.* **101** : 216-227.

AYRES A.S., HAGIHARA H.H., *and* G. STANFORD. (1965). Significance of extractable aluminium in Hawaiian sugar cane soils. *Proc. Soil Sci. Soc. Am.* **29** : 387-392.

CLEMENTS H.F. (1965). The roles of calcium silicate slag in sugar cane growth. *Rep. Hawaiian Sug. Technol.* **24** : 103-126.

CRAIG, N. (1934). Some properties of sugar cane soils of Mauritius. *Sug. Cane Res. Stn Mauritius*, Bull. No. 4.

CRAIG, N. *and* P. HALAIS. (1934). The influence of maturity and rainfall on the properties of lateritic soils in Mauritius. *Emp. J. exp. Agric.* **2** : 349-358.

FEILLAFE, S.M. (1949). *Rep. Sug. Cane Res. Stn Maurit.* **19** : 26.

HALAIS, P. (1967). Si, Ca and Mn contents of cane leaf sheaths, a reflexion of pedogenesis. *Rep. Maurit. Sug. Ind. Res. Inst.* **14** : 83-85.

HALAIS, P. *and* D.H. PARISH. (1964). Silica and manganese contents of cane leaf sheaths in relation to soil and nutrition. *Rep. Maurit. Sug. Ind. Res. Inst.* **11** : 74-76.

JONES, L.H.P. *and* K.A. HANDRECK. (1963). Effects of iron and aluminium oxides on silica in solution in soils. *Nature, Lond.* **198** : 852-853.

JONES, L.H.P. *and* K.A. HANDRECK. (1965). Studies on silica in oat plant. III. Uptake of silica from soil by the plant. *Pl. Soil* **23** : 79-96.

REYES SOTO *and* VELEZ RAMOS. (1966). Results of calcium silicate experiments at C. Brewer P.R. Co. *Sug. Azuc.* **61** (11) : 40.

SHIUE, J.J. (1964). The silicon content in soils of Taiwan sugar cane fields. *Rep. Taiwan Sug. Exp. Stn.* **36** : 109-116.

WILLIAMS, E. *and* J. VLAMIS. (1957). The effect of silica on yield and Mn^{54} uptake and distribution in the leaves of barley plants grown in culture solutions. *Pl. Physiol., Lancaster* **32** : 404-409.

4. A PRELIMINARY NOTE ON THE EFFECT OF CALCIUM SILICATE ON PLANT GROWTH

P. Y. CHAN, L. ROSS & C. FIGON

Silica has been known for some time to have beneficial effects on the growth of plants, but whether it plays an essential role in nutrition is still a matter of conjecture. Much of the recent knowledge accumulated on the role of this element in plant nutrition has been derived from work on the rice plant by Japanese workers.

This effect of silica on plant growth can be divided into two parts : its effect on the soil and its effect on the plant.

Effect on the soil. In the soil, silica exists mainly as silicate, often associated with uncombined silica, in primary minerals of unaltered rock, and as alumino-silicates in secondary minerals. There is also some free silica derived from the decomposition of plant material and rock minerals. One of the earliest references reported that silica improved the uptake of phosphate by the plant (FISHER, 1929) by causing the release of phosphate ions from the soil. Other workers (RAUPACH and PIPER, 1959, and KHAN and ROY, 1964) have also obtained this release of phosphate ions from the soil by silicate treatment.

In these soils where the concentration of soluble aluminium is high, addition of silica to the soil may have the effect of reducing the concentration of soluble aluminium by the direct combination of silica with alumina.

Silica can influence the absorption of minor elements by its action on the soil. Addition of silica to the soil raises its pH, which is accompanied by a decrease in the solubilities of many of the minor elements, such as Fe, Mn, Cu, B, among others. The concentration of extractable aluminium also decreases sharply with increasing pH of the soil. Therefore, one role of silica is to reduce aluminium toxicity.

Effect on the plant. The physiological role of Si is not understood, although much information on this is now available.

WILLIAMS and VLAMIS (1957) have shown that there was a close link between silica in leaves and manganese toxicity. Generally, silica reduces the uptake of iron and manganese (OKUDA and TAKAHASHI, 1964); this is important in cases where these elements are present in toxic quantities in the soil. These authors suggested that silica, by its action on the plant, increased the oxidising power of the roots of the rice-plant, whereby the iron and manganese ions became oxidised and insoluble. They also claimed that silicate treatment had no effect on aluminium toxicity.

Application of calcium silicate has improved stem elongation and rooting and also produced earlier earing (OKUDA and TAKAHASHI, 1964).

Another role played by silica is to increase the resistance of the plant to diseases and pests, probably by acting as a barrier to the penetration by insects and fungi as silica is mainly deposited in the structural parts of the plant (ISHIBASHI and AKIYAMA, 1960).

D'HOTMAN (1947) in Mauritius was the first to report the beneficial effect of basalt dust on cane growing in highly-weathered soils; he used massive doses of finely-ground basalt dust in these soils and obtained significant increases in sugar cane yields. Subsequent work on the use of a silicate material for the growth of sugar cane was carried out by SHIUE (1963), CLEMENTS (1965) and AYRES (1966). HALAIS and PARISH (1964) had observed that sugar cane yields were related to the Mn/SiO_2 ratio of the cane sheath and that this ratio was high in very weathered soils. They, however, attributed the yield response to applications of 100 tons of basalt dust per acre to a physical rather than a chemical effect on the soil. SHIUE (1963) suggested that soluble soil silica was related to the yields of sugar cane obtained.

CLEMENTS (1965) concluded that a yield response would be obtained from the application of silicate to sugar cane whose sheath silica was less than 1.5% D.M. and suggested that the main function of silica was probably the redressing of minor elements, particularly Mn, or other elements imbalance in the plant. AYRES (1966) obtained highly significant increases in yields of sugar cane in both field and pot tests with the application of calcium silicate slag to an Aluminous Humic Ferruginous Latosol. Although Si uptake was significantly increased, there was no significant change in the uptake of other nutrients except Ca and P, and that author concluded that "*there is a level of available, or extractable, soil Si below which satisfactory growth of sugar cane will not obtain, regardless of supplies of macro and micro nutrients to which it has access*". Calcium silicate has also been shown in Puerto Rico to have a beneficial effect in the soil in reducing plant uptake of Mn and B, and in increasing the sucrose content of cane juice (SOTO and RAMOS, 1966).

As there may be sugar cane areas in

Mauritius where the application of calcium silicate slag may improve sugar cane yields, it was decided to carry out a survey of these areas and to lay down field trials in those soils which were lowest in Si content. Seven field trials were laid down, but the canes have not yet been harvested. However, in order to obtain preliminary information on the possible advantages of the application of silicate slag, pot tests are being carried out with soils from the experimental sites. The results of one series of pot tests are presented in Tables 30 & 31.

Soil analysis. The extractable Si of the experimental soil (Humic Ferruginous Latosol at Belle Rive) is 12 ppm., which is below the threshold value (50 ppm Si) found by AYRES (1966) to be the level below which increases in sugar yields were obtained.

Except for the diatomite (African Industries Ltd., Kenya) treatment, all the other silicate treatments, either with or without the addition of $CaCO_3$, increased the pH of the soil. The calcium silicate slag at 6 tons/acre had the same acid neutralising power on the soil as the calcium carbonate treatment of 3.4 tons per acre. Although the diatomite was a finely-ground material, it had no effect on the pH of the soil.

There was no increase in soil extractable Si from the application of diatomite, whereas calcium and potassium silicates greatly increased it, the calcium silicate more so than the potassium silicate at equivalent levels of application. Pure calcium carbonate and coral sand also slightly increased extractable soil silicon, but the effect was probably not significant.

The soil extractable manganese was not materially affected by the Ca treatments or by any of the silicate materials although there was a suggestion of a decrease.

There was a sharp reduction in extractable aluminium in all treatments where the soil pH had significantly changed. As coral sand and calcium carbonate had brought about a similar decrease in extractable aluminium level, it would seem that this was mainly a pH effect. However, at comparable final soil pH (5.7), calcium silicate at 6 tons/acre had had a greater effect in lowering soil extractable aluminium than the calcium carbonate treatment. It would seem that, in addition to the pH effect, the silicate ions had also had a direct effect on reducing the extractable aluminium concentration.

Plant yields, composition and nutrient uptake. Pot yields and plant composition and nutrient uptake are given in Table 31, and the relative growth of plants from each treatment is shown in Plate V.

The greatest yield increase was obtained with the treatment of calcium silicate (3 tons/acre), the higher level of treatment of calcium silicate giving a lower yield. Positive yield responses were obtained with both calcium carbonate and coral sand applications. There was no significant difference in yield between the control and potassium silicate treatment, but addition of calcium carbonate to the potassium silicate significantly improved yields. Diatomite was ineffective except at the higher level of treatment when a yield increase, although not significant, was obtained, and when Ca was also added, yields were significantly increased, but the lower treatment level was more effective.

Analysis of the results shows that there was a definite calcium effect as all treatments which contained calcium were significantly better than control. In addition to this calcium effect, there was also a definite silicate effect in the case of the lower level of treatment of calcium silicate.

The poor yield response in the case of the potassium silicate treatment was due to the fact that lack of Ca was limiting plant growth; in fact, plant yields significantly increased when Ca was added.

The low yields obtained with the "diatomite only" treatments at 3 tons/acre were also due to a Ca deficiency as can be seen from plant Ca uptake figures. The Ca and the SiO_2 in the diatomite must not have been easily available as no effect on soil pH was obtained; this is supported by the fact that as the treatment level of diatomite was increased, the plant yields improved.

It is clear that calcium was the first limiting factor in this soil. Although there was an increase in Si uptake in the potassium silicate treatment, plant yields were not improved because plant Ca was low. Also in the coral sand and calcium carbonate treatments, plant yields were significantly better than control, in spite of the low plant Si.

Calcium silicate also significantly increased the uptake of the major elements N, P, K, Ca, Mg. Except for the diatomite and potassium silicate only treatments, similar but smaller increases were obtained in the other treatments.

All treatments, except for the "diatomite only" treatments, decreased plant uptake of manganese although greater yields were obtained. Diatomite had no effect owing to the inertness of the material. Coral sand and calcium carbonate

Table 30. Soil analysis data

Treatment	*Final Soil pH*	*Extract. Si (ppm)*	*Extract. Mn (ppm)*	*Extract. Al (ppm)*
Control	4.5	12	35	340
$CaSiO_3$ (3 tons/acre)	5.2	42	31	182
$CaSiO_3$ (6 tons/acre)	5.7	73	36	116
$CaCO_3$ (3.4 tons/acre)	5.7	18	33	155
Diatomite (3 tons/acre)	4.6	12	34	364
Diatomite (6 tons/acre)	4.5	12	36	371
Diatomite (3 tons/acre) + $CaCO_3$ (3.4 tons/acre)	5.4	17	30	200
Diatomite (6 tons/acre) + $CaCO_3$ (3.4 tons/acre)	5.6	20	30	124
K_2SiO_3 (3 tons/acre)	5.2	28	28	232
K_2SiO_3 (3 tons/acre) + $CaCO_3$ (3.4 tons/acre)	6.0	73	29	122
Coral sand (4 tons/acre)	5.5	14	30	165

Table 31. Mean plant yie ds and nutrient uptake per pot

	Dry matter yields (g.)	*mg*						*μg*		
		N	*P*	*K*	*Ca*	*Mg*	*Si*	*Mn*	*Fe*	*Al*
Control	4.18	82	0.42	18.1	0.96	0.50	1.05	610	660	320
$CaSiO_3$ (3 t./acre) ...	5.84	10.7	0.64	26.7	2.28	0.77	3.98	540	960	500
$CaSiO_3$ (6 t./acre) ...	5.13	9.3	0.55	22.3	2.35	0.65	4.21	370	710	450
$CaCO_3$ (3.4 t./acre) ...	4.92	8.8	0.47	20.1	2.24	0.62	0.69	300	780	300
Diatomite (3 t./acre) ...	4.24	8.3	0.43	17.0	1.01	0.49	1.03	600	600	210
Diatomite (6 t./acre) ...	4.51	9.0	0.46	20.7	1.04	0.52	1.22	680	780	250
Diatomite (3 t./acre) + $CaCO_3$ (3.4 t./acre) ...	5.15	9.3	0.52	23.1	2.26	0.67	0.77	410	820	370
Diatomite (6 t./acre) + $CaCO_3$ (3.4 t./acre) ...	4.85	8.9	0.48	21.4	2.26	0.63	1.22	340	800	370
K_2SiO_3 (3 t./acre) ...	4.05	8.9	0.43	20.5	0.87	0.42	2.69	310	630	400
K_2SiO_3 (3 t./acre) + $CaCO_3$ (3.4 t./acre) ...	4.92	11.0	0.57	22.1	1.68	0.51	4.16	150	730	370
Coral sand (4 t./acre) ...	4.68	10.1	0.48	19.8	1.87	0.68	0.68	390	780	470
LSD ($P = 0.05$)	0.51	1.06	0.04	3.4	0.22	0.10	0.83	90	220	120
LSD ($P = 0.01$)	0.69	1.44	0.05	4.5	0.29	0.13	1.12	120	290	170

were just as effective as the silicate materials in reducing the uptake of manganese. In the case of iron, however, there was generally increased uptake of this element with the treatments of silicate and liming materials, simply due to increases in plant yields as there was no difference in plant levels of that element. The same considerations hold for the uptake of aluminium. Calcium silicate (3 tons/acre) gave the highest plant yield and highest aluminium uptake; it would seem that in this soil aluminium toxicity was not a problem, at least to sorghum, and that the effect of silicate was not to redress aluminium toxicity.

In this experiment, therefore, the main factor limiting growth was Ca, but once this deficiency was made up, further yield increases could be expected from an application of silicate. The best material was calcium silicate, which was found to be superior to a combination of potassium silicate and calcium carbonate.

The results of this pot experiment can only serve as a guide to the value of calcium silicate on this type of low-silicon and low-calcium Humic Ferruginous Latosol, but it is clear that calcium silicate does have a highly beneficial effect on plant growth.

The field trials with sugar-cane will be harvested in 1968 and will give more detailed information on the value of calcium silicate for sugar cane growing in these soils low in calcium and silicon.

REFERENCES

AYRES, A.S. (1966). Calcium silicate slag as a growth stimulant on low silicon soils. *Soil Sci.* **101** : 216-227.

CLEMENTS, H. (1965). The roles of calcium silicate slags in sugar cane growth. *Rep. Hawaiian Sug. Technol.* **24** : 103-126.

D'HOTMAN, 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. sucr. Ile Maurice* **26** : 160-175.

FISHER, R.A. (1929). A preliminary note on the effect of sodium silicate in increasing the yield of barley. *J. Agric. Sci.* **19** : 132.

HALAIS, P. *and* PARISH, D.H. (1964). *Rep. Maurit. Sug. Ind. Res. Inst.* **11** : 74-76.

ISHIBASHI, H. *and* AKIYAMA, K. (1960). Physiological function of silica in the rice plants. *Rep. III. Bull. Fac. Agric., Yamaguchi Univ.* **11** : 1 (Cited by Comhaire, M. 1966. *Agric. Dig.* No. 7, pp. 9-19).

KHAN, D.H. *and* ROY, A.C. (1964). Growth, P-uptake, and fibre cell dimensions of jute plant as affected by silicate treatment. *Pl. Soil.* **20** : 331-335.

OKUDA, A. *and* TAKAHASHI, E. (1964). Le rôle du silicium. *Agron. trop., Nogent* **19** : 534.

RAUPACH, M. *and* PIPER, C.S. (1959). The interaction of silicate and phosphate in a lateritic soil. *Aust. J. Agric. Res.* **20** : 818-831.

SHIUE, J.J. (1963). A study of the silicon content in the soil of Taiwan sugar cane fields. *Rep. Taiwan Sug. Exp. Stn* **31** : 109-116.

REYES SOTO *and* VELEZ RAMOS (1966). Results of calcium silicate experiments at C. Brewer P.R. Co. *Sug. Azuc.* **61** (11) : 40.

WILLIAMS, E. *and* VLAMIS, J. (1957). The effect of silica on yield and Mn^{54} uptake and distribution in the leaves of barley plants grown in culture solutions. *Pl. Physiol., Lancaster* **32** : 404-409.

5. SAMPLING ERRORS IN FOLIAR DIAGNOSIS : NPK GRADIENTS IN THE LEAF LAMINA

P. HALAIS & L. ROSS

The method of foliar diagnosis for detecting the nutritional status of sugar cane has been steadily improved during the last thirty years under conditions prevailing locally on an industry-wide scale.

The sampling technique has been stabilized for at least ten years and Permanent Sampling Units, about six hundred in number, have been selected by this Institute to represent the standard cane fields on the various sugar estates as far as soil family, climate, fertilizer practices and agricultural management are concerned.

Full details have already been published, namely in the *Proceedings of the XIth Congress I. S. S. C. T.* held in Mauritius in 1962, and should be available for consultation by every agronomist or field superintendent interested (HALAIS, 1963). A more recent version will appear in the forthcoming *Actes du Colloque sur la Fertilité des Sols Tropicaux*, held in November 1967 in Tananarive, Madagascar (HALAIS, 1967). In addition, the team of Field Officers of the Agricultural division and the staff of the Chemistry division of the Institute have tried their best to provide full information, by actual demonstration, on the exact leaf sampling technique to be followed in the field, and the right method for rapid leaf preparation and drying to be carried out in the sugar factory laboratory prior to chemical analyses to be performed at the M.S.I.R.I.

Nevertheless, there are strong reasons to suppose that, on a few occasions, the rules carefully laid down for leaf sampling and preparation have not been carefully followed, especially as far as the true centre of the blade and the prescribed precautions for rapid drying are concerned. The detailed instructions given in the 1963 publication mentioned above are reproduced below.

"*True central portion of leaf less midrib* : the leaf portion to be kept for desiccation prior to analysis is 10 cm. of the central part of the blade from which the midrib is carefully removed and discarded. The easiest way is to sort the sixty leaves in three bundles with leaves of approximately the same length. The true centre is found either by folding one leaf or by actual measurement. A portion just 10 cm in length right across the centre of each leaf bundle should be cut by making use of a pair of hedge-clippers and delimited by a piece of plywood 10 cm. in length. The mid-ribs are carefully eliminated leaving 120 central half portions of leaves which are all placed inside a bag of approximate size, made of mosquito or cheese cloth, together with the corresponding cardboard label.

This procedure of central leaf sampling though comparable is quicker than the leaf punch technique previously used, and allows for more samples to be taken early in the morning, which constitutes a further advantage. However it necessitates the use of a grinding mill in the laboratory".

Other research workers, FARQUHAR and LEE (1963) of the C.S.R. Co. in Queensland and SAMUELS (1967) of the Experimental Station of Rio Piedras, Puerto Rico, have been unanimous in stressing the necessity of strictly adhering to the recommended sampling technique which consists in keeping for analysis the true centre of the leaf blade after elimination of the midrib.

It has been considered useful, however, to initiate under our conditions, a special study to show the magnitude of the systematic error involved when the tissue for analysis deviates from the established rule : a 10 cm. section right on the true centre (50% of the total length of the 3rd leaf blade) as compared to samples taken in low (40%) or in high (60%) portion starting from the base (dewlap).

A series of first ratoons aged 5 to 6 months were sampled in this connection in the first week of January 1968 when vegetative growth was at its peak and climatic conditions optimum. Each sample consisted of thirty 3rd leaf blades taken before eight in the morning. A special board was used to sample the three leaf positions on each leaf individually. The whole leaf preparation was carried out rapidly so that drying of the leaf tissue was started before 1 p.m. in a powerful forced draught oven already brought to a temperature of 90°C. A total of 108 leaf samples (Table 32) were thus prepared for analysis, after appropriate grinding using 0.5 mm sieve, (3 positions × 6 locations × 3 varieties × 2 nitrogen-levels = 108 samples).

Tissue Position (% total length of blade)	*Locations of Final Variety Trials (early reaping)*	*Varieties*	*Nitrogen levels (in each trial)*
	AGRO. 7/66 Mont Choisy		
Low (40%)	,, 8/66 Beau Vallon	M.147/44	
Centre (50%)	,, 11/66 FUEL	M.93/48	0 kg N/arp
High (60%)	,, 14/66 Médine	M.442/51	60 ,, ,,
	,, 15/66 New Grove		
	,, 16/66 Alma		

Each leaf sampled was analysed for total N, P, K by the wet combustion methods in use at this Institute :

N and K : mixture of sulphuric and phosphoric acid with Cu and Se catalysts kept at 370°C for 12 minutes, followed by colorimetric (Nessler) determination of N and flame photometric (emission type) determination of K.

P : use of a sulphonitro hydrogen peroxide mixture kept at 150°C for 2 hrs followed by molybdenum blue colorimetric method, ascorbic acid being used as the reducing agent so as to eliminate interference from silicon (DUVAL, 1966).

The results are presented in Tables 32-34.

Tables 32, 33 and 34 show conclusively that within the comparatively short distances 40, 50 and 60% of the total length of the 3rd leaf blade starting from the base (dewlap), the K gradient is the most pronounced, followed by the N gradient, but in the opposite direction. The P gradient is variable and of low magnitude in this central zone of the blade.

Table 32. NPK contents for three leaf positions of six Final Variety Trials 1st ratoons early reapings, January 1968

Locations	*N % d.m.* Low 40%	Centre 50%	High 60%	*P % d.m.* Low 40%	Centre 50%	High 60%	*K % d.m.* Low 40%	Centre 50%	High 60%
14/66 Médine	1.76	1.86	1.90	0.208	0.197	0.181	1.17	1.07	1.01
7/66 Mont Choisy	2.03	2.03	2.02	0.180	0.180	0.180	1.38	1.24	1.14
16/66 Alma	2.16	2.14	2.16	0.249	0.249	0.244	1.38	1.23	1.15
8/66 Beau Vallon	2.10	2.18	2.16	0.185	0.173	0.169	1.09	1.03	0.92
15/66 New Grove	2.28	2.36	2.46	0.221	0.225	0.224	1.08	1.00	0.93
11/66 FUEL	2.25	2.38	2.46	0.189	0.197	0.204	1.20	1.05	0.99
Mean	*2.10*	*2.16*	*2.19*	*0.206*	*0.204*	*0.201*	*1.22*	*1.11*	*1.03*

Table 33. NPK contents for three leaf positions of three commercial cane varieties

Variety	*N % d.m.* Low 40%	Centre 50%	High 60%	*P % d.m.* Low 40%	Centre 50%	High 60%	*K % d.m.* Low 40%	Centre 50%	High 60%
M.147/44	2.12	2.16	2.18	0.203	0.201	0.202	1.14	1.04	0.97
M.93/48	2.08	2.09	2.14	0.201	0.199	0.193	1.26	1.13	1.06
M.442/51	2.08	2.22	2.25	0.212	0.214	0.207	1.25	1.13	1.05
Mean	*2.10*	*2.16*	*2.19*	*0.206*	*0.204*	*0.201*	*1.22*	*1.11*	*1.03*

Table 34. NPK contents for three leaf positions and two nitrogen levels

Level	*N % d.m.* Low 40%	Centre 50%	High 60%	*P % d.m.* Low 40%	Centre 50%	High 60%	*K % d.m.* Low 40%	Centre 50%	High 60%
O kg. N/arp.	1.95	1.97	2.00	0.196	0.190	0.185	1.14	1.04	0.97
60 " "	2.25	2.35	2.38	0.216	0.218	0.216	1.29	1.18	1.08
Mean	*2.10*	*2.16*	*2.19*	*0.206*	*0.204*	*0.201*	*1.22*	*1.11*	*1.03*

Consequently important systematic errors for K and N may arise if the established rule of choosing the true centre of the leaf blade is not followed. Sampling at too low position, 10% from the true centre, will increase the K content of the tissue by 0.11%, and reduce the N content by 0.06% dry matter. On the other hand, sampling at a high position, 10% above the true centre, will reduce the K content by 0.08% and increase the N content by 0.03% dry matter. It appears that the common error made in practice when the middle of the length of the leaf is estimated visually is, through an optical error, the unavoidable selection, due to the triangular shape of the leaf, of the centroid of the lamina, resulting in the selection of a point below the correct one. Such a selection will give results higher in K and lower in N than the actual ones, thus leading to incorrect diagnosis and interpretation.

It is now planned to investigate the real importance of two other critical sampling errors :

(a) field leaf sampling later in the day than the specified limit of 8 a.m. in locations with high, medium and low insolation;

(b) delay in the preparation and drying of the leaf sample after field collection exceeding the 6 hours limit recommended.

REFERENCES

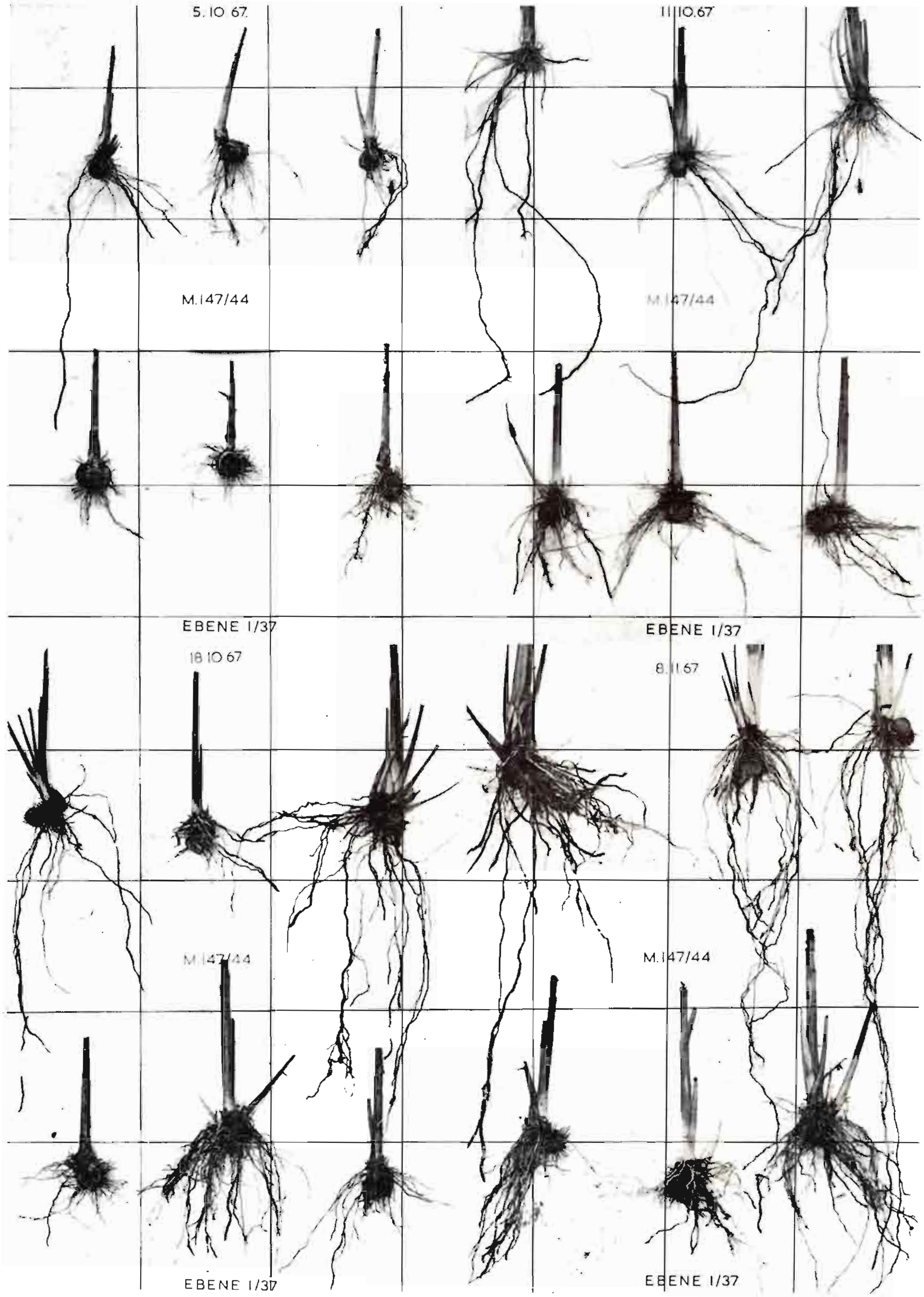
DUVAL, L. (1966). Influence du silicium, du germanium et du fer sur le dosage céruléomolybdique de l'acide phosphorique. *Chim. Analyt.* **19** : 290-299.

FARQUHAR, R.H. *and* J.B. LEE. (1963). Variability associated with sugar cane leaf sampling for foliar diagnosis. *Proc. int. Soc. Sug. Cane Technol.* **11** : 203-214.

HALAIS, P. (1963). The detection of NPK deficiency in sugar cane crops by means of foliar diagnosis run from year to year on a follow-up basis. *Proc. int. Soc. Sug. Cane Technol.* **11** : 214-221.

HALAIS, P. (1967). Normes du diagnostic foliaire pour les repousses de canne à sucre récoltables annuellement en régions tropicales. *Actes du Colloque sur la Fertilité des Sols Tropicaux*, Tananarive, novembre 1967 (in press).

SAMUELS, G. (1967). Influence of using various sugar cane leaves and parts of the sugar cane leaf on chemical composition. *J. Agric. Univ. P. Rico.* **51** (1): 22-28.



An illustration of the root system development of M. 147/44 and Ebène 1/37 (date of plantation 25.7.67) at different stages of growth $(\times \frac{2}{15})$

PLANT-SOIL-WATER RELATIONSHIPS

C. MONGELARD

1. THE EFFECT OF DIFFERENT WATER REGIMES ON GROWTH OF THE VARIETIES EBENE 1/37 AND M.147/44

THE object of the experiment was to study the effect of five different soil water régimes on the early growth of the varieties Ebène 1/37 and M.147/44 and to determine if the two varieties responded differently to the treatments imposed. The water régimes selected as treatments, and hereafter named A, B, C, D and E, consisted in allowing the soil water potential at 15 cm below the surface to reach pre-determined minimum values of –0.25, –0.5, –0.75, –3.0 and –9.0 atm. respectively before the soil was restored to saturation point.

Material and methods

The experiment was carried out in a well ventilated greenhouse in ten cylindrical containers 33 cm high and 28 cm in diameter, filled with Low Humic Latosol soil from the "A" horizon. Free drainage was ensured by means of holes in the drums allowing excess water to drain when the soil was watered to capacity.

Soil suction measurements were made with irrometers for treatments A, B and C. One irrometer was introduced in the soil in the centre of each drum at 15 cm below the surface. Gypsum blocks, also inserted at 15 cm depth, were used to measure suctions in treatments D and E since irrometers cannot be used to measure suctions greater than 0.8 atm. The gypsum blocks had previously been calibrated in a pressure membrane apparatus.

Single-eyed cuttings of both varieties were planted on 5th April 1967 in plastic bags (15 cm × 10 cm) filled with soil of the Low Humic Latosol type. The cuttings were subjected before planting to a short hot-water treatment (52°C, 20 minutes) and allowed to germinate under conditions of adequate moisture. On 3rd May, fifteen germinated cuttings of each variety were selected for uniform height and vigour. Three plants were transferred to each of five containers for each variety without interference with their root system. This was achieved by tearing the plastic bags and transplanting the plants together with the mass of soil surrounding the roots. The soil in all the drums was then watered to capacity, and on the 9th May the first measurements were taken. On that date, though the soil in any of the treatments had not reached a tension greater than 0.1 atm. it was re-watered to capacity. Measurements were carried out at weekly intervals on shoot height and dewlap height. At the end of the experiment which lasted 9 weeks, the mean leaf area per plant and stem dry weight for each treatment were measured.

Results

Weekly mean increments in dewlap height under the different water régimes are shown in fig. 20 for the variety Ebène 1/37 and in fig. 21 for the variety M.147/44. Results obtained in treatment C were discarded after a breakdown of the irrometer during the course of the experiment. Weeks during which watering was made in the various treatments are shown by dark circles in figs. 20 and 21.

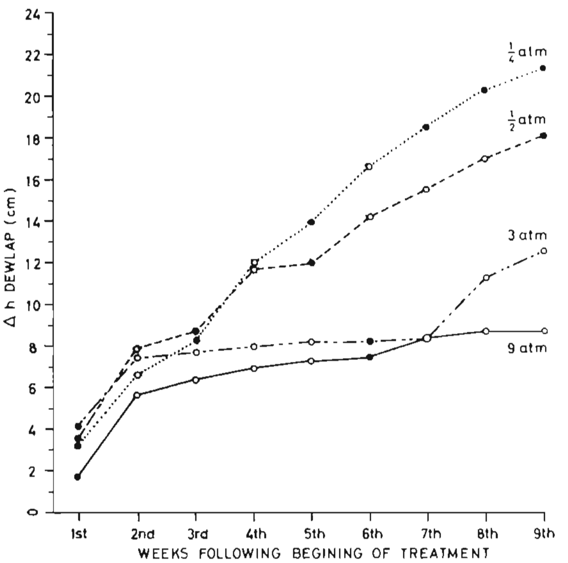


Fig. 20. Effect of ∅ soil on Δh dewlap of Ebène 1/37. Dark circles indicate the weeks during which the soil was restored to water saturation point.

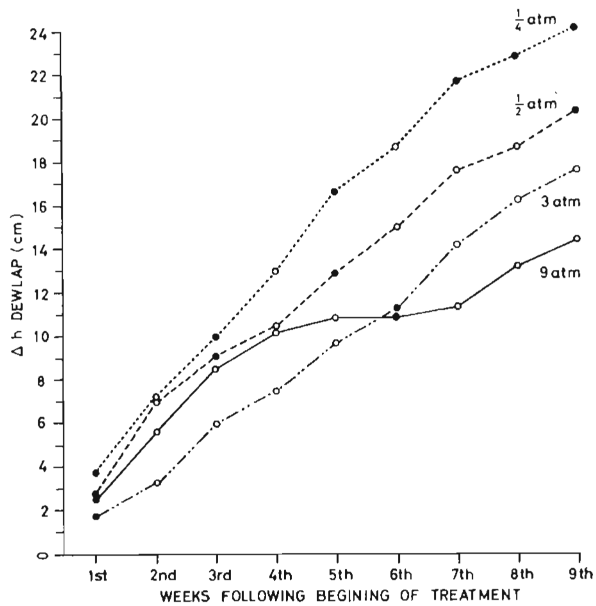


Fig. 21. Effect of ∅ soil on Δh dewlap of M. 147/44 Dark circles indicate the weeks during which the soil was restored to water saturation point.

During the first two weeks of the experiment, soil moisture conditions were the same in all treatments since the lowest maximum soil water suction (0.25 atm.) was not reached before the beginning of the third week. In the eight drums, the treatments during week 1 and week 2 were identical and an analysis of variance of the results comparing the growth of the two varieties was carried out. The mean height of plants in each drum for each variety was considered a replicate, and growth in week 1 when soil suction was below 0.1 atm. was compared with growth in week 2 when soil suction was reaching 0.25 atm. In week 1, no difference in growth increment was noted. In week 2, there was no evidence that the growth of M.147/44 was affected, but the highly significant difference between the growth increments of Ebène 1/37 in week 1 and in week 2 shows that this variety is sensitive to a low decrease in moisture potential, and this could partly explain its susceptibility to drought.

A second point of interest was the different response of the two varieties to further decrease in soil water potential. In week 3, the soil suction at 15 cm below the surface had already reached 0.5 atm. and was increasing in treatments D and E, which drums had not received any additional water. Suctions of 3 atm. were reached early in week 6 and later in the same week, tensions of 9 atm. were recorded. Fig. 20 shows that the growth of the variety Ebène 1/37 was very slow when the soil suction had reached 0.5 atm. and had stopped when the soil suction was approximately 3 atm. This was, however, not the case with the variety M.147/44 (fig. 21) which continued to grow but at a reduced rate until the soil suction was approximately 9 atm. before growth stopped. Further, resumption of growth activity on rewatering in treatment E was more marked in the variety M.147/44 than in the variety Ebène 1/37 which seemed to have suffered more from the dry conditions imposed. To summarize, the results show that the growth of the "drought-susceptible" variety Ebène 1/37 was adversely affected before the soil had reached a suction of 0.25 atm, at 15 cm below the surface in week 2, in contrast with the variety M.147/44 whose growth was not impaired. This different response of the two varieties to equal increases in soil water stress at 15 cm depth could be due to at least two causes : (i) the root system of the variety Ebène 1/37 was less developed in depth, and hence the soil water suction in the vicinity of its roots was higher than what was obtained with M.147/44; (ii) the latter variety could withstand a higher soil moisture stress than Ebène 1/37 at the soil-root interface. The results obtained in treatments D and E confirmed that the adverse effects of increased soil moisture stress were more pronounced on Ebène 1/37 whose growth stopped before a soil suction of 3 atm. was reached, in contrast with M.147/44 whose growth was checked only when the soil suction was reaching 9 atm.

The effects of the different treatments on total increment in dewlap height and shoot height during the nine weeks' treatment are shown in figs. 22 and 23. The measurements on final mean leaf area and stem dry weight at the conclusion of the experiment are given in figs. 24 and 25. The stem dry weights, mean leaf area and shoot growth of both varieties were adversely affected by a decrease in soil moisture, and the results clearly demonstrate that maximum growth was obtained with maximum soil water potential.

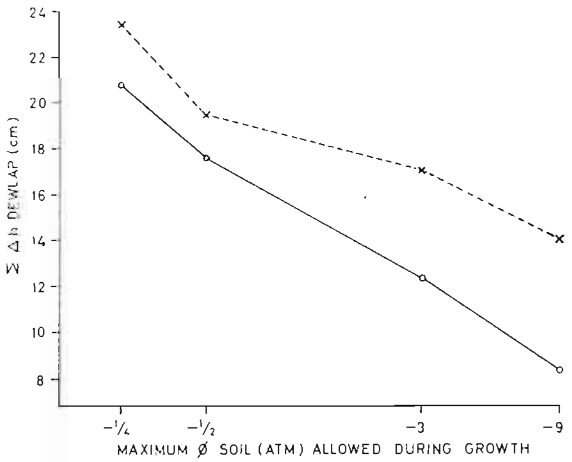


Fig. 22. Effect of ∅ soil on ≶ Δh dewlap during the whole treatment period. (Plain line: Ebène 1/37; broken line : M.147/44).

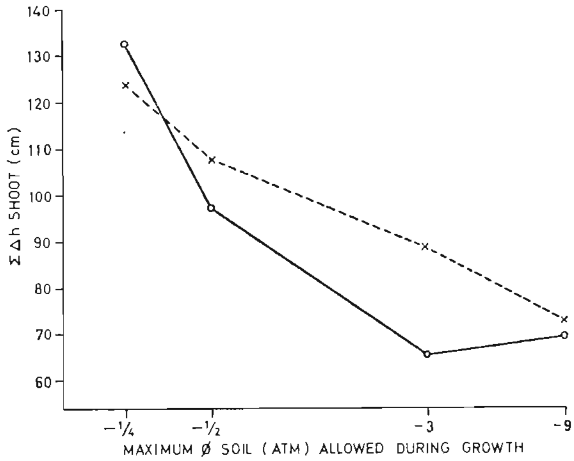


Fig. 23. Effect of ∅ soil on ≶ Δh shoot during the whoel treatment period. (Plain line : Ebène 1/37 ; broken line : M.147/44).

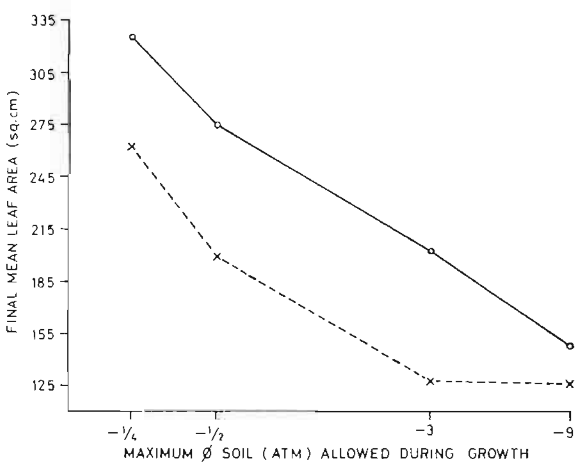


Fig. 24. Final mean leaf area as affected by different ∅ soil during treatment. (Plain line: Ebène 1/37; broken line: M.147/44).

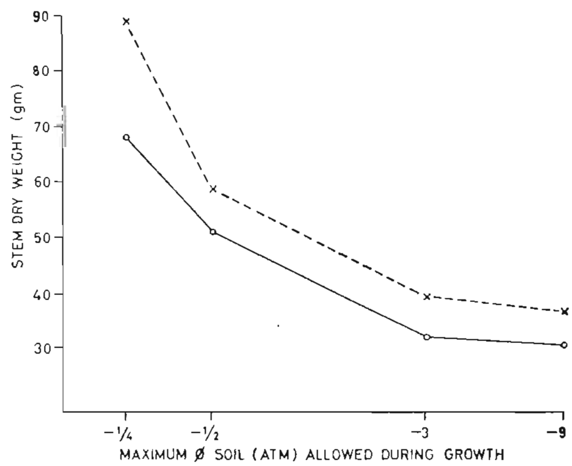


Fig. 25. Effect of different ∅ soil on stem dry weight of canes 3 months after planting. (Plain line: Ebène 1/37; broken line: M.147/44).

2. THE EFFECT OF SOLUTE POTENTIAL ON GROWTH OF THE VARIETIES EBENE 1/37 AND M.147/44

In an attempt to obtain confirmation of the greater adverse effects of increased suctions around the roots of Ebène 1/37 than around those of M.147/44, experiments on the effect of solute potential on growth of the two varieties were undertaken. Varying concentrations of sodium chloride solutions with osmotic pressures 0, 0.5, 1.0, 2.0, 4.0, 8.0 and 16.0 atm. were prepared and poured in containers 2m × 15 cm × 15 cm high. Single-eyed cuttings of the two cane varieties were placed in the containers and held by wire gauze so that the cuttings were half immersed in the solution with their bud above the solution. Water was added every other day to the solutions to make up for the amount of water evaporated. One month later, it was observed that root growth was very poor in all treatments and this was attributed to poor aeration of the root system. A second experiment was set up in a similar way, but the solutions were constantly aerated by an electric pump. No better results were obtained.

A further experimental approach was tried, and this consisted in planting the cuttings in perforated plastic bags 15 cm × 10 cm, filled with soil and the bags were put in the trays containing the solution so that only the bottom half of the bag was immersed. Five cuttings of each variety were used for each treatment. Water was added to the solution every other day, and on alternate days the solutions were used to re-water the soil in the bags to prevent an increase in the concentration of the soil solution resulting from evaporation. Three months after planting, growth measurements were carried out and the results show that the growth of both varieties was adversely affected by a decrease in solute potential, Ebène 1/37 being more susceptible to an increase in the concentration of the solution than M.147/44. Heavy chlorosis of the leaves was observed with both varieties, especially in the more concentrated solutions, and this chlorosis could be due to the effect of potential or salt toxicity. In the latter case, toxic effect during early growth may have affected subsequent growth, and the adverse effects on growth may have been due to either or both of the two factors, *viz.* solute potential and salt toxicity. Further experiments using polyethylene glycol solution as the osmoticum did not yield better results and no definite conclusion could be reached. It was therefore decided to put up a field scale trial with different water régimes and study the response of the varieties to the different water treatments.

3. FIELD TRIALS TO DETERMINE SOIL WATER CONDITIONS ON GROWTH OF EBENE 1/37 AND M.147/44

The field trial was carried out to confirm or not the results obtained in the greenhouse experiments and determine what other factors, if any, are responsible for the "drought-resistivity" or "drought-susceptibility" of the two varieties. The experiment was carried out in the Low Humic Latosol at Pamplemousses Experiment Station, and consisted of a latin square design comprising four different water régimes A, B, C and D. These consisted in allowing the maximum soil water suctions at 15 cm soil depth to reach 0.2, 0.4, 0.6 and 3.0 atm. respectively before the soil was restored to field capacity. The treatments were replicated four times for each of the varieties Ebène 1/37 and M.147/44, and each plot comprised 4 rows 6 metres long. The months of August to December, being normally the driest months at Pamplemousses, the experiment was started on the 25th July 1967. On that date, single-eyed cuttings were planted at 4 cm depth at the rate of 10 cuttings per metre and on 12th September, the number of germinated canes was reduced to a uniform number of 40 plants per row. The soil water conditions were adequate in all treatments and never exceeded 0.2 atm. because of rainy conditions that prevailed until the 12th September when the first growth measurements were carried out.

Soil humidity measurements. Measurements of soil water suctions were made with irrometers and gypsum blocks. In treatments A, B and C, irrometers were placed in the rows with the ceramic cups at 15 and 30 cm depth, and in treatment D, Bouyoucos blocks were introduced at 15 cm and 30 cm and irrometers at 30 cm below the soil surface. Water content per unit volume of soil (Hv%) for different soil profiles was determined with the neutron probe. Only twelve duralumine tubes were available, and eight of them were introduced into the soil to a depth of 1 metre in eight Ebène 1/37 plots to obtain readings from 2 replicates of each of the treatments A, B, C and D. Two other tubes were placed in the M.147/44 plots, one in treatment A and one in treatment D. The tubes were, in all cases, placed less than 50 cm away from the irrometers and the gypsum blocks. The remaining two tubes were set up a few metres outside the experimental plots for calibration purposes. The apparent density of the soil was determined with the rubber balloon density apparatus for soil depths Z_i (i = 10, 20, ... 120 cm) in order to calculate Hv%. Immediately after planting, the whole experimental site received an artificial overhead irrigation until the soil was saturated. On the day following the irrigation, counts were made with the neutron probe for different horizons Z_i = (i = 10, 15, 20, 30... cm) in each of the ten duralumine tubes, thus obtaining the readings for the different profiles at saturation point. These readings were repeated daily for three days to give an estimate of the maximum retention capacity.

Climatological measurements. The amount of precipitation was measured daily at 9 a.m. during the whole experimental period by rain gauges situated some fifty yards away from the edge of the experimental site. Daily evaporation rate from an open water surface (U.S. Weather bureau Class A pan) and solar radiation (Gunn Bellani radiation integrator) were also recorded.

Results

Atmospheric and soil water conditions. The climatic conditions during the experiment were highly unfavourable and the amount of rainfall since plantation date was abnormally high. The soil did not dry out to an extent suitable for the purpose of the experiment, and the four treatments initially chosen could not be applied. The soil water suction (⌀ soil) at 15 cm below soil level was never greater than 0.4 atm. and at 30 cm depth, 0.3 atm. Therefore only the two wettest treatments were applicable, and the information obtained with the neutron probe readings under the circumstances was of restricted value. There was, however, an indication that water absorption by the roots was taking place at a greater depth in the variety M.147/44 than in the Ebène 1/37 variety. It is probable that if drier conditions had prevailed, more information could have been obtained with the neutron probe measurements. The use of a protective hydrogen concentrated polythene cap was found to be of little value to prevent the escape of neutrons when measurements were made in the top 30 cm of soil. It followed that the relation between Hv% and neutron probe readings for successive soil depths must be determined at least down to the 40 cm layer before it becomes possible to translate neutron probe readings to ⌀ soil at different depths from curves relating Hv% and ⌀ soil.

Plant growth measurements. Three criteria were chosen for an estimation of growth, and these were dewlap height, shoot height, and area of leaf surface. In each experimental plot, on 12th September, ten plants of uniform height in the two central rows in each of the 4 replicate plots for each treatment were measured and tagged for subsequent weekly growth measurements of dewlap and shoot height. The cumulative mean weekly growth increments of the plants under conditions of treatments A and B for the two varieties are shown in figs. 26 and 27, and the weekly shoot growth rate in fig. 28. Leaf area measurements every week were made as from the 5th October on five of the ten plants selected for shoot height measurements, and the mean increments per week of total leaf area per plant for each treatment and for each variety are shown in fig. 29. Also, at chosen intervals, three plants of each variety were carefully uprooted in the outside rows and measurements on the shoot and root system of the uprooted plants were carried out, the main

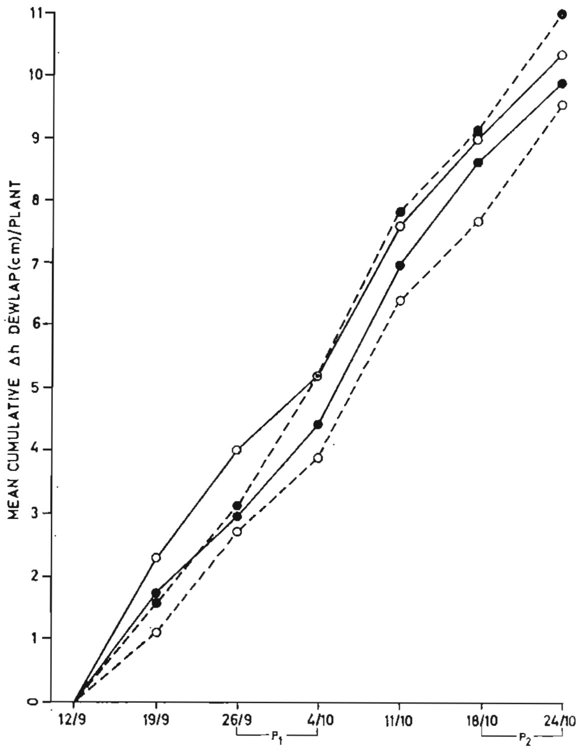


Fig. 26. Cumulative weekly Δh dewlap when the plants were subjected to two different water régimes. Plain line: M.147/44; broken line: Ebène 1/37; black dot: treatment A; white circle: treatment B.

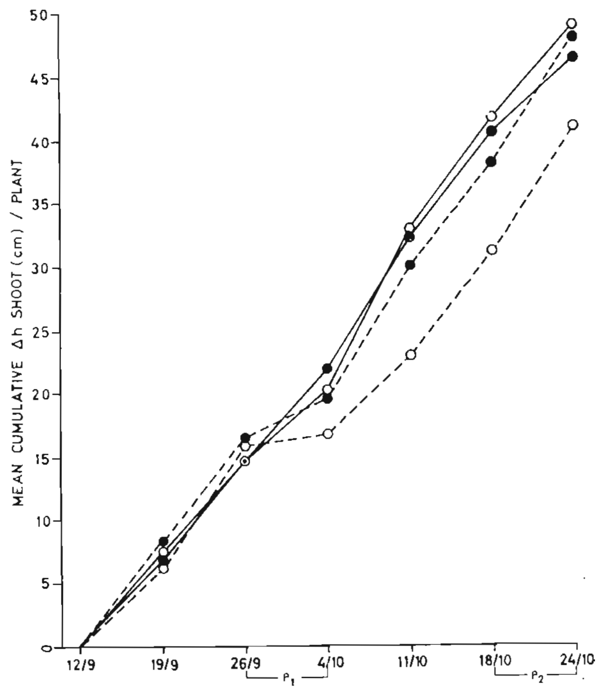


Fig. 27. Cumulative weekly Δh shoot when the plants were subjected to two different water régimes. Plain line: M.147/44; broken line: Ebène 1/37; black dot: treatment A; white circle: treatment B.

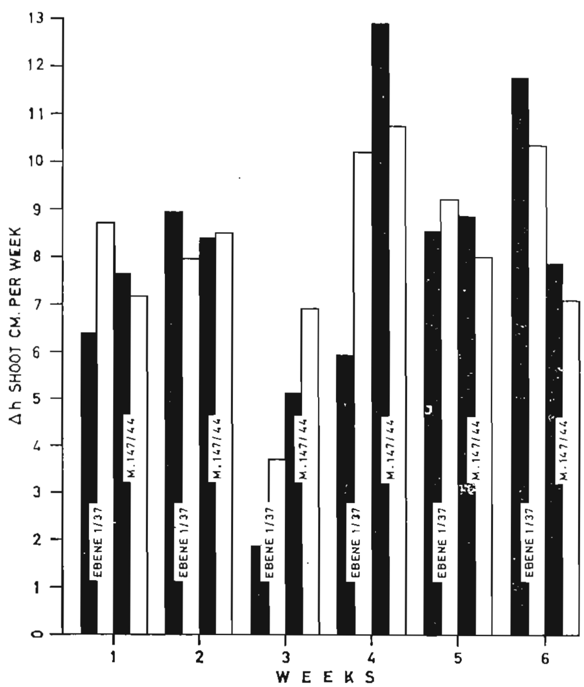


Fig. 28. Weekly growth rate of shoot of M.147/44 and Ebène 1/37 under treatments A (black column) and B (white column).

purpose being to follow root growth in the two varieties. It was intended to follow the development of the root system under the different water régimes, but the unfavourably wet conditions encountered during the experiment precluded this study.

The mean number of sett roots and shoot roots per plant for each variety was determined and measurements made on the length of the sett roots and shoot roots (Table 35), and also on the surface area of leaves and shoot roots (Table 36), Prior to these measurements however, photographs of the root system were taken and selected examples have been grouped together for illustration in Plate VII. The surface areas of the shoot roots for each variety exploring the different depths of the soil profile at different stages of growth are illustrated in (fig. 30).

The results clearly show that the growth of both varieties was affected when the soil water was allowed to reach a suction of 0.4 atm. at 15 cm depth, and that Ebène 1/37 was more susceptible to the drying treatment than M. 147/44. It was found that Ebène 1/37 was entirely dependent on its sett roots which explore only the top 15-20 cm of soil during the first three months' growth, whereas M.147/44 produces shoot roots as early as two months after planting. These shoot roots grow rapidly

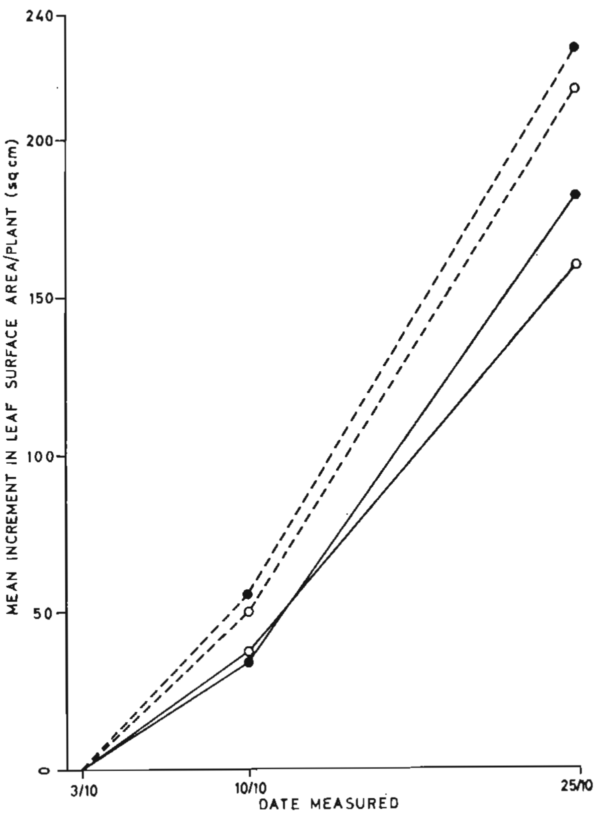


Fig. 29. Mean cumulative increment in leaf area per plant of M.147/44 and Ebène 1/37 when subjected to two different water régimes. Plain line: M 147/44; broken line : Ebène 1/37; black dot: ¼ atmospere ; white circle : 3 atmospheres.

Table 35. Plant growth measurements of varieties Ebène 1/37 and M.147/44 (shoot and sett roots)

	Mean total root length (cm) per plant				*Mean number of roots per plant*			
	Shoot Roots (cm)		*Sett Roots (cm)*		*Shoot Roots*		*Sett Roots*	
Date	*Eb.*1/37	*M.*147/44	*Eb.*1/37	*M.*147/44	*Eb.*1/37	*M.*147/44	*Eb.*1/37	*M.*147/44
21/ 9/67	—	67.2	274.5	219.0	—	7.00	48.67	33.33
28/ 9/67	1.4	38.3	152.7	156.2	0.67	5.67	44.00	23.67
5/10/67	30.1	54.6	228.2	176.6	6.33	8.67	58.67	29.00
11/10/67	138.3	215.4	241.8	127.6	18.67	17.67	52.33	21.67
19/10/67	331.8	330.4	217.8	136.6	31.67	25.67	60.67	34.67
26/10/67	364.6	362.4	201.3	88.0	28.00	32.33	34.00	17.67

Table 36. Plant growth measurements of varieties Ebène 1/37 and M.147/44 (surface area, leaf & shoot roots)

Date	*Mean surface leaf area (sq. cm) per plant*		*Mean surface area of shoot roots (sq. cm) per plant*	
	*Eb.*1/37	*M.*147/44	*Eb.*1/37	*M.*147/44
21/ 9/67	—	—	—	26.52
26/ 9/67	80.4	103.5	0.67	22.64
4/10/67	261.78	150.16	10.79	27.26
11/10/67	369.40	264.63	46.86	101.80
17/10/67	353.72	273.33	111.94	149.98
24/10/67	—	—	111.88	173.26

in depth where humidity conditions are more favourable to plant growth than in the top soil layers, and they evidently help the sett roots in keeping a favourable plant water balance under dry atmospheric conditions. The better location of the root system of M.147/44 in the deeper soil layers at an early age, which is an inherent varietal character, seems to be one of the most important factors that contribute to the drought tolerance of this variety.

This experiment illustrates the importance of carrying out soil moisture measurements at different depths in the soil profile depending on the age of the plant and its root system. The measurement of soil suction at any one depth only to obtain optimal soil moisture conditions throughout the life cycle of the sugar cane plant is certainly not the solution. Soil suction, at least in the first 30 cm of the soil profile, where the roots are in the early growth phase

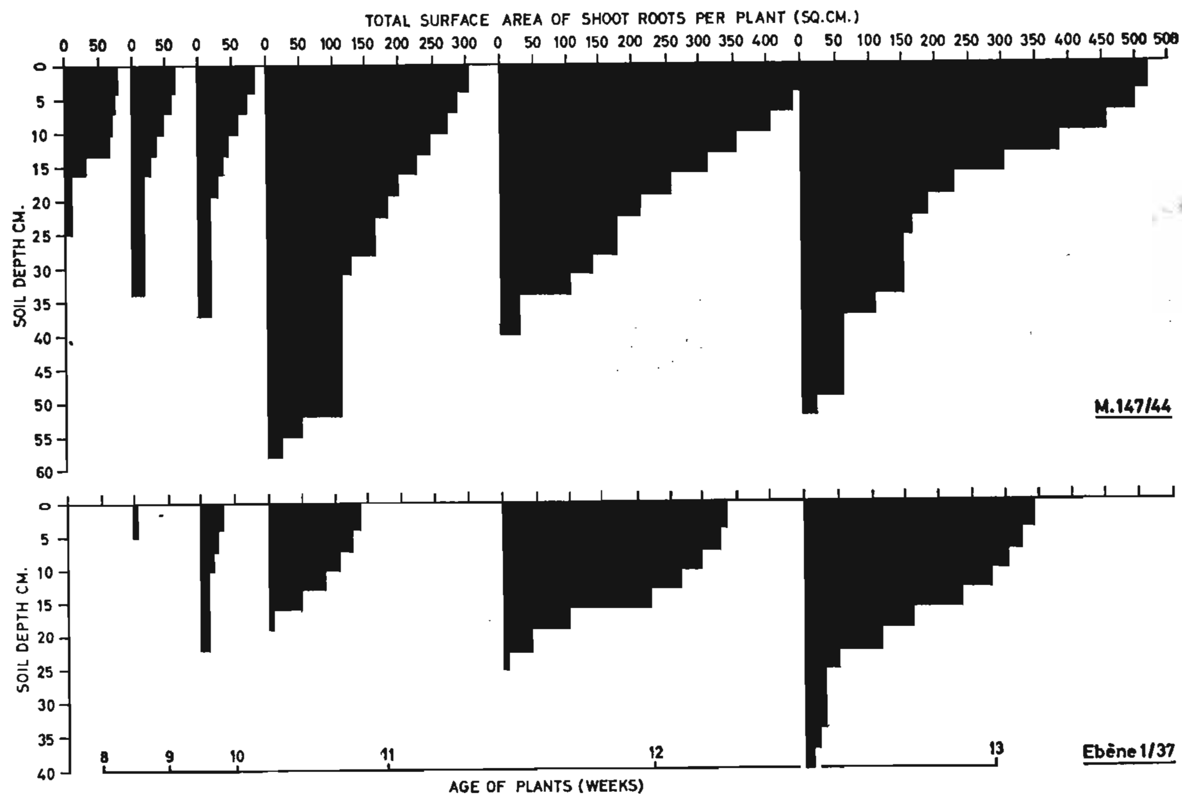


Fig. 30. Shoot root surface area of M.147/44 and Ebène 1/37 at different soil depths and at different stages of growth.

of the plant, varies with depth, soil type and climatic conditions; root growth rate is an inherent varietal character and depends also on whether the plant is a virgin or a ratoon crop. Therefore, measurements of soil suction at any one depth, even during the early growth phase of the sugar cane plant, is not sufficient. A knowledge of the soil characteristic and of the rooting capacity of each cane variety in plant canes and ratoons in successive years in different soil types, is essential if soil moisture measurements are to be taken as the criterion for irrigation purposes.

4. THE USE OF SINBAR TO SELECT DROUGHT-RESISTANT VARIETIES OF SUGAR CANE

In a series of experiments carried out to determine the tolerance of different cane varieties to Sinbar (3-tert-butyl-5-chloro-6-methyl uracil) it was found that the varieties showing tolerance were invariably those that had been previously classified as drought-resistant. The drought-susceptible varieties were much affected, showing leaf chlorosis, even at low dosage rates. The chlorotic symptoms were usually observed some two months after the herbicide application and the plausible reason was that the chemical leached slowly into the soil until it reached the root system where it was taken up into the plant, accumulated in the green tissues before toxic symptoms appeared.

These observations, in parallel with the finding that the early development of the shoot root system was one of the factors inherent to the drought-tolerant variety M.147/44, were the basic reasons for carrying out experiments to determine whether Sinbar could be used to classify varieties into drought-tolerant and drought-susceptible.

An experiment was set up at Belle Rive Experiment Station and consisted of a randomized block design with two replicate plots for each of the eight varieties M.147/44, M.351/57, M.442/51, M.31/45, Ebène 1/37, M.93/48, M.99/48 and B.3337. Each plot included 4 rows of 50 feet, and three-eyed cuttings were planted before the herbicide application. The Chesterford logarithmic spraying machine was used to spray concentrations of Sinbar in decreasing dosage rates as from 3 lb active ingredient per arpent on cane rows immediately after plantation.

Observations were made 6 weeks and 8 weeks after the chemical spray. The chlorotic symptoms were obvious at the earlier date on the varieties Ebène 1/37, B.3337, M.93/48 and M.31/45. On the 8th week, the leaves of Ebène 1/37 and B.3337 were yellow, and the green colour of the leaves of M.93/48 and M.31/45 was fading at all dosage rates. Very slight chlorosis was apparent on M.147/44, M.99/48 and M.442/51 at the highest dosage rates, while the variety M.351/57 did not appear affected at all. Chlorophyll content per unit turgid weight of leaf at various dosage rates are being determined. But it is obvious that the deleterious effect of Sinbar on the drought-susceptible varieties Ebène 1/37, B.3337 and M.93/48, where severe chlorosis of the leaves was observed, contrasted with the tolerance to Sinbar of the drought-resistant varieties M.147/44, M.442/51 and M.351/57. Of the varieties adapted to humid localities, M.31/45 was much affected by the herbicide whereas M.99/48 appears to be tolerant.

Root distribution studies are being carried out, and the first results obtained confirm that the drought-tolerant varieties have a deeper shoot root system than the drought-susceptible varieties. It is possible that a greater absorption of Sinbar in the transpiration stream by the shallow root system of the latter varieties accounts for the differences in the toxic symptoms observed. This experiment indicates that a broad and rapid classification of newly developed varieties into categories as regards drought tolerance is possible, and if confirmation of the above results with a larger number of varieties is obtained, this approach will be useful in the selection programme of new varieties.

CLIMATE AND CULTIVATION

1. WEATHER CONDITIONS AND SUGAR PRODUCTION IN 1967

PIERRE HALAIS

General

The four graphs (figs. 31-34) reproduced in the text of this note represent :

(i) For the vegetative period, from November 1966 to June 1967, monthly mean air temperature deviations, ten-day rainfall totals deviations, monthly highest hourly wind speed deviations and monthly relative insolation deviations in each case from normal values.

(ii) For the maturation period, from July to October 1967, the same information, except for temperature deviations for which the monthly average minimum values are given, as they are more critical for cane ripening.

These four graphs give in addition similar data collected during the two previous campaigns in order to facilitate direct comparisons of the various meteorological elements selected.

All the different weather data are averages which have been calculated from a network of observations made at strategic locations. In doing so, a valid representation for the whole sugar cane area of the island is obtained.

Conditions for cane growth were excellent throughout 1967, with two notable exceptions : in January the passage of cyclone *Gilberte* brought highest wind speed of 39 m.p.h. for one hour, and later in February and early March when a drop in rainfall occurred. As dry weather had prevailed during the maturation period of 1966, the canes were comparatively short when cyclone *Gilberte* occurred so that damage to the standing young crop was somewhat restricted.

High temperatures and abundant rainfall extended later on, and outside their regular seasonal boundaries, so that cane vegetation exceeded normal expectations, especially in the sub-humid lowlands of the northern sector of the island where cane yields from millers' plantations reached the record of 37.7 tons, only to be surpassed by the irrigated plantations of the millers in the western sector which yielded 40.3 tons per arpent harvested.

However, the reverse was true for cane maturation, for the reason that all the six critical meteorological elements which ocurred from July to October 1967 were unfavourable : high wind speed 21 m.p.h. (normal 18); very high sum of monthly rainfall excesses 10.8 in. (normal 2.5); low relative insolation 57% (normal 58); high average minimum air temperature 17.1°C (normal 16.5); low mean daily range 7.3°C (normal 8.2); and low temperature ratio 0.85 (normal 0.98). Furthermore, for other reasons, mainly labour shortage, the duration of harvest reached the unprecedented length of 168 days (normal 142) and encroached considerably on the 1968 vegetative period, with most undesirable effects on cane quality in particular.

The final result was that sugar manufactured (S.M.) % cane crushed barely reached 11.0, the lowest value on record apart from the 1960 campaign which suffered from two highly destructive cyclones. The corresponding figures for the northern and eastern sectors were the lowest, with 10.8 and 10.7 S.M. % cane respectively.

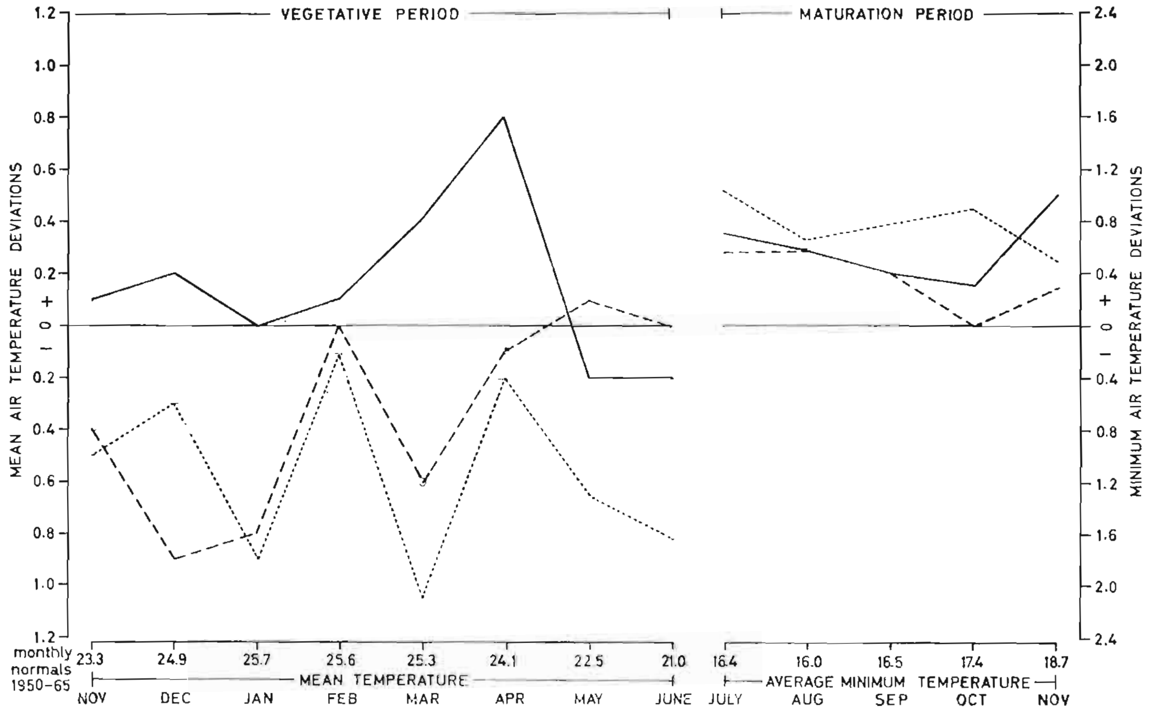


Fig. 31. Air temperature; deviations from monthly normal values. Average mean temperature for vegetative period; Average minimum temperature for maturation period : dotted line: 1964-65 ; broken line : 1965-1966; Plain line : 1966-67. Scale used for vegetative period is double that for maturation period.

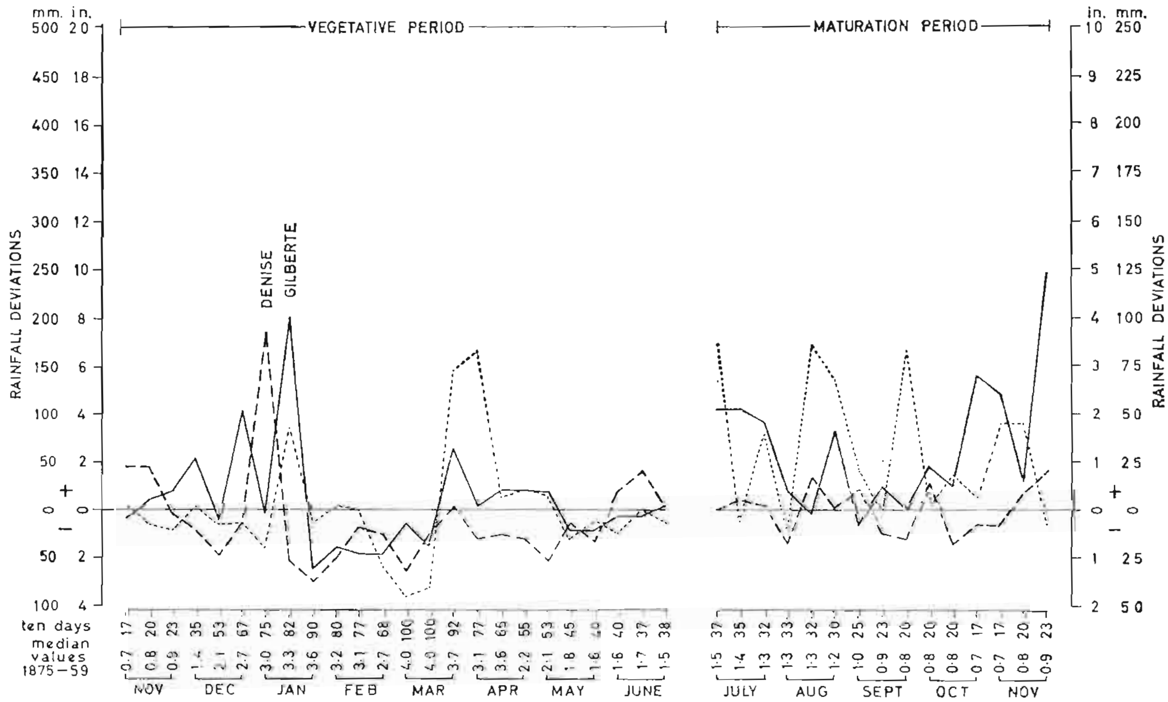


Fig. 32. Rainfall ; deviations from 10 days median values : dotted line : 1964-65 ; broken line : 1965-66 ; plain line : 1966-67. Scale used for maturation period is double that for vegetative period.

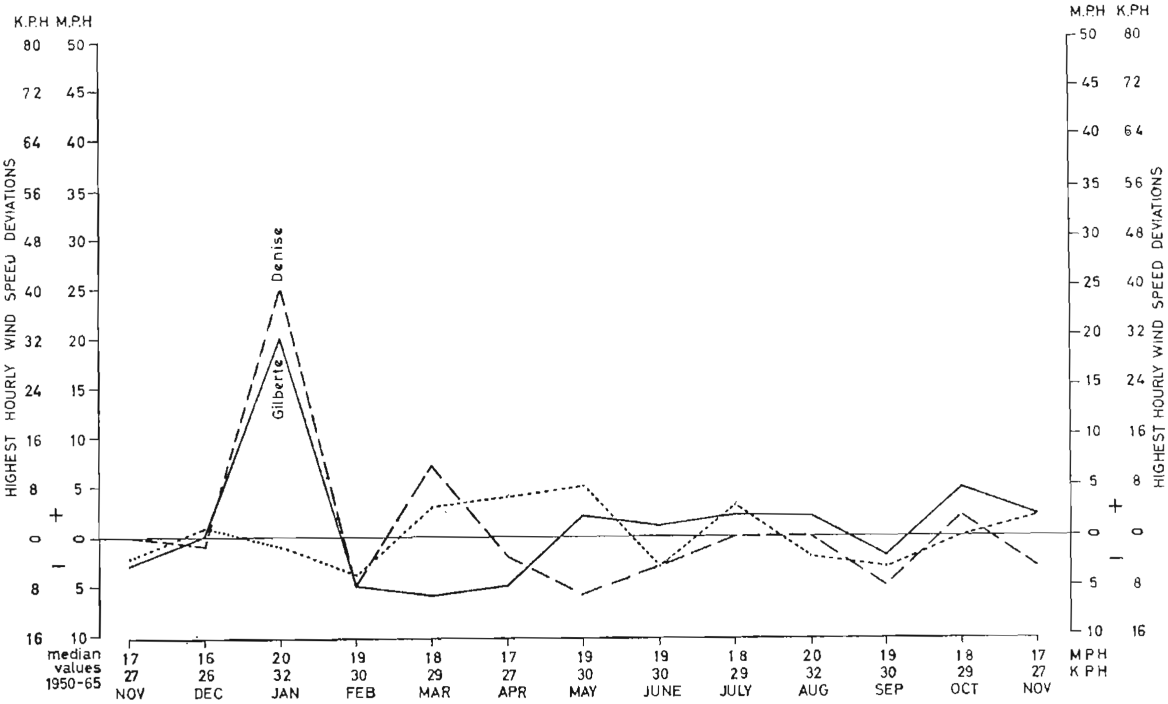


Fig. 33. Highest hourly wind speed ; deviations from corresponding median values: dotted line : 1964-65; broken line : 1965-66 ; plain line : 1966-67.

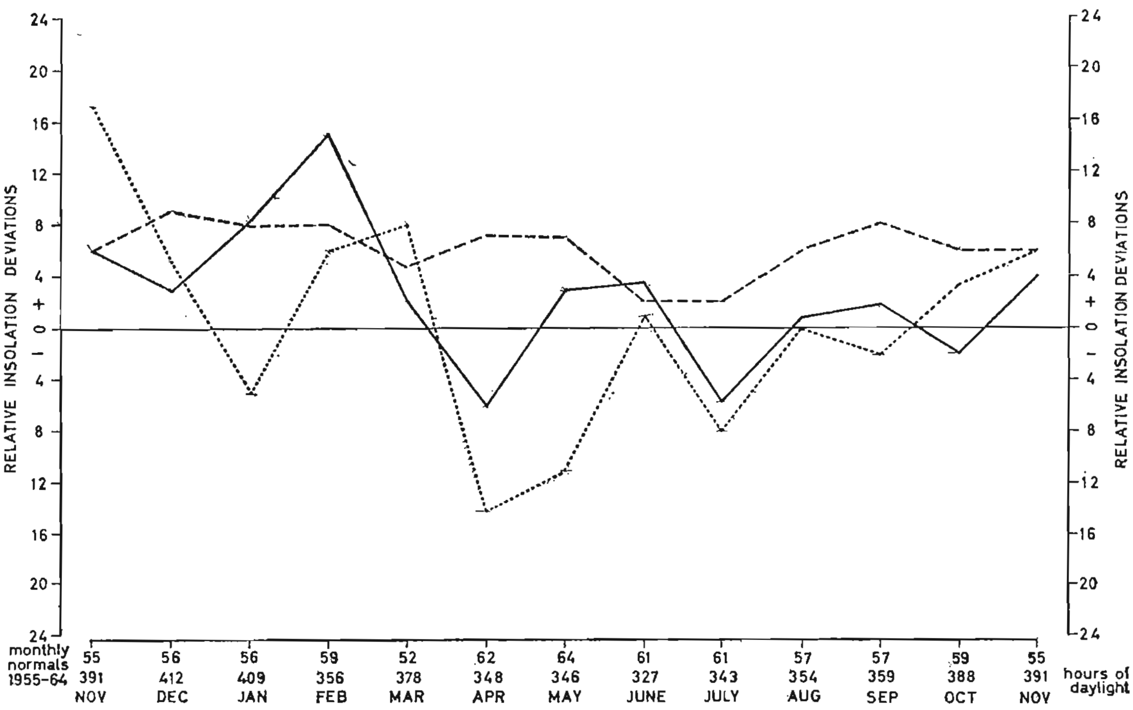


Fig. 34. Relative insolation ; deviations from monthly normals: dotted line : 1964-65 ; broken line : 1965-66; plain line : 1966-67.

In conclusion, the profitable sugar index for the island, as worked out from the empirical formula 0.01 TCA (SM-4) only reached the value of 2.12 against the highest value to-date, 2.35, observed on two occasions in 1956 and 1963. This corresponds to a difference of 10% in the profitable sugar index. Such a level of profitable production observed twelve years ago in 1956 justifies the term "exceptionally favourable" applied to that campaign.

The final statistics for the 1967 campaign show a decrease of approximately 4,000 arpents in the acreage reaped. A comparison of the three best sugar cane crops in recent years is shown in Table 37.

Vegetative period

Comparative meteorological data of critical interest to cane growth for the last three campaigns and extreme values observed since 1950 are given in Table 38 for the vegetative period, November to June.

Table 37. Comparison of three best sugar crops

Sugar campaigns	*Area reaped (arpents)*	*Duration of harvest (days)*	*Tons Cane/ arpent (TCA)*	*Sugar made % cane (SM)*	*Sugar made/ arpent (TSMA)*	*Profitable sugar index*	*Sugar Production Island (th. tons)*
1963	194.1	153	29.6	11.93	3.53	2.35	685.5
1965	194.9	156	30.7	11.10	3.41	2.18	664.4
1967	191.7	168	30.3	10.98	3.33	2.11	638.3

Table 38. Variations in critical meteorological elements for vegetative periods and cane production, 1965-1967.

	Normals	*1967*	*1966*	*1965*	*Extremes since 1950*		
Highest hourly wind speed (m.p.h.)	26	39 (Jan.)	45 (Jan.)	24 (May)	18 (1959)	—	74 (1960)
Sum of monthly rainfall deficits (in.)	*15.0*	11.1	23.7	14.1	5.7 (1962)	—	28.7 (1961)
Relative insolation % ...	*58*	63	65	59	53 (1963)		66 (1961)
Mean temperature °C (March-June, Autumn)	*23.3*	23.5	23.1	22.6	22.6 (1965)		24.6 (1961)
Tons cane per arpent, Island ...	*31.5*	30.3	24.7	30.6	12.7 (1960)		30.6 (1965)

Cane tonnages per arpent reaped, recorded in the five sugar sectors and the island in 1967, are compared below to corresponding normals :

	West	*North*	*East*	*South*	*Centre*	*Island*
Normals	*37.0*	*29.0*	*30.7*	*31.8*	*31.9*	*31.5*
1967	36.6	29.3	29.5	30.8	29.7	30.3
Differences	—0.4	+0.3	—1.2	—1.0	—2.2	—1.2

As mentioned already, the high cane yields observed in the northern sector in 1967 can be ascribed to an unusual extension of wet conditions in the lowlands beyond the regular vegetative period, and the comparatively low cane yields in the central sector to the direct influence of cyclone *Gilberte* on the high grounds.

Maturation Period

Table 39 gives for the maturation period, July to October, comparative meteorological data of critical interest to cane ripening for the last three campaigns, and extreme values observed since 1950, while variations in critical meteorological elements during the maturation periods, and sugar production are shown in Table 40.

Table 39. Variations in critical meteorological elements for cane ripening, 1965-1967.

	Normals	*1967*	*1966*	*1965*	*Extremes since 1950*
Mean of highest hourly wind speed (m.p.h.)	*18*	21	18	18	15 — 22 (1957) (1953)
Sum of monthly rainfall excesses (in.)	*2.5*	10.8	0	14.1	0 — 14.1 (1956 1966) (1965)
Relative insolation % ...	*58*	57	64	56	51 — 65 (1953) (1956)
Average minimum temperature (°C)	*16.5*	17.1	16.9	17.6	15.7 — 17.6 (1963) (1961 1965)
Mean daily range (°C) ...	*8.2*	7.3	7.9	6.7	6.7 — 9.3 (1965) (1956)
Temperature ratio	*0.98*	0.85	0.93	0.77	0.77 — 1.15 (1965) (1956)

Table 40. Sugar production, 1965-1967.

	Normals	*1967*	*1966*	*1965*	*Extremes since 1950*
Area harvested, th. arp.	*196*	192	196	194	151 — 196 (1950) (1966)
Duration of harvest, days	*142*	168	139	156	113 — 168 (1960) (1967)
Sugar manufactured % cane (SM) ...	*11.6*	10.98	11.60	11.10	
Tons sugar made per arpt., Island ...	*3.65*	3.33	2.86	3.42	1.26 — 3.53 (1960) (1963)
Profitable sugar index, Island: 0.01 TCA (SM-4)	*2.39*	2.12	1.88	2.18	0.74 — 2.35 (1960) (1956 1963)
Total sugar production, th. tons	*715*	638	562	665	254 — 686 (1960) (1963)

The following figures for sugar made % cane crushed were obtained during the 1967 campaign for the five sugar sectors and the island, and are compared with the corresponding normal values adjusted to date :

	West	*North*	*East*	*South*	*Centre*	*Island*
Normals	*12.2*	*12.0*	*11.4*	*11.2*	*11.8*	*11.6*
1967	11.7	10.8	10.7	10.9	11.4	11.0
Differences	—0.5	—1.2	—0.7	—0.3	—0.4	—0.6

The important difference (-1.2) of sugar made % cane between the normal value and the 1967 realization for the northern sector results from a conjunction of three factors which have been operating simultaneously only on three occasions during the last twenty years: in 1953, 1965 and 1967, when the harvest seasons were very wet, the cane yields very high, and the duration of crushing extended beyond normal limits.

On the other hand, the following figures for tons of sugar made per arpent reaped show some compensating influences as the differences between the normal values and the 1967 realizations were of the same order for all the sugar sectors. The normals have been adjusted to-date to the best of our knowledge:

	West	*North*	*East*	*South*	*Centre*	*Island*
Normals	*4.51*	*3.48*	*3.50*	*3.56*	*3.66*	*3.65*
1967	4.28	3.18	3.16	3.36	3.39	3.33
Differences	—0.23	—0.30	—0.34	—0.20	—0.27	—0.32

In the figures given below, the profitable sugar indices: 0.01 TCA (SM-4) are compared:

	West	*North*	*East*	*South*	*Centre*	*Island*
Normals	*3.03*	*2.32*	*2.17*	*2.29*	*2.49*	*2.39*
1967	2.82	1.99	1.98	2.13	2.20	2.12
Differences	—0.21	—0.33	—0.19	—0.16	—0.29	—0.27

On a comparative basis and during the 1967 campaign, the profitable sugar index proved to be less unfavourable (–0.16) in the southern sector than in the northern (–0.33) compared to normal values.

1960 to 1967 Recapitulation

Table 41 recapitulates the salient weather conditions in relation to sugar production per arpent harvested from 1960 to 1967.

It is interesting to observe that for the 1963 campaign with a sugar production nearing the normal value, all the weather elements have differed very little from their normal values given above.

Of course, it is quite possible that for a particular campaign some of the weather elements might prove superior to their normal values. If such rare circumstances actually occured, the sugar production per arpent as well as the profitable sugar index would surpass the present normal values of 3.60 and 2.36 respectively. Such a campaign could certainly be qualified as "exceptionally favourable". The last one to have occurred was the 1956 sugar campaign.

Table 41. Weather conditions in relation to sugar production, 1960-1967

Sugar campaigns	*Vegetative periods (November-June)*			*Maturation periods (July-October)*			*Duration of harvest (days)*	*Tons sugar made per arpent reaped, Island*	*Profitable sugar index 0.01 TCA (SM—4)*
	Sum monthly rainfall deficits (in.)	*Highest hourly w. speed (m.p.h.)*	*Mean air temperature March-June (°C)*	*Sum monthly rainfall excesses (in.)*	*Relative Insolation %*	*Temperature ratio*			
Normals to date	*15.0*	*26*	*23.3*	*2.5*	*58*	*0.98*	*142*	*3.60*	*2.36*
1960	12.0	*Alix* (53) *Carol* (74)	23.2	5.2	57	0.86	113	1.26	0.74
1961	28.7	16	24.6	4.8	60	0.92	150	2.95	1.90
1962	5.7	*Beryl* (43) *Jenny* (59)	22.8	3.4	56	1.00	140	2.75	1.80
1963	13.9	26	23.2	2.2	51	1.11	153	3.53	2.35
1964	10.3	*Danielle*(60) *Gisele* (34)	22.7	2.9	61	1.00	121	2.66	1.76
1965	14.1	24	22.6	14.1	56	0.77	150	3.42	2.18
1966	23.7	*Denise* (45)	23.1	0.0	64	0.93	139	2.86	1.88
1967	11.1	*Gilberte*(39)	23.5	10.8	57	0.85	168	3.33	2.12

2. SUGAR CONTENT AND WEATHER CONDITIONS : TEST CASE FOR THE NORTHERN SECTOR

PIERRE HALAIS

This study covers a period of twenty years from 1948 to 1967, the sugar campaign 1960 having been discarded on account of the very abnormal conditions which prevailed as a result of two disastrous cyclones.

Two ten-year periods, the first from 1948 to 1957, and the second from 1958 to 1967, have been grouped in order to minimise long-term changes, such as varieties under cultivation, milling and processing efficiencies, and labour evolution.

It is a recognized fact that the northern sector shows much more variability in sugar manufactured % cane crushed than the four other sugar sectors. For instance, during the decade 1948-1957, the extremes for the northern sector were 13.9% in 1957 and 10.9 in 1953, whereas the corresponding values for the four other sugar sectors were 12.7 and 11.1 respectively. During the decade 1958-1967, the extremes for the North were 12.5% in 1964 and 10.8% in 1967 against 11.6% and 11.0% respectively for the four other sugar sectors.

The chief causes for such differential behaviour, as far as sugar manufactured % cane is concerned, are to be ascribed to fluctuations in meteorological conditions from year to year.

The climatic data for the five sugar sectors are given in Table 42.

The northern sector is characterised, as far as climatological conditions influencing cane growth and quality are concerned, by warm conditions (lowlands), moderate rainfall (55 inches), but extremely variable distribution (windward) during the July to October maturation period.

This maturation period is a comparatively short season lasting four months (some 120 days) from July to October, which is normally but not always, favourable to satisfactory cane ripening. Weather conditions outside these chronological limits being generally unfavourable to cane ripening, the ill effects in the lengthening of the duration of harvest are obvious.

For the reasons mentioned above, the maturation of the cane crop to be harvested reacts in a more pronounced manner to these annual fluctuations of weather conditions.

During July to October, two meteorological criteria govern cane ripening under local conditions : they are the sum of monthly rainfall excesses which have varied from 0.0 inches in 1956 to 14.2 inches in 1965, and temperature ratio* from 1.12 to 0.78 during the same two years.

Low rainfall excesses and high temperature ratio are associated with excellent cane quality, and high rainfall excesses and low temperature ratio to poor cane quality.

Table 42. Climatic data for the five sugar sectors

Sector	*Topography*	*Mean Annual rainfall (in.)*	*Cool season (May-Oct.) rainfall % of total*	*Exposure*
West	Slopes	45	18	Leeward
North	Lowlands	55	30	Windward & transition
East	Slopes	95	35	Windward
South	Slopes	90	34	Windward
Centre	High ground	90	30	Leeward & transition

* Temperature ratio $= \dfrac{2\,(\text{Max T} - \text{Min T})}{\text{Min T}}$

In Table 43 the cane quality is contrasted between the northern and the four other sugar sectors.

Table 43. Sugar made % cane and weather conditions for two ten-year periods

(a) Period 1948-1957

Cane quality	*Years*	*Jul-Oct. Monthly rainfall excesses (in.)*	*Temp. ratio*	*Northern sector Duration of harvest (days)*	*Northern sector Sugar made % cane*	*Four other sectors Duration of harvest (days)*	*Four other sectors Sugar made % cane*	*Differences between North and others*
Lowest	1951 & 1953	5.1	0.96	168	11.2	156	11.0	+0.2
Mean	1948 to 1957	2.2	1.01	138	12.7	140	11.9	+0.8
Highest	1956 & 1957	0.2	1.13	120	13.7	132	12.6	+1.1

(b) Period 1958-1967

Cane quality	*Years*	*Jul-Oct. Monthly rainfall excesses (in.)*	*Temp. ratio*	*Northern sector Duration of harvest (days)*	*Northern sector Sugar made % cane*	*Four other sectors Duration of harvest (days)*	*Four other sectors Sugar made % cane*	*Differences between North and others*
Lowest	1965 & 1967	12.5	0.81	157	10.8	162	11.1	—0.3
Mean	1958 to 1967	5.3	0.95	128	12.0	144	11.5	+0.5
Highest	1963 & 1964	2.5	1.05	124	12.4	136	11.7	+0.7

As the values for the two meteorological criteria, monthly rainfall excesses and temperature ratio are both more detrimental to cane ripening in the second decade (1958 to 1967), the comparatively lower cane quality in terms of sugar manufactured % cane observed recently in the northern sector is not specially alarming.

3. INTERLINE CULTIVATION AND EARTHING-UP IN THE SUPERHUMID ZONE

GUY ROUILLARD

It is the usual practice on some estates of the super-humid zone to cultivate the cane interlines with tynes during the first three ratoons. For subsequent ratoons a small mouldboard plough is used to dig a shallow drain between the rows, the soil being brought up along the canes in the earthing-up operation.

The effects of earthing-up have already been discussed (*vide Rep. Maurit. Sug. Ind. Res. Inst.* 1955: 68-69) and the results of the operation shown to be non-significant. Experiments had also been carried out on interline cultivation in the various climatic zones, except under super-humid conditions. In order to obtain information on the effects of this agricultural operation in regions subjected to high rainfall, four trials (latin squares) were laid down in 1st ratoons in 1963 and concluded in 5th ratoons in 1967. Two trials were under M.202/46, and two under Ebène 50/47. The treatments were as follows :

a) Control.

b) Earthing-up done every year.

c) Interlines cultivated :
   (i) with tynes for the 1st to 3rd ratoons;
   (ii) with mouldboard plough for the 4th and 5th ratoons.

d) Combination of earthing-up and interline cultivation (i.e. treatments a + b).

Each plot consisted of 6 lines of 40 feet, of which the two central rows were weighed every year and the canes were sampled from each plot for analysis.

The usual estate fertilizer practice consisting of 45 kg. of both nitrogen and potassium and 22 kg. of phosphoric acid per arpent annually was followed.

The results obtained are summarized in Table 44.

These show that neither earthing-up, nor cultivation of interlines, irrespective of the tool employed, has produced an increase in cane or sugar yield. The operations might, in certain cases, help weed eradication, and this aspect should be the only one considered when any of the operations is adopted.

Table 44. Effects of earthing-up and cultivation of interlines with tynes for 1st to 3rd ratoons, and with moulboard plough for 4th to 5th ratoons on yields of cane and sugar.

Treatment	*T. C. A.*		*I. R. S. C.*		*T. S. A.*	
	1st to 3rd ratoons	*4th to 5th ratoons*	*1st to 3rd ratoons*	*4th to 5th ratoons*	*1st to 3rd ratoons*	*4th to 5th ratoons*
a)	31.7	24.4	11.5	11.4	3.65	2.78
b)	31.3	23.4	11.3	11.5	3.55	2.69
c)	31.0	23.5	11.5	11.4	3.55	2.68
d)	30.8	23.5	11.3	11.4	3.49	2.67

4. CULTIVATION OF POTATOES IN CANE INTERLINES

GUY ROUILLARD

The common practice followed in potato cultivation in cane interlines is to grow one line of potato on every alternate interline, or on every interline. A series of 12 experiments were planted in 1966 to determine if potato yields could be increased with a more intensive method of cultivation but without affecting cane yields.

Details of the experiments have already been discussed (*vide Rep. Maurit. Sug. Ind. Res. Inst.* 1966: 114-115). The trials were planted both in cane and potatoes from April to July 1966, and the potatoes harvested between 85 to 96 days after planting. The canes were harvested from August to October 1967.

The experiments consisted of 5 × 5 latin squares with the following treatments :

a) Control.
b) 1 line of potatoes on every alternate cane interline
c) 2 lines ,, ,, ,,
d) 1 line of potatoes on every cane interline.
e) 2 lines ,, ,, ,,

Fertilization in the different treatments is shown in Table 45.

Table 45. Fertilizers used for cane and potato per arpent of cane cultivated

Treatments	*Before planting Guano phosphate*	*Along the cane interline: Sulphate of ammonia*	*Triple super phosphate*	*Muriate of potash*	*On potatoes at planting: Sulphate of ammonia*	*Triple super phosphate*	*Sulphate of potash*	*Farmyard manure*	*Total amount soluble fertilizers: Nitrogen*	*Phosphoric acid*	*Potash*
	Kg	*Kg*	*Kg*	*Kg*	*Kg*	*Kg*	*Kg*	*Tons*	*Kg*	*Kg*	*Kg*
a	800	300	200	200	—	—	—	—	60	90	120
b)	,,	,,	,,	,,	40	20	20	2	74	99	132
c)	,,	,,	,,	,,	60	30	30	3	81	104	138
d)	,,	,,	,,	,,	80	40	40	4	88	108	144
e)	,,	,,	,,	,,	120	60	60	6	102	113	156

The results, obtained for the eight experiments which were not affected by diseases, are summarized in Table 46, from which it may be seen that the cultivation of potatoes in cane interlines caused no reduction in cane and sugar yields. It is possible that the small decrease in sucrose content may be due to the higher dose of nitrogen applied on potatoes, part of which being in an organic form. However, the yield of potatoes has been substantially increased by more intensive cultivation. Double line planting has produced a gain of nearly two tons of tubers, as compared to single line on every cane interline.

It should be noted that potato growing in cane interlines requires much care for cultivation, control of weeds, pests and diseases. The cost of insecticides and fungicides, and the labour required for cultural operations, is nearly the same irrespective of the density of the potato crop. It is therefore advisable to plant a double line of potatoes on every cane interrow instead of a single line.

Table 46. Yields of cane and potatoes per arpent of cane cultivated

Treatments	*Tons cane*	*Industrial recoverable sugar % cane*	*Tons sugar*	*Tons potatoes*
a)	41.0	10.1	4.13	—
b)	43.4	9.9	4.28	1.60
c)	42.3	9.8	4.16	2.55
d)	42.5	9.8	4.17	3.22
e)	43.1	9.7	4.17	5.14

5. NOTES ON SUNFLOWER CULTIVATION IN RATOON CANE INTERLINES

G. ROUILLARD & G. MAZERY

Several food crops, such as potatoes, groundnuts and beans, which can be successfully grown in the interrows of virgin cane, cannot be intercropped with ratoons. In order to make maximum use of arable land for food production, and considering that the sugar cane is cultivated over a long cycle in Mauritius, with the result that a large proportion of cane land is under ratoons, experimentation was started in order to investigate whether sunflower could be successfully grown as an intercalary crop in ratoon canes. The experiments were planned in order to obtain concurrently the effect of sunflower intercropping on sugar cane yields.

Two series of six trials each were established during 1967 in the different climatic zones. The first series was planted in sub-humid and humid zones, and each trial comprised seven treatments as follows :

(i) Trash from previous cane crop lined on alternate interlines and no sunflower planted.

(ii) As (i) above but single row of sunflower planted on trash-free interline.

(iii) As (ii) above but double row of sunflower planted.

(iv) All cane interlines clear of trash and no sunflower planted.

(v) As (iv) above but single row of sunflower planted on each interline.

(vi) As (iv) above but double row of sunflower planted on each interline.

(vii) Cane trash lined on all interlines and no sunflower planted.

The second series was established in humid and super-humid zones, and consisted of six trials comprising treatments (i) to (vi) only.

The sunflower seeds were supplied by Gunson Pty., South Africa. The trials were planted from July to October, and the sunflower harvested about three months after planting. Cane and sugar yields will be obtained during the 1968 harvesting season.

Observations made throughout the growing period revealed that in most cases the growth of the sunflower was rather irregular with, as a result, great variability in flower and seed production in individual plots.

Factors which affected growth and seed production, apart from date of planting and environmental conditions, were destruction of seeds after sowing by birds and rats, damage to seedlings and young plants by cutworms, hares, snails and stem-boring insects, collar rots of various types, damage to the flower head by birds and insects.

The results averaged for all trials are given in Table 47.

Table 47. Summary of results obtained in sunflower trials in ratoon canes

	Sunflower planted			
	On alternate cane interlines		*On every cane interline*	
	Single row	*Double row*	*Single row*	*Double row*
No. of flower heads/arpent of cane	3,714	7,420	8,964	14,013
Wt. of dry seeds/arpents of cane (kg.)	55	123	171	245
Wt. of dry seeds/head (grm.)	14.8	16.6	19.1	17.5
Wt. of oil % dry seeds	33.6	35.7	34.3	37.3
Wt. of oil/arpent of cane (kg.)	18.5	43.9	58.7	91.3

It follows from the results that, as was to be expected, treatment (vi) in which two rows of sunflower were planted in each cane interline, has given the highest yields. It remains however: (a) to assess the effect of the sunflower intercropping at such high density upon cane yields; (b) to obtain proper control of the pests and diseases which have been observed; and (c) to define the climatic areas in which the intercrop should be grown. In that connection, it should be noted that yield in dry seeds per arpent of cane varied from 123 kg to 490 kg for treatment (vi) in the various experiments.

These preliminary investigations, as well as large scale observation plots established on the various sugar estates, have shown that the sunflower can compete with ratoon canes. Further experimentation has therefore been planned for 1968 in order to obtain data on the economics of such intercropping from the point of view of both oil and sugar production.

WEED CONTROL

C. MONGELARD

1. EVALUATION OF NEW HERBICIDES

THE Chesterford logarithmic spraying machine was used in a screening trial with fifteen herbicides. Ten of them, BAS 2100, BAS 2552, Casoron 133, C.6313, C.6989, NPH 1357, WL 9385, Dacthal, Patoran and Tenoran were tested under humid conditions for the first time, and the performance of these herbicides was compared with Atrazine, DCMU Herban, Linuron and Sinbar. The rates of application varied between 6 lb active ingredient to 0.87 lb per arpent, and the herbicides were sprayed in pre-emergence of virgin canes (M.31/45) and weeds. Ninety-two days after herbicide application, a weed assessment was carried out following the frequency-abundance and the percent weed coverage methods, and measurements of dewlap height (mean per plant) at different dosage rates were recorded.

The experimental results are grouped in Table 48. Sinbar was by far the best herbicide and gave excellent weed control even at the lowest dosage rate, but its high toxicity to the variety M.31/45 was striking. Atrazine, DCMU, Herban, Linuron and BAS 2100 were more or less comparable in their effects on weed control and no toxic symptoms on the crop were apparent. The remaining nine herbicides did not affect cane growth but showed inferior herbicide activity, BAS 2552, C.6313, NPH 1357 and Patoran being more effective than Tenoran, WL 9385, C.6989, Dacthal and Casoron 133.

2. EXPERIMENTS WITH HERBAN, COTORAN, FENAC, SINBAR, DCMU AND ATRAZINE IN CANE FIELDS

Two trials were laid down in the super-humid zone to compare the efficacy of DCMU, Sinbar, Atrazine, Herban and Cotoran in regions of high rainfall. The experiments were carried out at La Flora and at Réal, and the herbicides were applied in pre-emergence of canes and weeds at the rate of 4 lb active ingredient per arpent, with the exception of Sinbar whose rates of application were $\frac{3}{4}$, 1, $1\frac{1}{2}$ and 2 lb a.i. per arpent. Each trial was a randomized block with three replicates and the plot size consisted of 4 lines of 20 feet.

A weed survey was made 90 days after the chemical spray and at La Flora where 38.33 inches of rain were recorded during the experiment, the dominant weed species were *Ageratum conyzoides* and *Oxalis spp.* The best results were obtained in the DCMU plots while Atrazine and Sinbar at 2 lb were comparable in their weed control properties. Cotoran, Herban and the low dosage rates of Sinbar did not give a sufficient control of *Ageratum conyzoides.* At Réal, where similar climatic and ecological conditions prevailed, the results obtained were comparable.

Four additional trials with the same herbicides at the same concentrations, as well as Fenac at 4 lb a.i. per arpent, were laid down in the humid zone at Union Vale, Deux Bras, Savannah and Etoile, with the following cane varieties respectively, M.442/51, M.93/48, M.409/51 and M.31/45. Each experiment comprised four replicates and the herbicides were applied in pre-emergence of virgin canes and weeds. The observation of the effects of the different herbicides on weeds and canes are summarized in Tables 49 and 50.

At Union Vale, where precipitation was low during the experimental period, Atrazine, Cotoran, Herban and Sinbar at $1\frac{1}{2}$ and 2 lb a.i. per arpent gave a relatively better weed control than DCMU. The dominant weed species recorded were *Oxalis spp.*, *Setaria barbata* and *Solanum nigrum*. The results obtained in the three other experiments showed that Sinbar at 2 lb and DCMU were more effective than the other herbicides. Attention must be drawn to the fact that Sinbar applied at rates higher than $\frac{3}{4}$ lb per arpent caused leaf chlorosis, the chlorotic effects being more pronounced at increasing dosage rates, resulting in some cases, in death of the young canes at the $1\frac{1}{2}$ and 2 lb rates. The deleterious effects were observed about 2 months after application, becoming worse with time until the canes were four months old, when the maximum ill-effects were noted.

These experiments emphasized the superiority of DCMU in weed control in the super-humid zone. In the humid localities, Atrazine and Cotoran compared favourably with DCMU, the efficiency of DCMU being probably affected by a higher degree of solar radiation following application in these regions. The poor control of weeds of the family *Compositae* by Herban was the cause of its lower relative efficiency, while Fenac, though also less effective on weeds than the other herbicides, had the disadvantage of affecting both cane germination and growth.

3. NOTES ON THE CONTROL OF *CYPERUS ROTUNDUS* AND *KYLLINGA MONOCEPHALA*

Further attemps to find better means of keeping these weeds under control were made at Savannah, where an experiment was laid down to compare the efficacy of BAS 2100 and NPH 1357 at 4 lb a.i. and Gramoxone at $\frac{1}{4}$ lb acid equivalent per arpent. The chemicals were sprayed on established weeds and the treatment plots were distributed according to a latin square design and included 4 control plots. The plot size was 4 cane rows of 10 feet each in a ratoon field of Ebène 1/37. The trash was removed from the alternate interrows, which because of that cover were nearly free from weeds. The weed population in the other interrows consisted of a dense cover of *Kyllinga monocephala* and of *Cyperus rotundus* which, however, was less abundant than the other weed.

Observations made two weeks after spraying revealed that BAS 2100 was ineffective in the control of both weeds, both in pre- and post-emergence. NPH 1357 gave a 50 per cent weed kill mainly on young plants, and it appears that this herbicide has a higher activity in pre-emergence than in post-emergence applications, and no activity at all on fully established weeds. Gramoxone was more efficient as a post-emergence spray than the other two herbicides, and it was noted that 90 per cent of the established weeds had completely desiccated. Three weeks later, no better control was observed, but Gramoxone had still a better check on weed growth where about 30 per cent regrowth had occurred in all plots. Pending further trials with new chemicals, it is believed that the best way to keep these weeds under control in ratoon canes is an application of $\frac{1}{2}$ lb a.e. of Gramoxone in 100 gallons of water per arpent, followed by monthly applications of the same herbicide at the rate of $\frac{1}{4}$ a.e. in 60 gallons of water per arpent. It is essential in this method of treatment, to prevent carbon assimilation by the green leaves which usually make their appearance above the soil surface about three weeks after the Gramoxone application. The basic idea is to deplete the underground storage organs of these weeds from their food reserves by making use of a powerful foliar desiccant which has the advantage of being a non-residual herbicide. Precautions, however, should be taken during the application of Gramoxone to avoid spraying the young cane leaves, otherwise scorching effect would result.

4. HERBICIDE TRIALS ON SUNFLOWER

(*a*) *Logarithmic spraying experiment*

The herbicides Atrazine, DCMU, Herban, Linuron, BAS 2100, BAS 2552, Casoron 133, C.6313, C.6989, Dacthal, NPH 1357, Patoran, Tenoran, WL 9385, Sinbar and Prometryne were included in a logarithmic spraying trial to study their effects in sunflower plantations. The chemicals were applied in pre-emergence of weeds and crop at dosage rates shown in Table 51 where the results of the trial are also summarized. Measurements were made of the mean height per plant, mean flower diameter per plant, and the number of plants that were apparently healthy in the experimental plots two months after herbicide application.

No effect on germination, shoot growth and flower diameter, was noted in the Herban-sprayed plots even at the highest dosage rate. It appeared from this trial that the standard of comparison for future experiments should be based on results obtained with Herban at about 3 lb a.i. per arpent, inasmuch as the weed control properties of this herbicide under humid conditions are fairly reasonable at this rate of application.

(*b*) *Field scale small plot trials*

With the exception of Herban and Linuron, the other herbicides were not included in three field-scale trials with sunflower, either because of their toxicity to the crop, or their relatively poor herbicidal activity. Ametryne and Cotoran which were not available when the logarithmic trial was carried out, were compared with Herban and Linuron in a latin square experimental layout. All the chemicals were applied at the rate of 3 lb a.i. per arpent before emergence of weeds and sunflower in plantations of ratoon canes.

Two of these trials had unfortunately to be abandoned because of a severe attack of *Cratopus* spp. which caused the complete defoliation of all standing plants. Observations made in the third trial revealed that the disadvantage of Herban, in comparison with other herbicides for general weed control in sugar cane plantations because of its low efficacy on certain weeds of the *Compositae* family, becomes an advantage in sunflower plantations in the interrows of sugar cane.

The germination and growth of sunflower did not seem affected by Herban at 3 lb a.i. per arpent. Linuron at 3 lb a.i. per arpent may give equally good results, but more trials are necessary to ascertain its effect on sunflower. Cotoran and Ametryne, at the same dosage rates, were found to affect germination and growth. Further studies will be carried out to determine the optimum rates of application of these herbicides that would give the best weed control at the most economic price. The results of the yield of sunflower heads in the different treatments are not yet available at the time of writing, but an estimate made on the standing crop, which was almost at maturity, indicated that the safest treatment was that of Herban at 3 lb a.i. per arpent.

Table 48. Results of the screening test with new herbicides

TREATMENT lb a.i. per arpent		*WEED ASSESSMENT* A. Frequency abundance method (Weed infestation % control) B. % Weed Cover (% Weed Cover in Control = 100). 6.4–4.5	4.5–3.4	3.4–2.6	2.6–2.0	2.0–1.5	1.5–1.15	1.15–0.87	*CANE MEASUREMENT* Dewlap height of canes (Mean dewlap height per plant in cm. – *Control*, 16.9) 6.4–4.5	4.5–3.4	3.4–2.6	2.6–2.0	2.0–1.5	1.5–1.15	1.15–0.87
Atrazine	A	15.8	17.5	19.3	21.1	19.3	—	—	15.2	17.7	16.3	14.8	16.3	—	—
	B	13	15	19	22	17	—	—							
DCMU	A	12.3	12.3	17.5	17.5	26.3	—	—	14.0	15.9	16.9	19.3	16.2	—	—
	B	14	14	19	26	29	—	—							
Herban	A	12.3	15.8	19.3	21.1	36.9	—	—	21.6	22.3	19.6	19.2	19.0	—	—
	B	11	16	18	24	36	—	—							
Linuron	A	—	—	14.0	17.5	15.8	17.5	21.1	—	—	18.7	16.6	18.1	16.9	16.4
	B	—	—	19	31	29	30	31							
BAS 2100	A	8.8	12.3	14.0	19.3	19.3	—	—	16.6	16.3	18.5	15.6	17.5	—	—
	B	5	8	8	13	18	—	—							
BAS 2552	A	14.0	22.8	19.3	24.6	38.6	—	—	19.7	20.3	19.4	20.4	20.2	—	—
	B	35	29	27	26	41	—	—							
Casoron 133	A	36.9	36.9	50.9	43.9	47.4	—	—	13.7	17.5	16.8	17.9	20.6	—	—
	B	30	35	50	39	63	—	—							
C 6313	A	—	—	24.6	24.6	33.3	40.5	52.6	—	—	21.3	16.8	17.7	18.2	16.3
	B	—	—	26	30	35	47	66							
C 6989	A	—	—	35.1	35.1	40.3	42.1	35.1	—	—	17.1	19.4	17.2	17.8	17.4
	B	—	—	49	62	68	67	55							
Dacthal	A	24.6	31.6	36.9	47.4	52.6	—	—	19.2	21.0	19.4	20.9	20.5	—	—
	B	16	22	27	41	58	—	—							
NPH 1357	A	—	—	24.6	21.1	28.1	26.3	31.6	—	—	20.9	28.0	18.5	17.7	15.7
	B	—	—	17	27	25	27	27							
Patoran	A	—	—	26.3	21.1	24.6	26.3	31.6	—	—	19.1	18.7	18.1	18.9	15.4
	B	—	—	32	29	33	34	23							
Tenoran	A	—	—	29.8	29.8	33.3	36.8	36.8	—	—	18.5	19.5	16.3	19.7	16.8
	B	—	—	28	40	42	55	67							
WL 9385	A	22.8	19.3	24.6	39.6	33.3	—	—	15.1	17.4	19.0	20.2	18.4	—	—
	B	27	32	42	63	57	—	—							
Sinbar	A	0	0	0	0	0	3	7	8.7	7.2	8.9	7.8	10.0	10.4	14.1
	B	0	0	0	0	0	3	7							

Duration of experiment : 92 days.

Variety of cane planted : M.31/45 (virgin).

Table 49. Summary of results of the weed survey made 3 months after herbicide application

ESTATE	*VARIETY*		*CONTROL*	*DCMU*	*ATRAZINE*	*COTORAN*	*HERBAN*	*FENAC*	*SINBAR ¾ lb.*	*SINBAR 1 lb.*	*SINBAR 1½ lb.*	*SINBAR 2 lb.*
Beauchamp Etoile No. 16	M.31/45	A	100.0	38.8	40.8	49.3	50.7	39.5	46.1	52.0	40.8	30.3
Rainfall : 25.09″		B	97.0	36.8	54.3	50.5	52.5	36.5	35.8	38.3	27.8	16.0
Mon Trésor Deux Bras No. 92	M.93/48	A	100.0	31.1	37.9	40.5	50.0	41.1	45.3	34.2	33.2	25.8
Rainfall : 32.04″		B	100.0	24.5	43.8	41.5	57.5	49.8	50.5	31.3	27.0	18.3
Mon Trésor U. Vale No. 46 bis	M.442/51	A	100.0	31.1	24.7	25.6	25.3	30.1	38.1	27.2	20.8	26.3
Rainfall : 14.25″		B	100.0	48.0	31.3	31.3	31.3	45.0	67.3	39.8	31.3	52.0
Savannah No. 8	M.409/51	A	100.0	53.1	50.6	55.8	73.1	48.1	45.7	54.3	38.2	19.8
Rainfall : 20.67″		B	52.0	17.0	21.8	21.0	24.5	20.0	13.0	17.3	12.3	9.0
MEAN	*F.A.*	*A*	*100.0*	*38.5*	*38.5*	*42.8*	*49.8*	*39.7*	*43.8*	*41.9*	*33.3*	*25.6*
	%W.C.	*B*	*87.3*	*31.6*	*37.8*	*36.1*	*41.5*	*37.8*	*41.7*	*31.7*	*24.6*	*23.8*

A Frequency-Abundance % Control. B = % Weed Cover

Table 50. Effect of different herbicides on cane germination and growth 3 months after spraying

ESTATE	*VARIETY*		*CONTROL*	*DCMU*	*ATRAZINE*	*COTORAN*	*HERBAN*	*FENAC*	*SINBAR ¾ lb.*	*SINBAR 1 lb.*	*SINBAR 1½ lb.*	*SINBAR 2 lb.*
Beauchamp Etoile No. 6	M.31/45	A	14.8	13.4*	14.3	14.4	14.7	13.0	14.1	13.2*	14.1	13.3*
Rainfall : 25.09″		B	76	83	84	88	101	76	85	75	90	69
Mon Trésor Deux Bras No. 92	M.93/48	A	17.4	16.2	17.3	16.7	16.4	15.4	16.8	15.9	16.0	16.3
Rainfall : 32.04″		B	80	78	86	79	73	72	82	76	74	76
Mon Trésor U. Vale No. 46bis	M.442/51	A	17.1	16.3	15.9	17.2	16.6	15.0	16.8	16.1	17.4	15.6
Rainfall : 14.25″		B	94	83	88	92	82	79	102	92	94	89
Savannah No. 8	M.409/51	A	20.8	20.2	20.3	19.7	18.5	18.7*	19.6	19.9	18.0	15.6*
Rainfall : 20.67″		B	105	107	107	105	95	101	98	107	93*	87*
MEAN	*D.H.*	*A*	*17.5*	*16.5*	*17.0*	*17.0*	*16.6*	*15.5*	*16.8*	*16.3*	*16.4*	*15.2**
	G.C.	*B*	*88.8*	*87.8*	*91.3*	*91.0*	*87.8*	*82.0*	*91.8*	*87.5*	*87.8*	*80.3**

A = Dewlap height (cm.). B = Germination count.

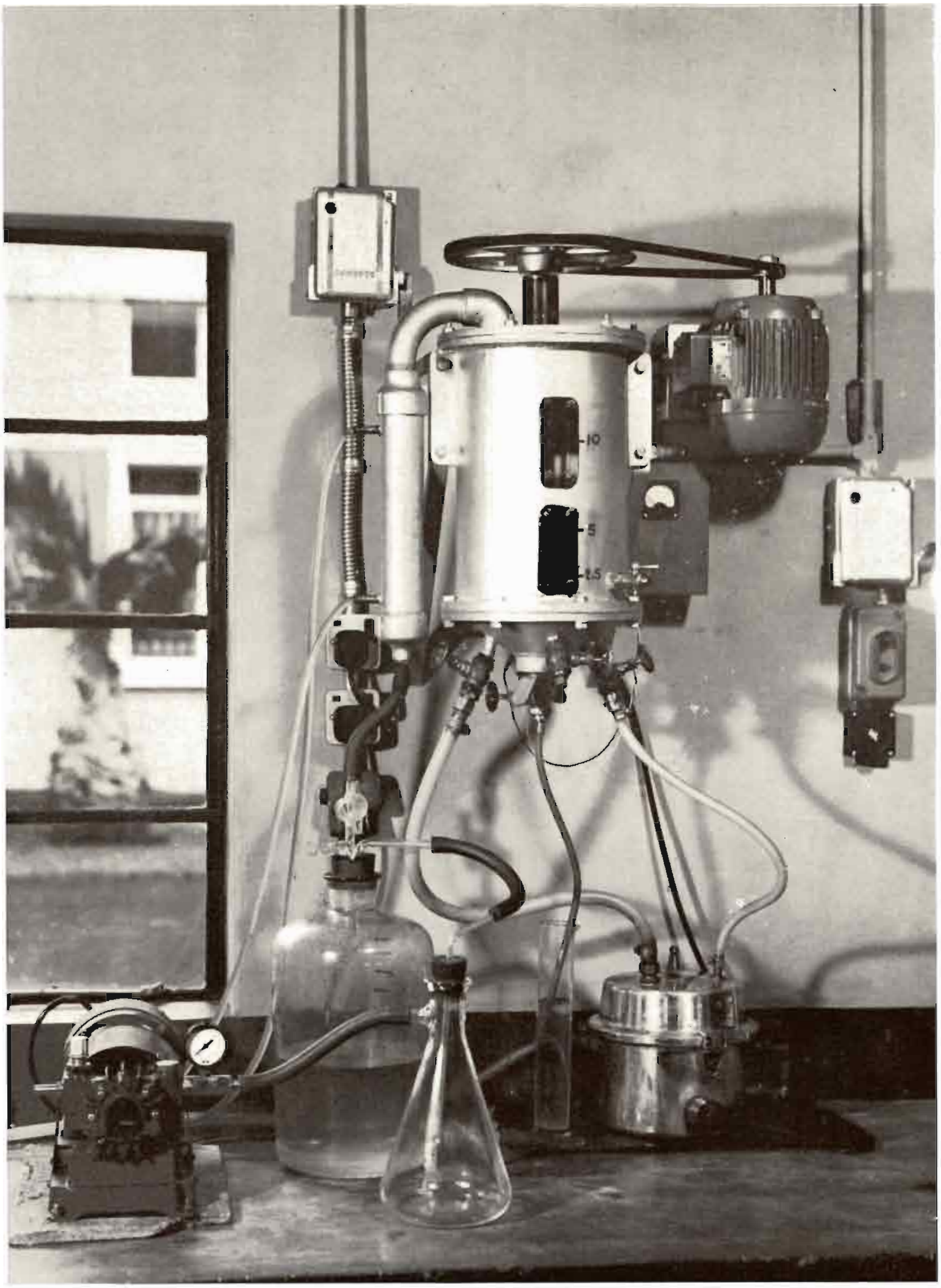
* Significant at 5% level.

Table 51. Results of herbicide trial on sunflower (log-spraying)

HERBICIDE		*MEASUREMENTS*						
DOSAGE (lb a.i. per arpent)		6.4-4.5	4.5-3.4	3.4-2.6	2.6-2.0	2.0-1.5	1.5-1.15	1.15-0.87
Atrazine	A	Nil	Nil	23.0	23.0	33.3	—	—
	B	Nil	Nil	1.5	0.5	3.38	—	
	C	Nil	Nil	2	1	4	—	
DCMU	A	55.5	34.7	51.9	39.4	49.8	—	
	B	3.50	2.25	4.72	3.25	5.08	—	
	C	2	10	9	8	12	—	
Herban	A	46.9	44.5	54.8	48.8	49.5	—	
	B	3.90	4.67	5.29	4.32	4.43	—	
	C	20	24	17	19	29	—	—
Linuron	A	—	—	43.0	46.9	43.8	48.2	52.4
	B		—	3.61	4.67	4.15	4.65	5.36
	C	—	—	9	9	10	20	11
BAS 2100	A	15.0	19.0	30.0	43.9	44.0	—	—
	B	1.50	Nil	1.75	5.50	4.17	—	
	C	1	1	4	7	11	—	
BAS 2552	A	53.4	40.0	34.8	40.0	42.6	—	
	B	5.00	2.94	2.14	3.90	4.25		
	C	5	8	11	15	12	—	
Casoron 133	A	50.5	41.1	44.4	55.1	60.9	—	
	B	3.91	3.82	4.56	5.91	5.27	—	
	C	11	11	8	11	26	—	—
C 6313	A	—	—	51.3	39.7	44.5	45.3	40.4
	B	—	—	4.06	4.60	3.68	5.17	5.20
	C	—	—	16	10	17	9	10
C 6989	A		—	48.6	51.4	43.6	42.8	50.6
	B		—	4.25	4.50	3.59	5.18	4.63
	C	—	—	12	11	16	17	16
Dacthal	A	63.6	54.8	63.0	57.3	60.3	—	—
	B	5.20	5.46	5.57	5.48	5.08	—	—
	C	13	12	21	20	12	—	—
NPH 1357	A	—	—	35.2	33.3	46.6	38.1	42.8
	B		—	2.17	3.20	3.90	2.42	3.22
	C		—	6	15	10	19	18
Patoran	A		—	45.9	44.8	42.6	46.9	43.7
	B		—	3.82	4.61	4.31	5.0	4.85
	C		—	14	14	18	16	15
Tenoran	A	—	—	41.5	47.0	51.2	49.7	48.1
	B		—	4.55	4.90	4.85	4.33	3.69
	C	—	—	22	20	13	15	13
WL 9385	A	30.3	42.0	43.8	37.7	50.3	—	—
	B	2.14	4.67	4.78	3.77	4.43	—	—
	C	7	9	9	11	23	—	—
Sinbar...	A	Nil	Nil	Nil	17.0	36.0	28.2	37.5
	B	Nil	Nil	Nil	2.0	4.50	1.40	4.50
	C	Nil	Nil	Nil	1	2	5	2
Prometryne	A	—	—	44.3	36.4	41.7	52.7	55.8
	B	—	—	3.21	2.69	3.39	4.77	6.04
	C	—	—	7	8	14	15	14

Measurement of sunflower :

A : Mean height per plant (cm.)
B : Mean diameter of flower per plant (cm.)
C : Number of plants



Laboratory vacuum pan (*vide* p. 135).

SUGAR MANUFACTURE

1. THE PERFORMANCE OF SUGAR FACTORIES IN 1967

J. D. de R. de SAINT ANTOINE

A SYNOPSIS of the chemical control figures of the 23 factories in operation in 1967 is given in *Statistical Table XVIII* i-v.

The climatic conditions which prevailed during the vegetative season extending from November 1966 to June 1967 are reviewed in a paper by HALAIS in this report. A comparison of cane and sugar produced is given in Table 52.

Table 52. Area harvested (thousand arpents), cane crushed and sugar produced (thousand metric tons), 1963 - 1967

	1963	*1964*	*1965*	*1966*	*1967*
Area harvested	194.1	195.4	194.1	195.7	191.7
Cane crushed	5547	4375	5985	4843	5814
Sugar produced	685.5	519.0	664.5	561.8	638.3

Cane quality

Very adverse climatic conditions prevailed during most of the maturity period. Except for two weeks early in August and four weeks in September when rainfall was about normal, July, the second half of August, and October had about twice the normal amount of rain. The sum of monthly excesses was exceptionally high, amounting to about 10 inches (as compared to a normal of 2.5 inches and to 14 inches in 1965), and was the second highest excess recorded in almost a century. As a result, differences in temperature between maximum and minimum were generally low, thus producing unfavourable conditions for cane maturity. Sucrose per cent cane averaged only 12.46, the lowest figure recorded (1960 excepted) since the beginning of the publication of reliable chemical control figures in 1926.

Table 53 gives average sucrose per cent cane figures from 1930 to date.

Table 53. Sucrose per cent cane, 1930-1967

Period		*Sucrose % cane*
1930-39	...	13.12
1940-49	...	13.78
1950-59	...	13.78
1961-67	...	13.10

Adverse climatic conditions during the maturity period are not the only cause of low sucrose in 1967. It is a fact that the cane variety M.147/44 released in 1956, although it produced more "profitable sugar" per arpent than the variety M.134/32 which it gradually replaced, is of lower sucrose content than the latter. However, with the recent release of the richer varieties M.409/51, M.13/53 and M.377/56, and with the advent of several promising varieties, it is anticipated that average sucrose per cent cane in Mauritius will soon take an upward trend.

Fibre per cent cane and mixed juice purity were 13.13 and 87.5 respectively, figures which show no large deviation from those obtained during previous years, as shown in Table 54. It should however be remembered that refractometer Brix has been adopted in all the sugar factories since 1965 only, and that Brix and purity figures recorded prior to that year cannot be compared with those for 1965 and onwards.

Table 54. Fibre per cent cane and mixed juice Gravity Purity, 1963-67

Year	*Fibre % cane*	*Mixed juice Gravity Purity*
1963	13.11	86.3
1964	13.85	86.4
1965	12.92	88.0
1966	13.46	87.7
1967	13.13	87.5

Milling

Crushing data and milling figures are given in Table 55.

It will be observed that the duration of the crop was unduly long, the average number of crushing days per factory amounting to 130, whilst the net crushing hours per day was just in excess of 19. The ten factories of the southern sector were the most handicapped in this respect with a figure just under 18 hours on the average, one factory even crushing less than 15 hours per day. This is indeed a paradoxical situation, to say the least, in an overcrowded island where unemployment exists on a large scale. As pointed out in the introduction to this report, this represents a large financial loss to the island.

Table 55. Milling results, 1963-1967

	1963	*1964*	*1965*	*1966*	*1967*
No. of crushing days	123	100	128	111	130
No. of net crushing hours/day	20.82	19.96	20.28	19.57	19.07
Hours of stoppages/day*	0.88	0.83	0.92	0.62	0.65
Factory running efficiency	95.9	96.0	96.6	96.9	96.7
Tons cane/hour	97.8	95.4	100.6	97.3	101.9
Tons fibre/hour	12.82	13.21	13.00	13.10	13.39
Imbibition % fibre	221	228	220	230	223
Pol % bagasse	2.08	2.03	1.93	2.05	1.89
Moisture % bagasse	48.4	48.5	48.9	48.7	48.6
Reduced mill extraction	96.0	96.2	96.0	96.1	96.1
Extraction ratio	31.7	31.0	31.7	31.9	31.2

* Exclusive of stoppages due to shortage of cane

Average tonnage of cane crushed per hour was the highest recorded so far, amounting to 102 metric tons, equivalent to 13.4 tons fibre. Milling performance was generally good, reduced mill extraction and extraction ratio averaging 96.1 and 31.2 respectively. Comparative figures for Highlands factory, where the best results were obtained, are 97.3 and 21.0, an excellent performance indeed, in spite of the fact that this factory has a large milling capacity and the lowest specific feed rate in Mauritius, as shown in Table 56. It will be observed from this Table that only 9 factories out of 23 show a reduced mill extraction below 96.0.

Table 56. Comparative milling results, 1967 crop

Factory	*Set of knives*	*Shredder*	*No. of rolls*	*Specific feed rate*	*Imbibition % fibre*	*Dilution ratio*	*Extraction ratio*	*Reduced mill extraction*
Belle Vue ...	1 x 68 1 x 72	—	12	69.7	222	73	29.3	96.4
Médine ...	1 x 40 1 x 100	1	18	68.3	208	76	30.0	96.3
FUEL ...	1 x 60 1 x 80	—	21	67.3	204	78	29.1	96.4
St. Antoine ...	1 x 36 1 x 44	—	15	62.5	221	73	33.4	95.9
Mon Loisir ...	2 x 35	1	15	62.1	231	68	32.8	96.0
St. Félix ...	1 x 12 1 x 32	1	12	61.6	239	68	30.9	96.2
Riche en Eau ...	1 x 40 1 x 52	—	15	59.6	214	77	28.8	96.5
Mon Désert ...	1 x 34 1 x 92	—	15	59.4	214	73	30.1	96.2
Savannah ...	1 x 28 1 x 48 1 x 92	—	12	58.1	236	71	33.9	95.8
Constance ...	1 x 24 1 x 32	1	15	57.6	188	69	28.8	96.5
Solitude ...	1 x 42 1 x 84	—	14	56.7	196	74	33.0	95.9
Rose Belle ...	1 x 24 1 x 42	—	12	56.2	265	68	35.0	95.6
Beau Champ ...	1 x 42 1 x 72	—	15	56.1	223	71	27.8	96.5
Bel Ombre ...	1 x 16	1	12	54.8	302	74	31.0	96.2
Ferney ...	1 x 84 1 x 64	—	12	51.9	235	69	37.5	95.4
Réunion ...	1 x 30	1	15	49.9	225	71	37.2	95.3
Mon Trésor ...	1 x 40 1 x 80	—	12	44.4	236	68	36.5	95.5
Bénarès ...	1 x 62 1 x 124	—	14	44.0	187	64	41.0	94.9
Beau Plan ...	1 x 42 1 x 100	—	14	43.6	203	74	26.1	96.8
Britannia ...	1 x 32 1 x 60	—	14	42.4	220	66	34.0	95.8
Union St. Aubin	1 x 28 1 x 32	—	15	39.5	243	71	30.7	96.2
The Mount ...	1 x 34 1 x 88	—	15	37.9	221	75	26.8	96.7
Highlands ...	1 x 32 1 x 64	—	15	32.1	222	83	21.0	97.3

Clarification and filtration

Juice purity was good in 1967, averaging 87.5, and no major clarification problems were encountered. The enzymatic process of starch removal was adopted in most factories, whilst in many others boiling juice liming was resorted to, with good results. This aspect of the review is covered more fully in an article appearing further in this report.

Filtration was good, average pol lost % cake amounting to 1.7, a figure which includes the high losses encountered in the three factories where filter presses are still in use and where pol % cake has averaged 7.2.

Boiling house work

Boiling house work differed little from that of previous crops, as shown in Tables 57 and 58. If compared with 1965 and 1966, when refractometer Brix was also used for chemical control, Gravity Purity of final molasses has dropped slightly, but it should be observed that this was facilitated by a higher reducing sugar content.

Four new continuous centrifugals were in operation, in addition to the one installed at Britannia in 1966. All five were used on C-massecuites, in three cases as foreworkers, and in the other two as afterworkers. One of the new machines

Table 57. Syrup, Massecuites and Molasses, 1963-1967

	1963	*1964*	*1965*	*1966*	' *1967*
Syrup gravity purity	86.6	87.0	88.0	88.0	87.5
A-mcte app. purity	83.0	82.8	84.9	86.0	85.2
Purity drop : A-mcte	20.3	20.7	20.3	18.4	19.4
B-mcte	22.2	20.7	21.0	20.0	20.2
C-mcte	24.3	23.6	25.1	25.2	26.1
Crystal % Brix in C-mcte	35.9	35.5	38.6	39.3	39.9
Magma Purity	82.8	83.4	86.7	87.0	86.4
Final molasses : Gravity Purity	35.4	36.1	38.3	39.1	38.0
Red sugar % Brix	15.0	12.8	15.5	14.9	17.0
Total sugars % Brix ...	50.4	48.9	53.8	54.0	55.0
Wt. % cane at 85° Brix ...	3.04	2.85	2.64	2.88	2.76

Table 58. Losses and Recoveries, 1963-1967

	1963	*1964*	*1965*	*1966*	*1967*
Sucrose lost in final mol. % cane	0.89	0.91	0.86	0.95	0.89
Undetermined losses % cane	0.18	0.18	0.12	0.15	0.17
Industrial losses % cane	1.14	1.15	1.04	1.16	1.11
Boiling house recovery	91.2	91.0	91.4	90.8	90.7
Reduced boiling house recovery	90.2	90.0	88.8	88.4	88.5

was installed at The Mount factory in conjunction with a JEFF ROGERS resistance heater. The results of tests carried out with the latter are given further in this report.

It is customary in Mauritius to express sucrose losses as a percentage of the weight of cane entering the factory, whereas in most other sugar-producing countries these losses are expressed as a percentage of the sucrose contained in the cane, which is more logical and correct. When losses are expressed per cent of cane, they can only be compared from factory to factory, or from year to year, if the sucrose content of the cane is the same in both cases. As this is generally not true, such comparisons are misleading and may lead to erroneous conclusions. Thus if the 1967 total sucrose losses per cent cane for the island are compared to those of 1956, say, it would appear that the position has considerably improved, respective figures being 1.87 and 1.62 as shown in Table 59.

Table 59. Sucrose losses % cane (A) and % sucrose in cane (B), 1956 and 1967

	1956		*1967*	
	A	*B*	*A*	*B*
Bagasse ...	0.63	4.31	0.51	4.07
Filter cake ...	0.13	0.89	0.05	0.43
Final Molasses ...	0.92	6.29	0.89	7.15
Undetermined ...	0.19	1.30	0.17	1.33
Industrial ...	1.24	8.48	1.11	8.91
Total ...	1.87	12.79	1.62	12.98

But if these total losses are expressed per cent of the sucrose in the cane, it will be observed that they have actually slightly increased from 12.79 to 12.98. But this does not mean that the efficiency of the factories has decreased since 1956. It results from the fact that, whereas sucrose per cent cane in 1956 was 14.62, it was 12.46 in 1967. However, an examination of Table 59 reveals that :

(i) losses in filter cake have been reduced by more than 50 per cent, mostly as a result of the replacement of filter presses by vacuum filters;

(ii) milling work has also improved: only four per cent of the sucrose in the cane being lost in bagasse;

(iii) undetermined losses have remained at a low level;

(iv) losses in final molasses are high, accounting for 50-55 per cent of the total losses registered.

Hence, as already often mentioned, any efforts made towards further reducing sucrose losses in Mauritius should be spent in the boiling house as this is where investments can be expected to pay dividends rapidly.

Sugar quality

Average CSR filterability of Mauritius raws has improved further in 1967. Although this improvement has not been spectacular as compared to 1966, yet two important results have been obtained :

(i) deviations from the mean were much smaller in 1967; thus 13 factories were in the 45 – 55 filterability group as compared to 7 in 1966;

(ii) spectacular results were obtained in certain factories where it was believed in some quarters that raws of good filterability could not be produced because of the inherent conditions prevailing; thus Rose Belle factory produced the best filtering sugar in 1967, whereas in 1966 it ranked 22nd out of 23.

2. THE INFLUENCE OF TEMPERATURE ON THE pH OF CANE SUGAR FACTORY PRODUCTS

E. C. VIGNES

The determination of the pH of factory products is an important part of routine chemical control. The common practice is to take the sample of hot sugar liquor to the lab where it is cooled, and then measure the pH at room temperature. Since the influence of temperature on the different constituents of the solutions is unknown, it is impossible to calculate the exact pH of the material under actual working conditions, which is precisely the sort of information required. The importance of maintaining a correct pH at different stages of the manufacturing process needs hardly be stressed. A low pH gives rise to inversion, while a high pH causes destruction of sugars, produces coloured products, and increases the amount of soluble calcium salts in a defecation process. Yet factory control is based on pH values determined at room temperature, which are inevitably different from those prevailing under actual working conditions.

The literature data concerning the relationship between temperature and pH of sugar cane products is scanty. CAMERON (1930) has reported the differences of pH he found in clarified juices between 5° and 95°C. In general, there was a drop of pH with increasing temperature.

GROSS (1954) studied the pH/temperature relationship to clarify the position as regards the main sugar refinery products. All acid liquors gave negative, and alkaline liquors, positive coefficients. For 60° Bx solutions of raw sugars from different countries, the temperature coefficient of pH, i.e. the change in pH per °C rise in temperature, between 20° and 100°C varied between +0.0016 for Australian sugars to +0.0041 for British West Indian raws, Mauritius sugars giving a temperature cœfficient of +0.0019.

HONIG (1963) observed in cane sugar mills that a clarified juice with a pH of 7.2 at 30°C gave a pH of 6.5 at 80°C, although in certain cases the pH at 80°C was 7.3. According to this author, for cane sugar products, the temperature coefficient was in general negative for alkaline products, but positive for pH values between 5.8 and 7.0, measured at room temperature. He also reported data obtained in a Cuban factory. A positive coefficient was found for clarified juice between 30° and 80°C, but the coefficient was negative for syrup between the same limits.

In a recently published article, KULKARNI *et al.* (1967) dealt with the influence of pH upon both raw and direct consumption white sugar manufacture under conditions obtaining in India. All the different products ranging from mixed juice to sugar were examined for a temperature range of 30-80°C. The authors observed in all cases a lowering of pH when temperature was raised. In the raw sugar house, clarified juice and syrup had large temperature coefficients. These decreased progressively from syrup (0.0138) to final molasses (0.0037).

Until 1966, clarification processes in all factories of Mauritius consisted in either straight cold liming or liming at about 60°C. With the drive to improve the filterability of local raws, a number of factories then proceeded to lime at the boiling temperature, a procedure which had given good results particularly in Queensland (DE ST. ANTOINE, 1966). In certain cases, great difficulties were experienced to obtain the correct pH in clarified juice and other products. In order to throw some light on this aspect of processing, it was decided in 1967 to carry out preliminary studies on the effect of temperature on the pH of the more important products, namely, clarified juice, syrup, A-and B-molasses. At the same time the study of the time factor in the pH/temperature relationship of limed juice was initiated. Unfortunately, owing to certain technical difficulties, this last study has had to be curtailed but will be resumed shortly.

The procedure employed is described below. All liquors investigated were factory processed. The samples were kept in a beaker provided with a cover to minimize evaporation. The beaker was placed in a thermostatically-controlled mantle for keeping the temperature constant. Spaces were provided in the asbestos lid for stirrer, thermometer, and for the electrodes at the time of measuring pH. The instrument used was a Cambridge bench-pattern pH meter having a temperature range of 10-100°C, provided with a remote liquid junction reference calomel electrode and a glass electrode of temperature range 10-140°C. At each temperature studied, the apparatus was standardized with the buffer heated to the temperature of measurement; the buffer employed being a 0.025 molar solution of potassium dihydrogen phosphate/disodium hydrogen phosphate, the pH of which is known at different temperatures.

The pH on A-and B-molasses was determined on a dilution of 1 : 1 wt/wt basis. Results obtained are reported in Table 60.

Table 60. Effect of temperature on the pH of sugar factory products

	pH at different temperatures									
Product	*30°C*	*40°C*	*50°C*	*60°C*	*70°C*	*80°C*	*90°C*	*95°C*	*Change in pH from 30° to 95°C*	*Average temperature coefficient : pH/°C*
	6.81	6.77	6.69	6.62	6.55	6.49	6.43	6.40	—0.41	—0.0063
Clarified juice	7.34	7.22	7.10	7.02	6.89	6.80	6.76	6.70	—0.64	—0.0098
	7.90	7.78	7.60	7.43	7.28	7.20	7.12	7.06	—0.84	—0.0129
Syrup	6.64	6.52	6.40	6.30	6.20	6.10	6.00	5.94	—0.70	—0.0108
	5.74	5.70	5.68	5.66	5.63	5.56	5.52	5.49	—0.25	—0.0038
A-molasses	5.90*	5.88	5.85	5.82	5.76	5.72	5.65	5.60	—0.30	—0.0046
	6.30	6.25	6.22	6.18	6.12	6.05	6.01	5.98	—0.32	—0.0049
B-molasses	6.23	6.18	6.12	6.03	5.96	5.90	5.85	5.82	—0.41	—0.0063

* pH determined on 28° Brix solution

It will be noticed that all pH values fall with a rise of temperature from 30° to 95°C, the drop being different for different products. Clarified juice and syrup have greater temperature, coefficient than molasses. Thus for a 65°C rise in temperature clarified juice pH drops by anaverage of 0.63 unit, syrup by 0.70, while A-and B-molasses by only 0.29 (average) and 0.41 units respectively. It can be inferred from the results, and from other literature data, that the pH/temperature relationship is not linear and therefore pH under actual working conditions cannot be calculated with accuracy from pH determined in the laboratory at room temperature. If the composition of technical sugar solutions as regards acids, bases and certain buffering salts were known, it might be possible to compute pH from their concentrations and dissociation constants at different temperatures. One way to deal with the situation would be to carry out pH measurements over a long period of time and work out average empirical temperature coefficients for different products. This procedure would obviously be subject to certain errors. Ideally, pH should be determined under working temperature conditions but this, apart from all the technical difficulties involved, demands the re-organization of the whole structure of chemical control. In the latter case the concept of neutrality would also have to be changed. The notion of a pH of 7 as being neutral could no longer apply. The ionic product of water (Kw) changes with temperature and attains 48.00×10^{-14} at 100°C. Since by definition, a solution in which the hydrogen – and hydroxide – ion concentrations are equal, is termed an exactly neutral solution, it follows that, for instance, at 100°C a neutral solution will have a pH of 6.16. It may be concluded that all the different aspects of pH control need to be carefully examined if, eventually, a satisfactory solution to the problem is to be attained.

REFERENCES

CAMERON, E.B.G. (1930). Studies in clarification on a basis of hydrogen ion control. *Proc. Qd. Soc. Sug. Cane Technol.* **1** : 43-53.

GROSS, D. (1954). Recent studies of pH measurement and control in the sugar industry. *Proc. 10th Int. Congress Agric. Ind. (Madrid)* **2** : 1362.

HONIG, P. (1963). Principles of sugar technology, Amsterdam, Elsevier v. **3** : chap. 3.

KULKARNI, D.P., PATIL, M.K. *and* VORA, K.C. (1967). Studies on pH in sugar manufacture. *Int. Sug. J.* **69** (826) : 297-301.

SAINT ANTOINE, J.D. de R. de (1966). The filterability of Mauritius raws in 1966. *Rep. Maurit. Sug. Ind. Res. Inst.* **13** : 139-145.

3. DESIGN OF pH CONTROL STATIONS FOR HOT LIMING IN CANE JUICE PROCESSING

F. LE GUEN

Until a few years ago, the normal practice in Mauritius for the liming of mixed juice was to use cold liming (SPENCER *and* MEADE, 1963). The lime was added to the juice in tanks provided with stirrers and inverted cones (LE GUEN, 1963) to ensure good mixing. Juices encountered in Mauritius had been fairly easy to clarify up to about that time, and that procedure had the advantage of being both simple and easy to control manually in the event of failure of the automatic pH controller. Moreover, coating of the electrodes gave little trouble, as with cold juice it took place slowly in most cases.

During the last few years, many factories have adopted the practice known as hot liming (SPENCER *and* MEADE, 1963). At first, this was carried out at 55-60°C, but the practice is now to lime at temperatures around the boiling point. Trouble due to coating of the electrodes has become far more common, but the change is considered to be necessary to improve the clarification of juices in an effort to obtain sugar of better filterability, workers in Australia having reported that hot liming is definitely superior to cold liming (RELF *et al.* 1967). At first, the general set up was very similar to the one used for cold liming, the only change being the presence of heaters between the juice scales and the liming station. In most factories the new procedure was at first followed on a trial basis, but as soon as it was decided to adopt it on a permanent basis, it became necessary to place the liming station as close as possible to the clarifier. The main reason for this is that with cold liming floc does not form readily until the juice is heated; with hot liming, especially at near to boiling temperatures, floc coagulates as soon as turbulence decreases sufficiently. It is, however, a well known and well established principle of good clarification that floc once allowed to form should not be ruptured or disturbed (DAVIES *and* YEARWOOD, 1941 ; DAVIES, 1953 ; SPENCER *and* MEADE, 1963), and this is always more efficiently achieved if the liming station is close to the clarifier.

The reaction between lime and cane juice is extremely complex (PAYNE, 1953), but for practical purposes in pH control, it consists of a fairly rapid initial rise in pH on addition of the lime, followed by a far slower drop which takes place mainly in the clarifier. With cold juice, the initial rise in pH cannot be considered to be instantaneous, since it has been found in preliminary experiments, which will be pursued next season, to be of the order of twenty seconds in the case of juice at 25°C. With juice around 100°C, however, this initial rise is for practical purposes almost instantaneous. Hence, whilst it is not possible to carry out liming of cold juice inside a 6-ft length pipe along which the juice is flowing, this is quite feasible with juice around 100°C. Hot liming may therefore be carried out in two ways : (a) in a tank as for cold liming, or (b) in one of the pipes leading the juice to either the flash-tank or the clarifier, provided adequate mixing is achieved inside the pipe by means of baffles or cross-current devices designed to create turbulence.

When designing a pH station for hot liming the important aspects which should be considered are very similar to those pertaining to cold liming. They are :

i) The rate of flow of juice must be steady and free from sudden disturbances. This is usually provided for by having buffer storage tanks between the juice scales and the liming station. When the enzymatic process of starch removal from the juice is carried out, the same tanks may be used for the enzymatic process and for providing buffer action in smoothing out the pulsating flow of juices from the juice scales.

ii) Difficulties are often encountered with devices installed on the buffer tanks to prevent them from overflowing. It is essential that the action of any level control device fitted should be smooth and that it should act gradually over a wide change in level. Sudden tripping action is to be avoided since sudden disturbances recurring regularly in the flow of juice at the point of liming may easily render smooth control impossible to achieve. Simple yet effective devices for preventing buffer tanks from over-flowing are displacers activating a butterfly valve on the outlet of the tank. Displacers are far superior to floats in this application, because a displacer can easily be designed to provide full valve travel smoothly and gradually for a change in level equal to the whole height of a tank; a float, on the other hand, usually has a tripping on-off action over a relatively small change in level near the top of the tank. A device requiring changes in level equal to the whole height of a tank for full valve travel does not interfere with the buffering capacity of the tank, whilst a device acting over small charges in level will prevent the tank from buffering out efficiently changes in the rate of flow of juice.

iii) The mixing device used to provide mixing after lime is added to the juice should be efficient, and there should be no dead zones between the point where lime is added and the point where the juice sample is led off to the electrodes.

iv) The pressure in the line bringing lime to the control valve should be fairly constant.

Sudden changes in pressure in this line are as harmful to good control as changes in rate of flow of juice.

v) The density of lime used should be low, around 2° Baumé. Otherwise, troubles are encountered through deposition of lime in the pipes and control valve. Hence it is necessary to have a control valve of capacity $1\frac{1}{2} - 2$ times the average amount of lime required at 2° Baumé. Attempts to use too small a valve usually result in the use of lime of high density leading in turn to pipe blockages.

vi) It is essential to provide for flushing of the lime piping as well as of the pipe bringing the juice sample to the electrodes, since these parts of the system are liable to become blocked with lime or floc unless they are flushed regularly. Normal practice in Mauritius is to provide also a by-pass for the control valve by means of a pipe returning the lime to the lime tank. This enables to keep the lime moving in the pipes whenever a shortage of juice occurs.

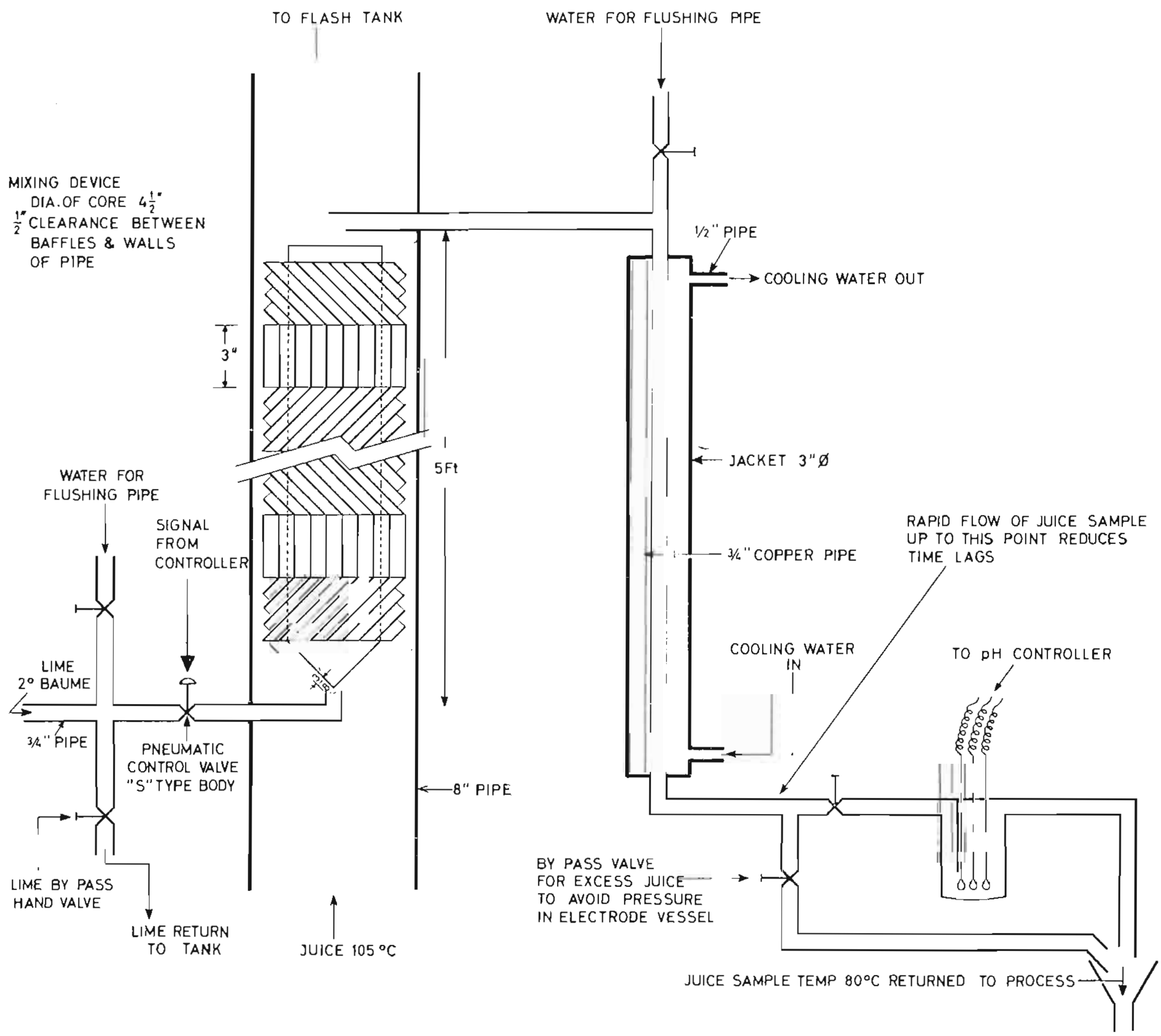


Fig. 35. Sketch of installation for liming in the pipe leading to the flash tank.

vii) It is of course of the utmost importance if good control is to be achieved to reduce time lags in the control loop to a minimum. Hence the sampling point should be placed at the exit of the mixing device, whilst the lime injection should be just before the mixing device. The juice sample should be brought as quickly as possible to the electrodes and the control valve also should be situated close to the point of lime injection.

A practical way of bringing the juice sample quickly to the electrodes is to achieve rapid flow of juice in the pipes leading to the electrode vessel, the excess of juice being made to by-pass the electrode vessel to avoid submitting the electrodes to a too high hydrostatic pressure (fig. 35). With hot liming, rapid rate of flow in the juice sample line also helps to avoid blocking of those lines with floc.

We now propose to consider a few problems arising when the liming point is (a) in the pipe leading to the flash tank; (b) in a pipe after the flash tank ; (c) at the flash tank ; (d) in a liming tank situated between the flash tank and the clarifier.

a) Liming in the pipe leading to the flash tank

The set-up shown in fig. 35 has been successfully used for liming in the pipe leading to the flash tank. The mixing device consisting of a cylindrical core supporting baffles, the direction of which changes every 3 inches, is fitted into the pipe leading to the flash tank, lime being injected at the inlet of the mixing device. The lime is mixed with the juice through the turbulence arising inside the device and a sample of the juice coming out of the device is led to the electrode vessel.

The main source of trouble when liming before the flash tank comes from the presence of bubbles in the juice due to partial flashing of the juice, as the pressure gets lower along the pipes. Each bubble opens the electric circuit as it passes between the electrodes and shows up as a kick of the pen on the pH chart. The presence of a large number of these bubbles may disturb completely the operation of the pH controller unless the trouble is overcome by allowing the juice to flash before reaching the electrodes, or by cooling the juice sample sufficiently below boiling point to suppress the flash. In many cases, cooling of the juice sample has to be resorted to in any case since many manufacturers of pH control equipment do not supply electrodes able to withstand temperatures higher than 90°C. Some manufacturers do supply electrodes withstanding up to 135°C and with such electrodes it is only necessary to allow the juice to flash to atmosphere before reaching the electrodes. Cooling of the juice to 80°C may be achieved by allowing the juice to flow through a jacketed copper pipe $\frac{3}{4}$ inch. diam. and about 7 ft long whilst cold water is circulated in the jacket. Fig. 37 shows a chart of the control achieved with the set-up of fig. 35, all the lime required being added to the juice through the control valve.

It should be noted that whenever liming is carried out in a pipe, split-globe valves (fig. 36) are extremely useful because they handle sludges quite well owing to the smooth S shape of their flow contour, are easy to service and maintain, and have far better control characteristics than Saunders Patent valves. This good control characteristic is highly desirable in such an application. Saunders Patent valves are quite suitable for cases where liming is carried out in a tank, but are at a disadvantage owing to their poor control characteristics when liming is done in the pipe.

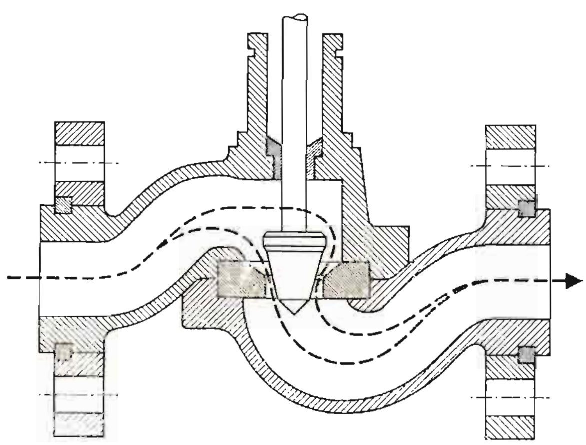


Fig. 36. Split-globe type valve.

b) Liming in the pipe between the flash tank and the clarifier

The set-up which has just been described could be installed in the pipe between the flash tank and the clarifier. No trouble should then be encountered with bubbles in the juice; in practice some difficulty is sometimes experienced in finding a portion of pipe suitable for the insertion of the mixing device, or to get sufficient hydrostatic head to ensure adequate rate of flow through it. But whenever liming is carried out before the flash tank, the latter should preferably be of the type in which the juice flashes and runs out immediately at the bottom. When this is the case, no stagnant zones exist where floc might coagulate readily. If the design of the flash tank is such that the level of juice is always high in it, there is opportunity for floc to form in the flash tank if the juice is already limed, and in such cases there is probably advantage in liming after that tank. In some factories, however, it has been claimed that slightly higher rates of settling are achieved when liming is done before the flash tank, but it is not yet possible to confirm or disprove these claims.

c) Liming at the flash tank

It may perhaps be possible, with a flash tank designed for the purpose, to achieve good pH control whilst using the turbulence created by the flashing juice to provide adequate mixing. In most cases, however, the existing flash tank is designed in such a way that the flash occurs in the upper half of the tank and there is in consequence insufficient mixing in the lower half. Unless a stirrer and inverted cone are added — a solution which rather defeats the purpose of using the flash to replace these items of equipment — difficulties are usually met with. In-

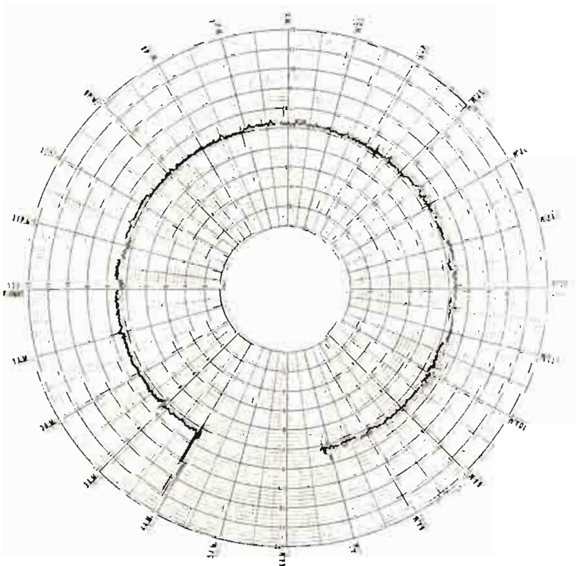


Fig. 37. pH control chart obtained when liming in the pipe leading to the flash tank as in fig. 35.

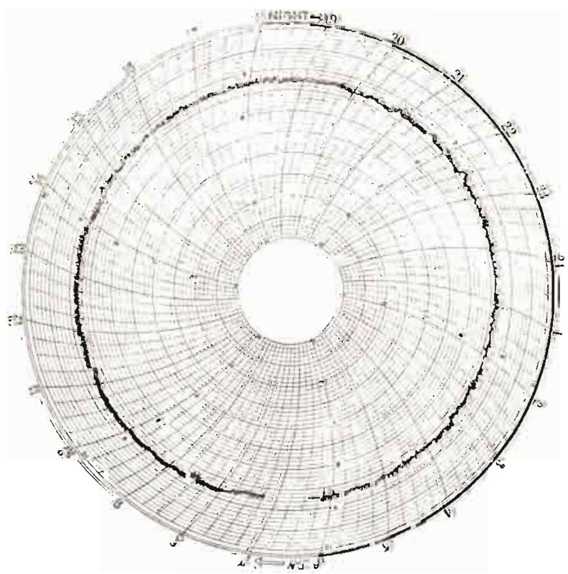


Fig. 38. pH control chart obtained with hot liming in a tank after the flash tank.

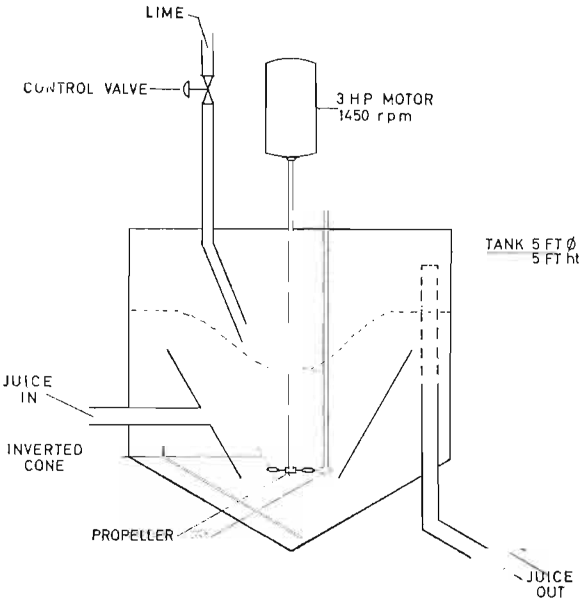


Fig. 39. Type of liming tank normally used in Mauritius.

sufficient mixing in certain regions of the tank gives rise to large time lags and poor control is obtained. Moreover the large amount of flash liberated creates difficult and unpleasant conditions for those who have to maintain items of equipment such as electrodes or control valves. This is an important consideration if adequate preventive maintenance is to be encouraged; and it is in general preferable to adopt one of the othei available schemes.

d) Liming in a tank between the flash tank and the clarifier

A solution which many factories have chosen to adopt is that of having a liming tank between the flash tank and the clarifier. This solution, although requiring more available space than that of liming in the pipe, is preferred by many who, having been used to the procedure and technique of liming in a tank at the time they were practising cold liming, prefer to go on with that procedure which has also been used in Australia (Relf *et al.* 1967) and is known to yield very good results. The design of tank commonly adopted in Mauritius is given in fig. 39, whilst fig. 38 illustrates a typical chart obtained with that set-up.

The author wishes to acknowledge the co-operation of members of the staff of The Mount and Mon Désert-Alma factories, as well as those of the many other factories where the problems of hot liming were studied last season.

REFERENCES

DAVIES, J.G. (1953). Technology of the clarification process. *Principles of Sugar Technology*, ed. P. Honig, Amsterdam, Elsevier chapter **14** : 559-563.

DAVIES, J.G. *and* R.D.E. YEARWOOD (1941). Clarification experiments. *Int. Sug. J.* **43** : 8-11.

LE GUEN, F. (1963). Notes on the installation and maintenance of pH controllers. *Rep. Maurit. Sug. Ind. Res. Inst.* **10** : 99-102.

PAYNE, J.H. (1953). Fundamental reactions of the clarification process. *Principles of Sugar Technology*, op. cit. Chapter **13** : 507-509.

RELF, E.T., R.J. ZEMEK, A.L. WILLERSDORF, P.G. WRIGHT *and* B.D. SOCKHILL (1967). Clarification investigations. II. Effect of various liming techniques. *Sug. Res. Inst. Mackay, Tech. Rep.* no. **81**.

SPENCER, E.F. *and* G.P. MEADE (1963). Cane sugar handbook. New York, Wiley & Sons, 9th edition. Chapter 7 : 91-93.

4. HEATING OF MASSECUITE BY THE JEFF ROGERS RESISTANCE HEATER

ERIC PIAT

A massecuite resistance heater was installed at The Mount S.E. in 1967 for conditioning final massecuites prior to curing in a continuous centrifugal. The Institute carried out a series of tests with the object of measuring the capacity and amount of sucrose re-solution taking place in this heater.

Description

Basically a resistance heater consists of two electrodes dipping in a solution. Current flowing between the electrodes heats the liquid which acts as a resistance between the two electrodes. The advantages of using this concept for heating massecuite are as follows :

1o. simplicity and compactness;

2o. low cost;

3o. heat being generated inside the massecuite itself, local overheating cannot take place due to contact with a hot surface.

The heater installed at The Mount S.E. (fig. 40) was supplied by Jeff Rogers Pty Ltd. and was designed by the Sugar Research Institute of Mackay, Australia. It is rated at 25 kW for a massecuite having a mean specific conductivity of 100 micromhos/cm and it operates on a 400 V two-phase power supply. It consists of two concentric electrodes between which flows the massecuite. The inner electrode which is a plain tube of metal has a diameter of 9 inches and is separated from the outer one by fibre glass supports. The outer electrode has a diameter of 15 inches, and is made up of nine copper rings 4 inches wide, separated by gaps of 2 inches. These copper rings are embedded on the inner side of a fibre glass tube of the same diameter. The voltage applied across the two electrodes is automatically controlled and has a maximum value of 400 volts. Above and below the electrodes are placed two earthed grids which prevent current leakages to the incoming and outflowing massecuite.

The heater is mounted vertically under the massecuite gutter. To the lower part of the heater is fixed a valve controlling the throughput of massecuite to the centrifugal below.

The temperature of the massecuite is controlled indirectly by controlling the current passing across the electrodes. The specific conductivity of massecuite is directly proportional to its temperature (WRIGHT, 1964), so that if the voltage is kept constant, the current tends to increase as the temperature rises. The function of the automatic controller is therefore to alter the voltage so as to keep the current constant at a pre-set value. Thus, as the temperature rises, the current tends to rise also but the voltage is automatically reduced so that the energy input to the massecuite is reduced, thus reducing the temperature of the massecuite. The system is therefore self-stabilizing.

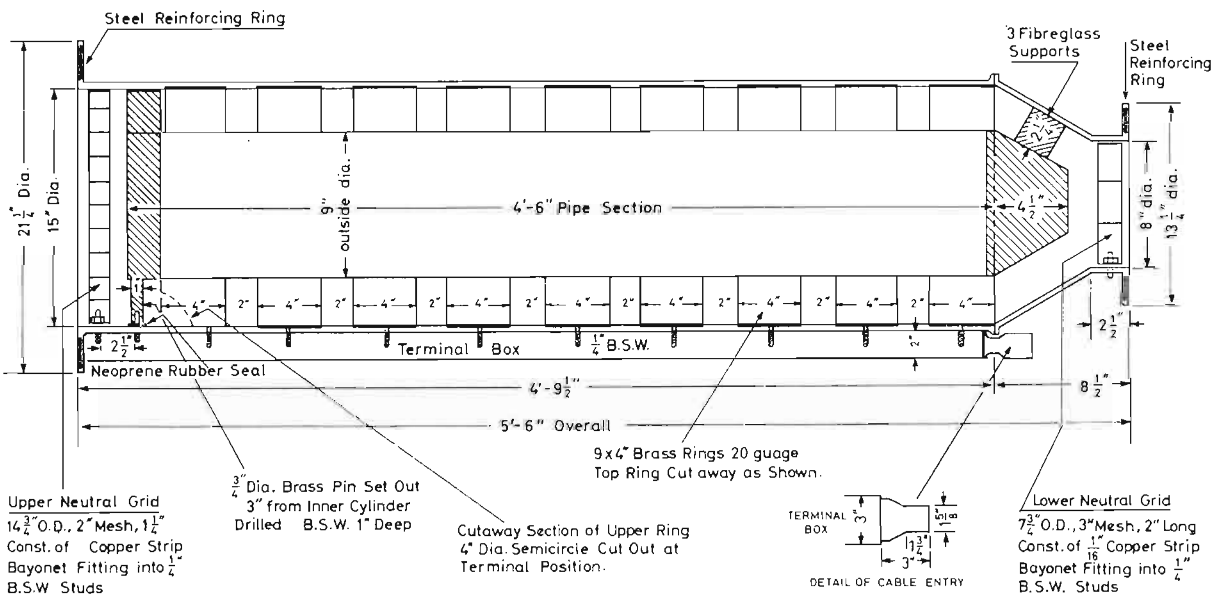


Fig. 40. Diagram of Jeff Rogers heater.

In practice, the automatic controller is adjusted by trial and error until the required temperature at the exit is obtained. Any change in the quality of the massecuite, or in the throughput of the machine necessitates an adjustment of the controller. However this is very easily achieved in practice.

Experiment

The experiments carried out on the heater consisted mainly in determining the amount of sucrose re-solution taking place in the heating process. They consisted in sampling the massecuite before and after the heater, filtering these samples in a pressure filter, and determining the apparent purities of the two mother liquors obtained. The difference gave a measure of the amount of re-solution taking place.

Ten tests of two hours each were carried out during the crop. Cold massecuite was sampled continuously before the heater. This sample was then filtered under pressure through a screen made of a piece of batch centrifugal lining. The hot massecuite was spot-sampled every twenty minutes and filtered immediately. The reason for doing so was to avoid any possibility of re-crystallisation of sucrose during the cooling of the sample. The average temperatures before and after the heater were recorded as well as the throughput of massecuite. Any other useful information gathered by the staff of the factory during the whole crop was also noted.

Results and observations

The results of the tests are shown in Table 61. In nine of them the final temperature averaged 45°C (113°F) or less, while in the tenth the final temperature was 48.9°C (120°F). The amount of sucrose re-solution in the first case was 0.6 degree purity or less, with a mean of 0.3, while in the second case it was 1.7 degree. It should be pointed out however that the analytical error alone was ±0.3 degree purity. The staff of the factory noted that when the massecuite was reheated to a temperature above 45°C (113°F), the purity of the molasses obtained by the continuous centrifugal tended to rise sharply. The comparison was made with respect to adjacent batch machines using a conventional massecuite heater.

In general, the resistance heater was considered as a bottleneck since its capacity could not exceed 45 cubic feet per hour, except on a few occasions when the massecuite was particularly loose. For the whole crop the average temperatures before and after the heater were in the region of 30°C (86°F) and 45°C (113°F) respectively.

Table 61. Results of tests on Jeff Rogers massecuite resistance heater

Test No.	*Mother liquor of cold massecuite*			*Mother liquor of heated massecuite*			*Re-solution*	*Capacity*
	Temp °C	*Brix*	*Purity*	*Temp °C*	*Brix*	*Purity*	*Degree Pty.*	*cu. ft/hr*
I	30.5	87.72	28.5	44.7	90.26	28.9	0.4	35
II	31.5	89.30	28.6	43.4	89.69	29.1	0.5	60
III	31.5	90.46	27.9	45.1	90.82	28.3	0.4	40
IV	29.0	88.59	31.8	40.7	88.86	31.8	0.0	52
V	33.0	88.91	29.4	42.6	90.17	30.0	0.6	43
VI	28.0	88.81	30.1	44.4	89.73	30.1	0.0	43
VII	29.5	90.07	29.2	43.3	90.21	29.6	0.4	42
VIII	32.0	90.14	29.4	43.1	90.52	29.0	–0.4	70
IX	36.0	91.03	27.6	44.0	91.50	28.2	0.6	42
X	31.0	88.47	29.8	48.9	89.61	31.5	1.7	—

Discussion

At The Mount S.E. the desired capacity was 65 cubic feet of massecuite per hour, i.e. 6000 lbs/hr for an inlet and outlet temperature of 28°C and 45°C respectively, i.e. a temperature rise of 17°C (30.6°F). According to the formula given by HUGOT (1960), the specific heat of final massecuite produced in this factory should be about 0.37. Therefore the energy "P" to be supplied by the heater is given by :

$$P = \frac{6000 \times 30.6 \times 0.37}{3415} \text{ kW} = 19.9 \text{ kW}$$

(3415 BTU/hr = 1 kW)

From first principles (*vide* Appendices I and II) the energy transferred to the massecuite per inch length of electrode is :

$$\frac{\bar{K}V^2}{10^7 \times 6.26 \times \log_e \frac{D_o}{D_i}} \text{ kW}$$

where : K log mean conductivity of massecuite in heater in micromhos/cm

V voltage across electrodes : 400 volts maximum

D_o diameter of outside electrode : 15 inches

D_i diameter of inner electrode : 9 inches

The heater has been rated for a log mean conductivity of 100 micromhos/cm.

Using these figures, the energy transferred to the massecuite per inch length of electrode should be 0.50 kW. The inner electrode is 52 inches long, while the nett length of the outer electrode is only 36 inches. Therefore the energy supplied by the heater should lie between 18 and 26 kW. Normally this should have been sufficient, but in practice the heater has proved inadequate. Hence laboratory tests were carried out to determine the conductivity of some local massecuites. The conductivities encountered varied greatly, some having a mean conductivity as low as 52 micromhos/cm between the temperatures specified above. But on the average a figure of 75 would be a fair estimate for design purposes. The energy supplied by the heater would then be reduced to a figure lying between 13.5 and 18.7 kW which is in closer agreement with the capacity of 45 cubic feet per hour met in practice. Therefore under local conditions the heater is inadequate as far as capacity is concerned.

On the other hand, sucrose re-solution was not significant so long as the final temperature did not exceed 45°C (113°F). In theory, since the massecuite is heated internally, there should be no re-solution of sucrose until the saturation temperature of the mother liquor is reached. But in practice, the flow of massecuite in the heater is not uniform : the massecuite adhering to the sides of the heater moves much slower than at the centre of the passage, and therefore this fraction is retained in the heater for a longer time than expected; its temperature rises above the 45°C (113°F) limit and causes some sucrose re-solution. In order to obviate this difficulty, it would perhaps be interesting to re-investigate the merits of the original design by DOSS *and* VISHNU, (1956) which used electrodes placed in a staggered arrangement. This design, although less attractive than the one under test, ensures a better mixing of the massecuite and a more uniform temperature distribution inside the heater.

Conclusion

The Jeff Rogers massecuite resistance heater is excellent from the point of view of keeping sucrose re-solution at a low level provided the final temperature does not exceed 45°C (113°F). However, due to the low conductivity of local massecuites, it cannot be expected to reheat more than 45 cubic feet of massecuite per hour from 28°C (82°F) to 45°C (113°F).

REFERENCES

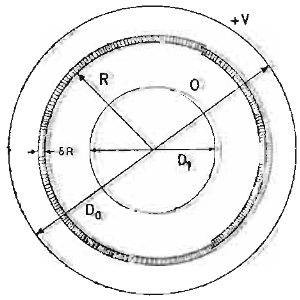
DOSS, K.S.G. *and* VISHNU (1956). Laboratory experiments on resistance heating of massecuites. *Proc. int. Soc. Sug. Cane. Technol.* **9** : 323-328.

WRIGHT, P.G. (1964). The resistance heater for conditioning of low grade massecuites. *Proc. Qd. Soc. Sug. Cane Technol.* **31** : 281-288.

HUGOT, E. (1960). Handbook of cane sugar engineering. *Amsterdam, Elsevier* : 460.

Appendix I

Consider a massecuite resistance heater consisting of two concentric electrodes of diameter D_o and D_i, and of height 1 inch.



The mean conductivity of the massecuite is $\bar{k}$ micromhos/cm (see Appendix II).
The voltage across the two electrodes is V volts.
The current flowing across the electrodes is i amps.

Consider one cylindrical element of massecuite of radius R inches and thickness dR
Let potential drop across element equal dV
Area of element is $2 \pi R \times 1$ inch^2

$$\text{Resistance of element} = \frac{1}{\bar{k}} \times \frac{dR}{2 \pi R} \; \frac{\text{cm}}{\text{micromhos} \times \text{inch}}$$

$$= \frac{1}{\bar{k}} \; \frac{dR \times 10^6}{2 \pi R \times 2.54} \text{ ohm}$$

$$\text{Therefore } dV = \frac{i \times 10^6 \, dR}{\bar{k} \times 2 \pi R \times 2.54} \text{ volts}$$

Integrating over the whole thickness of massecuite

$$V = \frac{10^6 \times i \times \log_e \dfrac{D_o}{D_i}}{2 \pi \times 2.54 \, \bar{k}} \text{ volts}$$

$$i = \frac{2\pi \times 2.54 \times \bar{k}V}{10^6 \times \log_e \dfrac{D_o}{D_i}} \text{ amps}$$

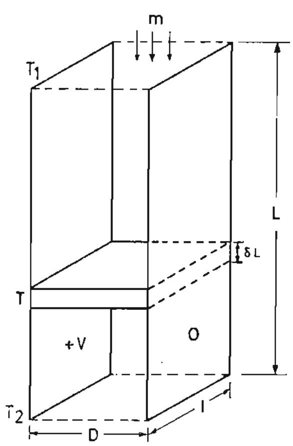
Power generated $P = Vi$ watts $= \dfrac{Vi}{10^3}$ kW

$$P = \frac{2\pi \times 2.54 \times \bar{k}V^2}{10^6 \times 10^3 \times \log_e \dfrac{D_o}{D_i}} \text{ kW}$$

$$P = \frac{\bar{k}V^2}{10^7 \times 6.26 \times \log_e \dfrac{D_o}{D_i}} \text{ kW per inch length of heater}$$

Appendix II

Consider a massecuite resistance heater consisting of two parallel electrodes of unit width between which massecuite is flowing at a constant rate.



L = height of electrodes,
D = distance between electrodes,
V = voltage across the electrodes,
m = flow rate of massecuite,
c = specific heat of the massecuite,
T_1 = temperature of massecuite at entry,
T_2 = temperature of massecuite at exit,
k_1 = conductivity of massecuite at entry,
k_2 = conductivity of massecuite at exit,
(all above units are chosen so as to be consistent).

The conductivity of massecuite has been shown to be directly proportional to its temperature (WRIGHT, 1964). This has been confirmed by tests carried out on various local massecuites.

Therefore $k_1 = aT_1$, $k_2 = aT_2$ where "a" is a constant.

Let $\bar{k}$ be the mean conductivity of the massecuite throughout the heater.

$$\text{Conductance of massecuite between electrodes} = \frac{\bar{k}L}{D} \times 1$$

$$\text{Energy balance through heater : } V^2 \frac{\bar{k}L}{D} = mc(T_2 - T_1)$$

$$\text{Therefore} \quad \frac{\bar{k}}{T_2 - T_1} = \frac{mcD}{V^2L} \qquad \text{...(1)}$$

Consider an element of massecuite as shown in diagram

dL = thickness of element
k = conductivity of massecuite element
T = temperature of massecuite element
dT = temperature rise through element

$$\text{Conductance of element} = \frac{kdL \times 1}{D}$$

$$\text{Heat balance through element} \quad V^2 \frac{kdL}{D} \quad mcT$$

Since $k = aT$,

$$\frac{V^2aTdL}{D} = mcdT$$

$$\frac{V^2adL}{D} = mc \frac{dT}{T}$$

Integrating over the whole heater

$$\frac{V^2aL}{D} = mc \log_e \frac{T^2}{T_1}$$

Therefore

$$\frac{mcD}{V^2L} = \frac{a}{\log_e \dfrac{T_2}{T_1}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Comparing (1) and (2)

$$\frac{\bar{k}}{(T_2 - T_1)} = \frac{a}{\log_e \dfrac{T_2}{T_1}}$$

Replacing aT_1 by k_1 and aT_2 by k_2

$$\bar{k} = \frac{k_2 - k_1}{\log_e \dfrac{k_2}{k_1}} \qquad \text{log mean conductivity of massecuite}$$

5. DESIGN AND OPERATION OF A LABORATORY VACUUM PAN

E. PIAT & A. BÉRENGER

Design

During the 1966 crop it was felt that a laboratory vacuum pan would be most handy for carrying out various studies relating to raw sugar filterability. The pan was designed by E. Piat and, after a few modifications, was completed by the beginning of the 1967 crop. It is shown in plate VIII and fig. 41 and has the following characteristics :

Diameter	...	9 in
Height ...	...	14 in.
Capacity ...	...	10 litres (maximum)
Graining volume	...	2 litres
Heating surface	...	96 sq. in.
Speed of impeller	...	300 r.p.m.
Diam ,, ,,	...	$3\frac{7}{8}$ in.
Diam. of downtake	...	4 in.

The body of the pan is made up of three parts : a flanged cylinder, a flat cover, and a conical bottom. On the cylindrical part, sight glasses made from ordinary $\frac{3}{16}$ inch slab glass are provided. These are held in position by means of 4 bolts, and the air-tight seal is conveniently made from Devcon Flexane 185 which is applied as a putty and becomes rubber-like on setting. A drain cock placed on the side of the pan, is used for seeding the massecuite.

Mounted on the conical bottom are :

i) the central downtake consisting of a piece of 4-inch diameter copper pipe;

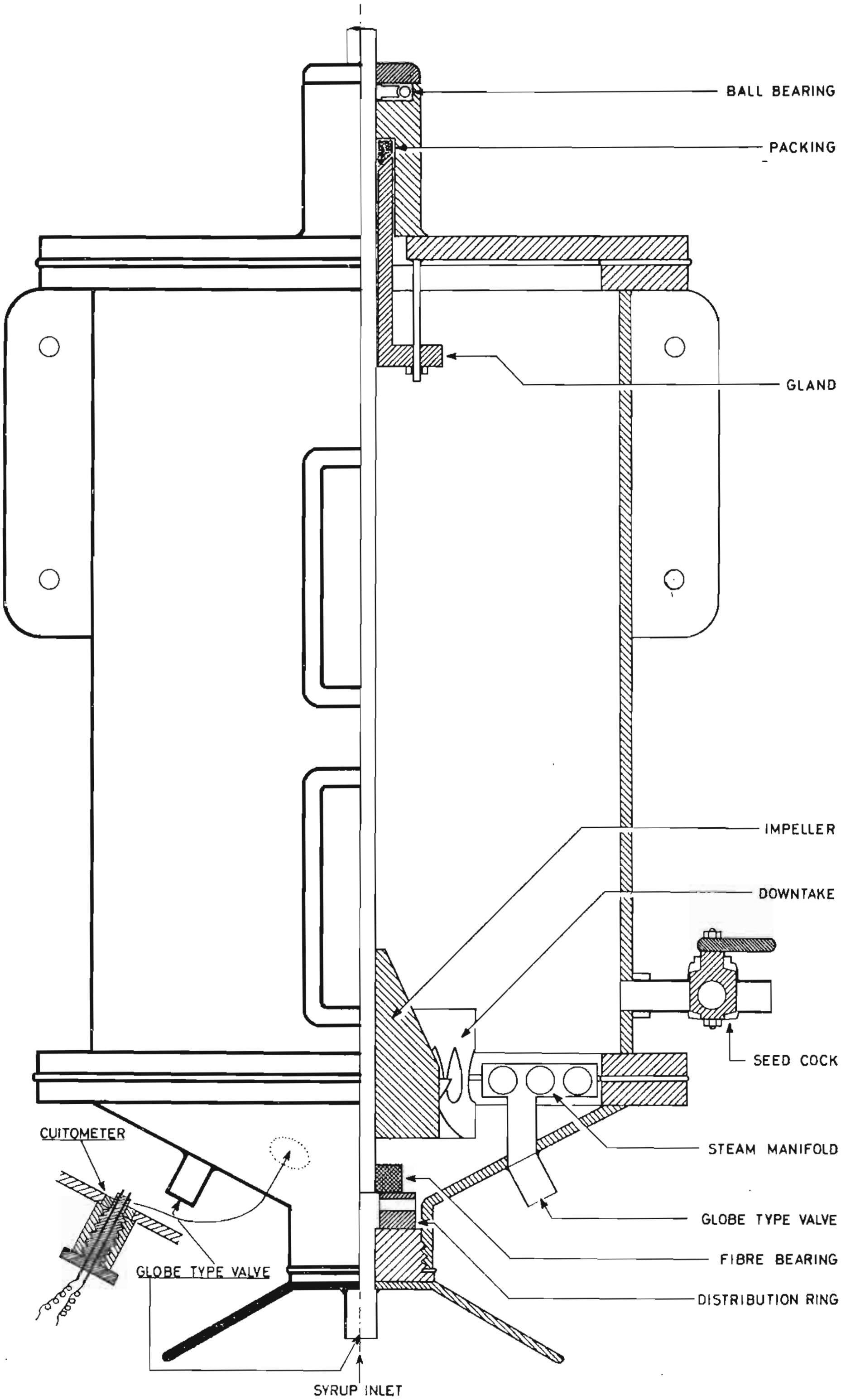


Fig 41. Laboratory vacuum pan (details).

ii) the steam-heated element, which consists of three concentric rings made of $\frac{1}{2}$ inch diameter copper tubing, the inlet and outlet manifolds being opposite to each other;

iii) the cuitometer electrodes which have been specially designed for ease of removal and cleaning;

iv) the drain plug which fits in a two-inch socket at the apex of the cone; in the centre of this plug is the juice inlet which is controlled by a valve immediately below the plug; fixed to the top of the plug is a fibre bushing which acts as a guide for the shaft of the stirrer;

v) the sampler : it was found that the simplest and most reliable sampler consisted of a valve to which is adapted a 2-inch length of transparent tubing; the finger is pressed on the open end of the tubing to form an air-tight seal and the valve is opened; massecuite flows down the tubing by gravity and after closing the valve, the sample is drained off.

At the centre of the top cover are the bearing and air-tight packing of the stirrer. The latter is composed of a $\frac{1}{2}$-inch diameter stainless steel shaft to which is attached a $3\frac{7}{8}$-inch diameter Webre-type impeller. The drive is by means of a $1\frac{1}{2}$ H.P. electric motor rotating at 1500 r.p.m., speed reduction of 5 : 1 being obtained by belt coupling.

The surface condenser used consists of a piece of 2-inch B.S. pipe one foot long, inside which four $\frac{1}{2}$-inch diameter copper tubes form the cooling surface. The cooling water circulates outside the tubes and the vapour inside.

The vacuum pump has a nominal displacement of 2.5 cubic feet per minute, and maintains a vacuum of 26 inches Hg.

The boiler used to generate 5 lb/sq.in steam is a pressure cooker fitted with a 2.6 kW kettle element. Condensed steam from the pan coil returns to the boiler by gravity, so as to form a closed circuit. Thus no additional water is needed during the whole strike, but the system requires a vent pipe in the circuit so as to allow removal of incondensible gases from time to time.

Operation

The vacuum pump is switched on and 3.5 litres of syrup are sucked into the pan. The steam valve is opened and the syrup concentrated to a $\frac{1}{2}$-inch thread. When this point is reached, the cuitometer reading is noted and slurry (1.6 ml of a finely ground slurry containing 390 grams of refined sugar per litre) is sucked in slowly. The cuitometer reading should henceforth not be allowed to drop until the grain is fully established and throughout the growing period.

Movement water at about 60°C is then fed to the pan during the grain establishment period which lasts 40-45 minutes, at the end of which about 2 litres of water have been consumed and the pan contents approximate $2\frac{1}{4}$ litres of massecuite.

Syrup diluted 1 : 1 with water and heated to 60°C is then fed in. The dilution is gradually decreased until the feed is made up of pure syrup. Feeding with the latter is continued until the desired volume of massecuite has been boiled. Exhaustion of the mother liquor is then carried out by feeding in gradually about 700 ml of movement water. Finally, about five minutes prior to discharging the pan, the cuitometer reading is allowed to drop to a figure approximately ten per cent below that registered so far in order to heavy up the massecuite.

Before using the pan in studies relating to raw sugar filterability it was first necessary to determine whether reproducible results could be obtained with the equipment and under the carefully controlled conditions described above. To this end strikes were boiled in duplicate from various syrups, and the sugar fugalled from the massecuites obtained were analysed for filterability by the CSR method. Typical results obtained are given in Table 62.

Table 62. Reproducibility of results when boiling strikes in the laboratory vacuum pan

Strike No.	*Pan boiler*	*Origin of syrup*	*Purity of syrup*	*Purity of running*	*Purity drop*	*CSR filterability*
1	A.B.	The Mount	90.7	74.6	16.1	69.4
1 bis	A.B.	,, ,,	90.7	74.2	16.5	69.6
2	S.M.	The Mount	87.5	71.0	16.5	67.6
2 bis	S.M.	,, ,,	87.5	70.3	17.2	67.8
3	A.B.	Mon Désert	89.5	76.4	13.1	76.8
3 bis	S.M.	,, ,,	89.5	75.7	13.8	76.5

As may be observed from the above results, reproducibility results can easily be obtained with the equipment, even when the strikes are boiled by different boilers. This important aspect of the question having been settled, it is hoped that the pan will help to throw further light on the causes of poor filterability in cane raw sugars.

6. QUANTITATIVE MEASUREMENT OF ENTRAINMENT IN VACUUM PANS

S. MARIE-JEANNE

The object of the study was to determine quantitatively the amount of sugar lost in vacuum pans by entrainment. To achieve this it was decided to observe two conditions :

i) accurate determination of small amounts of sucrose in condenser water ;

ii) precise measurement of the volume of condenser water.

Method of analysis

Several of the methods available for the quantitative determination of small amounts of sucrose in sample solutions were experimented with and the citric acid method (Ando *and* Kiuchi, 1965) was finally considered best suited and chosen. Recovery experiments with condenser water carried out in the laboratory showed that it is accurate to within 2 ppm. This method has also the advantage of providing rapid determinations and the reagent can be kept for seven weeks. The equipment and chemicals necessary are :

Citric acid — sulphuric acid.

Test tubes (int. diam. 1.5 cm, length 12.5 cm) with glass stopper.

Colorimeter.

Procedure

5.0 ml of the citric acid-H_2SO_4 reagent is pipetted into a test tube and 1 ml of sample solution added to the test tube within 20 seconds, after which the mixture is shaken vigorously for 5 seconds with glass stopper in place. After shaking, the test tube is first heated for 10 minutes in a boiling water bath, then placed in ice-cold water for cooling to room temperature. The solution is then transferred to a 1 cm cell and its absorbancy measured at 420 μ. This reading is compared with the standard curve prepared with pure sucrose solutions.

Measurement of condenser water

For this purpose it was decided to use a rectangular weir. The accuracy of the measurements had to be tested and this was achieved with the help of a vacuum pan equipped with its own barometric condenser. The vacuum pan was also equipped with the following :

i) mercury barometer for boiling pressure measurements;
ii) thermometers for condenser water inlet and outlet temperatures;
iii) by-pass and scale for weighing calandria condensate.

The rectangular weir was placed at the discharge of the seal tank of the condenser. The cooling water was fed to the condenser from a water tower, and its rate of flow therefore varied with the fluctuations in boiling pressure.

It was assumed at first that the total evaporation in the pan was equivalent to the amount of condensate from the calandria and by weighing this condensate it was therefore possible to obtain the amount of evaporation during a strike or any part of a strike. This assumption was verified by measuring the condensate and calculating the evaporation from a Brix balance. Condensate was measured by by-passing it to two tared cylindrical containers. As soon as evaporation had started, measurements were made during half-hour periods whilst weir, temperature and boiling pressure measurements were taken every 3 minutes.

The mean weir value was read against a previously calculated curve and gave the volume, hence the weight, of condenser water used during the 30-min. periods. On the other hand, the weight obtained from the condensate measurement gave the evaporation during these periods. From these figures the actual cooling water ratio was calculated and was found to be about 21.6.

The theoretical cooling water ratio was also calculated from the cooling water inlet and outlet temperatures and the boiling pressure; it was found to be 21.2. These figures show the reliability of the weir measurements in spite of frequent variations of the level of water over the weir due to boiling pressure fluctuations.

Sampling of condenser water

In the case under study, condenser water was not recirculated and it was therefore not necessary to analyse that water for sugar. But in cases where the water is recirculated and contains residual sugar, the percentage of sugar in the cooling water should be subtracted from that found in the condenser water, and the result multiplied by the total volume of condenser water to give sucrose lost. The error which is introduced by multiplying the percentage of residual sugar by the volume of water leaving the condenser, instead of that entering, is negligible since the cooling water ratio is large.

Sampling of condenser water was carried out at 3-minute intervals and composited over one-hour periods. No preservatives were used as prior laboratory experiments with condenser water had revealed no deterioration of sucrose for at least 3 hours.

The sucrose content obtained after analysis was multiplied by the volume of condenser water measured during the equivalent period to give the amount of sucrose lost by entrainment.

Results

Some of the results obtained will now be discussed. Table 63 gives figures for a strike in which a blend of syrup and A-runnings was concentrated and seeded with slurry for the production of footing to be used for A-and B-massecuites. Samples were composited over periods indicated as A, B, C and D, which corresponded respectively to concentration (39 mins), seeding and bringing together (60 mins), and growth (60 and 81 mins).

Table 63. Results of sampling and analysis (A-strike)

	PERIODS			
	A	*B*	*C*	*D*
Duration, mins.	39	60	60	81
Mean weir lecture, in.	4.67	4.97	5.10	4.82
Equivalent flow, cu. ft./sec.	1.35	1.50	1.54	1.43
Total flow, cu. ft.	3,159	5,400	5,544	6,948
,, ,, cu. metres	89.45	152.91	156.98	196.74
Colorimeter reading × 10	0.4	0.9	0.5	0.5
Equivalent sucrose content mg/l ...	4.0	8.0	5.0	5.0
Total sucrose lost, kg.	0.357	1.223	0.785	0.984

Total sucrose lost during the whole strike amounted to 3.3 kg. Yet it should be pointed out that the average time for boiling such a strike is normally $2\frac{1}{2}$ to 3 hours whilst, in the present case total duration was 4 hours. In other words, the evaporation was carefully controlled and entrainment minimized. In industrial practice, however, such is not always the case. Thus, during another similar test sucrose lost during concentration alone amounted to 3.4 kg, whilst in the case of an A-strike which lasted 1 hour 48 mins, total sucrose lost was 3.9 kg.

Conclusion

In Mauritius, losses due to entrainment in evaporators and vacuum pans are generally small. Thus, in several factories total undetermined losses amount to only about 0.05 per cent on cane. However, the smaller losses are, the more important it is for the chemist to locate them in order that he should be in a position to reduce them further.

In factories where pans are equipped with individual condensers, the method offers a tool to measure quantitatively which pans entrain more sugar. The method can also be applied to pan stations with central condensers, provided the accuracy of the weir can be checked.

Finally, the method could also be used with advantage for checking the efficiency of entrainment separators.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to the staff of Britannia Sugar Factory, particularly to Mr. R. Hardy, for their most valuable help.

REFERENCE

ANDO, M. *and* KIUCHI, R. (1965). Quantitative determination of small amount of sucrose in condenser water by the citric acid method. *Proc. Res. Soc. Japan Sug. Refin. Technol.* **15** : 91-104.

7. CHEMICAL CONTROL

(i) THE EXHAUSTIBILITY OF MAURITIUS FINAL MOLASSES

E. C. VIGNES, M. RANDABEL & M. ABEL

In any factory, the main object is to recover the maximum amount of sugar from the material entering the boiling-house. How far this is achieved in practice, is often judged from the purity of the final molasses. This figure, however, is not by itself the best criterion as the purity attained in not necessarily the minimum which could be obtained under the prevailing conditions.

It has long been known that the final purity attained depends to a great extent on the composition of the molasses, and varies according to the amount of non-sucrose impurity present. From GEERLIGS classical studies, and from the large amount of work carried out in several sugar countries, it appears that reducing sugars and ash exert the greatest influence. As a result, numerous authors have attempted to establish equations to relate minimum purity of final molasses with the impurities they contain.

For instance, after an extensive study of Java molasses, SIJLMANS (1934) derived the formula $\frac{100\ x_1}{100 \cdot x_1 + \text{[illegible]}}$ for calculating the so-called practical exhaustibility of final molasses, where x_1 is sucrose % non-sucrose and was obtained from another equation involving sucrose, hexose and ash. The main objection to Sijlmans' formula was the assumption that the solubility of sucrose in final molasses was influenced by hexose alone and no other non-sucrose constituents (Honig, 1959). Douwes Dekker (1949) carried out a statistical survey of 150 final molasses produced in Java factories during 1938 and 1939 and calculated the well-known "Douwes Dekker formula", which is the actual regression formula showing the relationship between final purity, reducing sugars % non-sugars and sulphated ash % non-sugars :

$$P = 35.886 - 0.08088\ r + 0.26047\ a$$

where P = expected true purity,
r = reducing sugars % non-sugars
and a = sulphated ash % non-sugars.

It must be emphasized that modern equipment enables factories to reach even lower purities than indicated by the above formula without difficulty.

In several other countries, attempts have been made to establish criteria by which to judge molasses exhaustion. Thus Hawaiian factories use a guide (Payne, Kenda & Iwata, 1952) based upon the Reducing Substances/Specific Conductance ratio. Specific conductance, which is proportional to ash, is determined on a molasses solution of 28° Brix. The formula reads as follows :

$$Y = 38.55 - 61.9x + 49.9\ x^2$$

where Y = refractometric sucrose purity
and X = reducing sugars/specific conductance.

In the Philippines, the apparent target purity of final molasses (Honig, 1956) is given by the expression :

$$24.0 - 0.11\ r + 0.26\ a$$

where r = reducing sugars % non-sugars
and a = ash % non-sugars

From the analytical data of final molasses from 36 factories for two consecutive milling seasons, Wei-Chen, Tsin-how Hsu and Pei-Chui Weng (1952) derived the following equation in Taiwan :

$$P = 19.789 + 0.233\ r + 0.4695\ a$$

where P = expected true purity
r = reducing sugars % non-sugars
and a = ash % non-sugars

The formula has proved successful in appraising the exhaustibility of final molasses in that country.

Although the Douwes Dekker formula was developed for Java, it has been found to apply quite well in other countries, in Queensland for example, where it has been used to show which factories are inefficient in low-grade work (Venton, 1951). In Mauritius certain factories have applied it satisfactorily to follow their molasses exhaustion. However, it is clear that the constants found in Java do not necessarily hold for Mauritius molasses, and a better insight into the low grade department work could be obtained if the formula were recalculated to bring it in line with local conditions. Also, local routine chemical control does not include the determination of dry matter by drying, and therefore, if true purity is needed for comparison purposes, it is necessary to derive an equation capable of converting refractometric Brix to dry matter.

Consequently, during 1967 the Sugar Technology Division carried out a comprehensive study designed, (a) to enable refractometer results, with corrections, to replace the delicate and time-consuming determinations of solids by drying; and (b) to calculate an exhaustibility formula applicable to local molasses.

Average crop samples from 21 defecation factories were collected and analysed for dry matter (true solids), refractometric Brix at 1 : 6 w/w dilution, sucrose, reducing sugars and sulphated ash. Dry matter was determined by drying in a Gardiner oven at Tate & Lyle Research Centre, Keston. Refractometric Brix, sucrose, reducing sugars and ash were determined by the usual analytical methods.

Gardiner and Farmiloe (1954) have shown that dry matter can be calculated from the refractometric Brix by applying invert sugar and ash corrections. The invert sugar correction adopted by them was given by $-0.00025 \times$ dry matter $\times$ invert sugar, a correction used in Tate & Lyle refineries for all products (de Whalley, 1949). When this correction was applied to local molasses, the ash correction worked out at $+0.0049 \times$ dry matter $\times$ sulphated ash (Table 64). It should be pointed out that the constant derived by the above-mentioned authors, namely + 0.0043, is in close agreement with that obtained in the present work. In other words, dry matter can be calculated from the equation :

$$\text{Dry Matter} = \frac{\text{Refractometric Brix at 1 : 6 w/w dilution}}{1 - 0.00025 \text{ invert sugar} + 0.0049 \text{ sulphated ash}} \quad \text{.......................(1)}$$

Table 64. Determination of ash correction factor for final molasses

Factory No.	*Solids by drying in Gardiner oven*	*Refractometric Brix*	*R.S. %*	*Sulphated ash %*	*Ash correction factor*
1 ...	82.93	88.44	15.02	16.17	0.0043
2 ...	83.12	88.77	12.48	16.47	0.0043
3 ...	83.33	89.54	16.93	15.83	0.0050
4 ...	82.32	88.71	14.68	16.44	0.0049
5 ...	82.31	89.07	10.96	17.31	0.0049
6 ...	82.59	89.13	12.73	17.02	0.0048
7 ...	83.50	89.73	15.19	15.79	0.0050
8 ...	80.87	86.61	15.77	14.35	0.0052
9 ...	81.25	87.18	14.56	14.27	0.0054
10 ...	82.33	88.20	15.55	15.22	0.0049
11 ...	83.11	89.67	13.10	17.55	0.0047
12 ...	82.18	88.65	13.23	17.80	0.0046
13 ...	82.21	88.95	13.10	16.79	0.0051
14 ...	84.24	90.51	14.03	15.63	0.0050
15 ...	79.59	85.59	15.72	13.59	0.0058
16 ...	82.40	88.17	13.62	17.39	0.0042
17 ...	82.46	89.25	14.37	15.93	0.0054
18 ...	81.81	88.65	12.83	17.66	0.0049
19 ...	82.18	88.92	12.62	16.01	0.0053
20 ...	80.49	86.46	12.62	16.06	0.0048
21 ...	81.97	88.14	12.49	16.36	0.0048
				Average value	*0.0049*

The correlation coefficient of equation (1) is 0.90. In addition, a statistical analysis was made of the relevant figures with a view to correlating dry matter directly with refractometric Brix and the following regression formula calculated :

$$\text{Dry Matter} = 0.834 \text{ Refractometric Brix} + 8.42 \quad \text{...(2)}$$

The correlation coefficient of this equation (2) is 0.94. It is intended to carry out further analyses of final molasses in order to determine which of the two above equations can predict dry matter more accurately. Until results are available either equation can be used in the calculation of true purity of final molasses.

Table 65 shows the difference between dry matter obtained by drying in a Gardiner oven and refractometric Brix corrected for invert sugar and sulphated ash.

The composition of average final molasses for the 1966 crop is given in Table 66 A statistical analysis was made of these figures, and the following regression equation, showing the relationship between true purity, reducing sugars % non-sugars and ash % non-sugars was calculated.

$$\text{Expected True Purity} = 46.4 - 0.14 \text{ reducing sugars \% non-sugars} - 0.02 \text{ sulphated ash \% non-sugars} \quad \text{...........(3)}$$

Table 65. Comparison between dry matter and corrected refractometric Brix

Factory No.	*Dry matter %* (*a*)	*Corrected refractometric Brix %* (*b*)	*Difference %* (*a — b*)
1	82.93	82.23	+ 0.70
2	83.12	82.38	+ 0.74
3	83.33	83.42	— 0.09
4	82.32	82.38	— 0.06
5	82.31	82.31	0.00
6	82.59	82.51	+ 0.08
7	83.50	83.58	— 0.08
8	80.87	81.22	— 0.35
9	81.25	81.76	— 0.51
10	82.33	82.38	— 0.05
11	83.11	82.82	+ 0.29
12	82.18	81.79	+ 0.39
13	82.21	82.44	— 0.23
14	84.24	84.35	— 0.11
15	79.59	80.54	— 0.95
16	82.40	81.50	+ 0.90
17	82.46	83.06	— 0.60
18	81.81	81.83	— 0.02
19	82.18	82.69	— 0.51
20	80.49	80.39	+ 0.10
21	81.97	81.84	+ 0.13

It is clear from the new formula that reducing sugars are the more important factor governing exhaustibility, ash content affecting true purity only to a small extent; this had already been noticed in Hawaii by PAYNE *et al* (*loc. cit.*) who found that *in fact a straight reducing substances guide would be equally as good as Reducing Substances – Ash Ratio.*

As the above equation demands long and involved calculations, a simple formula capable of easy application in industrial practice was desirable. An expression involving the relationship between purity and reducing sugars/ash ratio was obtained from the relevant figures of Table 66 in the form :

Expected True Purity = 43.4 – 2 × reducing sugars/ash ....(4)

Table 66. Composition of average Mauritius final molasses, 1966

Factory No.	*Dry matter*	*Sucrose %*	*True Purity*	*Reducing Sugars % Non-sugars*	*Sulphated Ash % Non-sugars*
1	82.93	33.87	40.8	30.62	32.96
2	83.12	34.82	41.9	25.84	34.10
3	83.33	32.64	39.2	33.40	31.23
4	82.32	33.06	40.2	29.80	33.37
5	82.31	34.94	42.4	23.14	36.54
6	82.59	34.94	42.3	26.72	35.72
7	83.50	34.66	41.5	31.10	32.33
8	80.87	33.25	41.1	33.12	30.13
9	81.25	35.18	43.3	31.60	30.97
10	82.33	34.84	42.3	32.74	32.05
11	83.11	33.51	40.3	26.41	35.38
12	82.18	33.33	40.6	27.08	36.44
13	82.21	34.23	41.6	27.30	34.99
14	84.24	36.07	42.8	29.13	32.45
15	79.59	32.36	40.7	33.28	28.77
16	82.40	35.42	43.0	28.99	37.02
17	82.46	34.23	41.5	29.79	33.03
18	81.81	34.15	41.7	26.92	37.05
19	82.18	34.79	42.3	26.63	33.78
20	80.49	34.60	43.0	27.50	35.00
21	81.97	34.83	42.5	26.50	34.71

Table 67. True purity compared to purities obtained by new formulae

Factory No.	*True Purity* (*a*)	*Formula* (3) (*b*)	*Difference* (*a* — *b*)	*Formula* (4) (*c*)	*Difference* (*a* — *c*)
1	40.8	41.5	— 0.7	41.6	— 0.8
2	41.9	42.1	— 0.2	41.8	0.1+
3	39.2	41.1	— 1.9	41.2	2.0—
4	40.2	41.6	— 1.4	41.6	1.4—
5	42.4	42.4	0.0	42.2	0.2+
6	42.3	42.0	0.3+	42.0	0.3+
7	41.5	41.4	0.1+	41.4	0.1+
8	41.1	41.2	0.1—	41.2	0.1+
9	43.3	41.4	1.9+	41.4	1.9+
10	42.3	41.2	1.1+	41.4	0.9+
11	40.3	42.0	1.7—	42.0	1.7—
12	40.6	41.9	— 1.3	42.0	1.4—
13	41.6	41.9	0.3—	41.8	0.2—
14	42.8	41.7	1.1+	41.6	1.2+
15	40.7	41.2	0.5—	41.0	—0.3—
16	43.0	41.6	1.4+	41.8	1.2+
17	41.5	41.6	0.1—	41.6	0.1—
18	41.7	41.9	0.2—	42.0	-0.3—
19	42.3	42.0	0.3+	41.8	0.5+
20	43.0	41.9	1.1+	41.8	1.2+
21	42.5	42.0	0.5+	41.8	0.7+

In Table 67 true purity obtained by drying is compared to the purities calculated from the new formulae. It will be observed that results obtained from (4) agree well with those derived from (3) and, since the former formula is simpler in its application, its use is recommended for calculating the expected true purity of final molasses with a view to comparing it with actual true purity. This procedure will enable factory chemists to assess more accurately the efficiency of their low-grade department.

As will have been noticed, so far no mention has been made of viscosity which is, however, an important factor to consider in molasses exhaustion. In fact, a complex relationship exists in molasses between viscosity on one hand, and concentration, temperature, purity and saturation temperature on the other. Viscosity varies widely on account of the nature and amount of non-sugars; unfortunately, nothing can be done to change the behaviour of these constituents.

A high concentration of solids is necessary to maintain effective supersaturation in low purity products. Viscosity increases with solids concentration, and finally becomes a limiting factor in molasses exhaustion. From the above, it can be assumed that maximum exhaustion will be achieved by working at the maximum viscosity compatible with the strength of the crystallizing equipment. However, in order to retain all the benefit attained in so doing, careful attention should, in addition, be paid to dilution and reheating and to centrifugalling procedure.

REFERENCES

DOUWES DEKKER, K. (1949). Comments on the exhaustibility of final molasses, on the Winter ratio and on the determination of colour in white sugar. *S. Afr. Sug. J.* **33** : 709-715.

GARDINER, S.D. *and* FARMILOE, F.J. (1954). Design and operating technique of a vacuum drying oven. *Analyst*, **79** : 447-453.

HONIG, P. (1956). Boiling house efficiency and the purity of final molasses. *Sug. News*, **32** : 301-306.

HONIG, P. (1959). Principles of sugar technology, Amsterdam, Elsevier, v. 2, chapter **14**.

PAYNE, J.H., KENDA, W. *and* IWATA, H. (1952). A guide to molasses exhaustibility. *Rep. Hawaiian Sug. Technol.* **11** : 81-88.

SIJLMANS, C. (1934). De practische uitputbaarheid van Javamelasse. *Arch. Suikerind. Ned.-Indie.* **42** (2) 167-209.

VENTON, C.B. (1951). The application of the Douwes Dekker formula to Queensland molasses. *Proc. Qd. Soc. Sug. Cane Technol.* **18** : 37-42.

WEI-CHEN, TSUI-HOW HSU *and* PEI-CHEI WENG (1952). *Rep. Taiwan Sug. Exp. Stn.*, **9** : 212.

WHALLEY, H.C.S. de (1949). *Proc. ICUMSA*, **10** : 19-20.

(ii) INVESTIGATION INTO THE POSSIBLE CAUSES OF DIFFERENCES BETWEEN DENSIMETRIC AND REFRACTOMETRIC BRIX OF FINAL MOLASSES

F. LE GUEN, M. RANDABEL & M. ABEL

Refractometric Brix has been in use in Mauritius since 1965 for routine chemical control of sugar factories, and it had been noted since that year (RANDABEL and LE GUEN, 1966) that whilst the difference between the densimetric and refractometric Brix of final molasses was in many cases of the order of 7 points, there were factories where the differences were as large as 13, and in others it was as small as 5.

In Hawaii which was the first country to adopt refractometric Brix for routine chemical control, it has been found that the differences in Brix are directly proportional to the ash content (HANSSON, 1940), but the differences in Brix that were reported there, lie within narrower limits, namely 3.2 and 7.9, whilst in Mauritius the range is 4.6 to 13.3.

With the aim of providing some explanation for this variation, mean samples of molasses from each of the twenty-three sugar factories were collected in 1965 and analysed for various constituents, as shown in Table 68. The object of the experiment was also to provide data for recalculating coefficients in formulae similar to those of SIJLMANS (1933), DOUWES DEKKER (1949) and DE SAINT ANTOINE *and* LAMUSSE (1959) that might be used when refractometric instead of densimetric Brix of final molasses is measured. Difficulties were experienced however in determining accurately the dry matter by means of the vacuum oven which was then available, and the following year the experiment was repeated with samples of molasses for the 1966 crop, the dry matter being determined this time by means of the more accurate GARDINER (1953) oven at Tate & Lyle Research Centre. The opportunity thus arose to collect data concerning the differences in Brix for 1966 as well as 1965 and the results obtained are given in Tables 68 and 69.

Table 68. Analysis of final molasses, 1965 crop

Factories	*Dry Matter (Vacuum Oven)*	*Densimetric Brix 1 : 10 wt/vol soln. (D)*	*Ref. Brix 1 : 6 wt/wt soln. (R)*	*(D — R)*	*Sulphated ash %*	*K_2O %*	*CaO %*	*MgO %*	*Na_2O %*	*Sucrose %*	*Reducing Sugars %*
Médine ...	80.90	96.9	87.30	9.60	17.12	5.18	1.18	1.18	1.32	32.74	16.43
Solitude ...	78.52	95.3	86.64	8.66	16.83	4.75	1.35	1.18	1.28	33.99	13.98
Beau Plan ...	80.63	97.2	88.68	8.52	16.84	4.46	1.47	1.28	1.22	30.77	17.44
Mount ...	78.27	95.1	86.70	8.40	16.76	4.57	1.90	0.99	1.43	32.22	15.35
Belle Vue ...	79.90	96.6	83.28	13.32	18.50	4.90	1.41	1.28	1.32	33.25	11.16
St. Antoine ...	79.16	95.3	88.02	7.28	17.60	4.90	1.38	1.43	1.80	33.56	12.95
Mon Loisir ...	78.07	95.3	87.84	7.46	16.17	3.53	1.70	1.26	1.54	31.60	16.48
Constance ...	76.75	93.5	87.42	6.08	14.52	3.92	1.35	1.45	1.22	31.05	17.63
F.U.E.L. ...	78.93	93.8	88.20	5.60	14.63	4.14	1.29	0.99	1.58	34.73	15.52
Beau Champ ...	79.19	95.9	88.38	7.52	15.95	4.46	1.55	1.14	1.32	34.07	15.44
Ferney ...	76.54	95.1	84.24	10.86	16.47	4.57	1.52	1.14	1.89	32.48	17.21
Riche en Eau ...	78.95	97.7	88.80	8.90	17.43	4.86	1.73	0.99	1.38	34.25	12.88
Mon Trésor ...	80.58	97.2	89.04	8.16	17.46	4.90	1.47	1.26	1.54	32.25	14.58
Savannah ...	78.04	94.0	87.60	6.40	15.97	4.46	1.27	1.08	1.17	33.93	13.41
Rose Belle ...	80.39	96.1	89.76	6.34	16.02	4.68	1.27	0.81	1.84	34.18	14.24
Britannia ...	77.23	92.5	87.36	5.14	13.62	4.03	0.83	0.95	1.28	31.85	16.64
Bénarès ...	79.09	97.9	85.80	12.10	18.21	5.18	1.78	0.89	1.80	36.44	12.50
Union St. Aubin ...	78.49	95.3	87.36	7.94	17.40	5.62	1.06	0.77	1.69	32.12	13.27
St. Félix ...	79.63	95.9	88.58	7.32	16.09	4.46	1.38	1.22	1.43	33.72	14.58
Bel Ombre ...	78.22	95.3	87.78	7.52	16.86	4.75	1.21	1.22	1.94	31.97	13.77
Réunion ...	77.98	94.8	88.26	6.54	15.50	3.92	1.52	1.03	1.28	33.83	14.15
Highlands ...	78.01	91.7	85.92	5.78	14.35	3.92	1.29	0.81	1.80	33.78	14.66
Mon Désert ...	78.83	94.0	87.66	6.34	15.21	4.57	1.15	0.74	1.32	35.78	12.88

Table 69. Analysis of final molasses, 1966 crop

Factories	*Dry Matter (Gardiner Oven)*	*Densimetric Brix 1 : 10 wt/vol soln (D)*	*Ref. Brix 1 : 6 wt/wt soln (R)*	*(D — R)*	*Sulphated ash%*	*Sucrose %*	*Reducing Sugars %*
Médine ...	82.93	95.6	88.44	7.16	16.17	33.87	15.02
Solitude ...	83.12	95.6	88.77	6.83	16.47	34.82	12.48
Beau Plan ...	83.33	96.9	89.54	7.36	15.83	32.64	16.93
Mount ...	82.32	95.9	88.71	7.19	16.44	33.06	14.68
BelleVue ...	82.31	97.2	89.07	8.13	17.31	34.94	10.96
St. Antoine	82.59	96.4	89.13	7.27	17.02	34.94	12.73
Mon Loisir	83.50	96.6	89.73	6.87	15.79	34.66	15.19
Constance ...	80.87	93.0	86.61	6.39	14.35	33.25	15.77
F.U.E.L. ...	81.25	93.0	87.18	5.82	14.27	35.18	14.56
Beau Champ	82.33	95.3	88.20	7.10	15.22	34.84	15.55
Ferney ...	80.24	94.8	85.44	9.36	16.82	32.23	15.53
Riche-en-Eau	83.11	98.2	89.67	8.53	17.55	33.51	13.10
Mon Trésor	82.18	96.4	88.65	7.75	17.80	33.33	13.23
Savannah ...	82.21	97.2	88.95	8.25	16.79	34.23	13.10
Rose Belle	84.24	95.1	90.51	4.59	15.63	36.07	14.03
Britannia ...	79.59	91.2	85.59	5.61	13.59	32.36	15.72
Bénarès ...	82.78	98.5	86.43	12.07	17.85	37.55	11.84
Union St. Aubin	82.40	95.9	88.17	7.73	17.39	35.42	13.62
St. Félix ...	82.46	95.6	89.25	6.35	15.93	34.23	14.37
Bel Ombre...	81.81	95.9	88.65	7.25	17.66	34.15	12.83
Réunion ...	82.18	95.6	88.92	6.68	16.01	34.79	12.62
Highlands	80.49	92.7	86.46	6.24	16.06	34.60	12.62
Mon Désert	81.97	95.3	88.14	7.16	16.36	34.83	12.49

Statistical analysis of the differences in densimetric Brix (D) and refractometric Brix (R) both in 1965 and 1966 indicated a linear relationship significant at 1% level between sulphated ash and the differences in Brix. The regression for 1965 was :

$$D - R = 1.3 \text{ sulphated ash} - 13.6$$

whilst in 1966, it was :

$$D - R = 0.8 \text{ sulphated ash} - 6.5$$

The analysis of covariance for the two years indicated that although the regressions for 1965 and 1966 did not differ significantly in slope, there was a difference in elevation due to the fact that in 1965 the differences in Brix had been significantly higher than in 1966, whilst the sulphated ash had been practically the same for the two years.

No statistical relationship could be established between the differences in Brix and invert sugar or individual ash constituents such as potassium, sodium, calcium or magnesium.

It is therefore possible to infer that high sulphated ash is accompanied by large differences between densimetric and refractometric Brix, but that there are probably other additional factors that affect this difference. The difference in slope between the two years was not significant, the mean regression coefficient of D – R upon sulphated ash being 1 : 1.

The authors wish to acknowledge the co-operation of Tate & Lyle Research Centre for the determination of the dry matter of the 1966 samples by means of their Gardiner oven.

REFERENCES

DOUWES DEKKER, K. (1949). Comments on the exhaustibility of final molasses, on the Winter ratio and on the determination of colour in white sugar. *S. Afr. Sug. J.* **33** : 709-715.

GARDINER, S.D. (1953). Design and operating technique of a vacuum drying oven. *Analyst*, London, **78** : 709.

HANSSON, F. (1940). Bausch and Lomb Precision Refractometer. *Hawaii. Sug. Plr's. Ass. Sug. Tech. Dept. Activities Report no.* **4**.

RANDABEL, M. *and* F. LE GUEN (1966). Notes on the use of the Bausch and Lomb Precision Sugar Refractometer for chemical control of sugar factories. *Rep. Maurit. Sug. Ind. Res. Inst.* **12** : 132-133.

SAINT ANTOINE, J.D. de R. de *and* J.P. LAMUSSE (1959). The relationship between Brix and dry matter in final molasses. *Rep. Maurit. Sug. Ind. Res. Inst.* **6** : 100-103.

SIJLMANS, C. (1933). Estimation of the true dry substance content of molasses from the Brix and sulphated ash content. *Int. Sug. J.* **35** : 116-117.

APPENDIX

THE MAURITIUS HERBARIUM

R. E. VAUGHAN

Accessions. The big increase in material acquired by the Herbarium in recent years has necessitated the installation of four new steel cabinets and a special cabinet for palms which are mounted on sheets nearly twice the size of those normally in use. This new accommodation should allow the intake of a further five thousand specimens. The work of re-arranging the Herbarium and preparing a new index, which this expansion has entailed, has now been completed.

During the year, 825 herbarium sheets have been laid in. These may be classified as follows :

Réunion	... 171
Rodrigues	... 115
Mauritius	... 424
Overseas	... 115
	825

Mr. Régis Julien has presented the Herbarium with a very useful working collection of European grasses which have been incorporated in the Herbarium. This is a departure from the essential policy of the Herbarium to restrict material to the Mascarene Islands. In this case, however, so many alien grasses are invading the montane and cooler parts of these islands, or are being introduced for various purposes, that a reliably named collection of grasses from temperate regions greatly assists the work of identification.

The material obtained by Mr. H. J. Schileben mentioned in last year's report has now been studied and an interim statement and list of determinations made. This is one of the most rewarding collections the Herbarium has received from Réunion, and includes many species of *Philippia*, *Helichrysum* and *Senecio* from the open scrub-lands and mist forests of the high plateau at 2000 m., in the regions of Plaine des Cafres and the active volcano in the south-east of the Island.

Special mention may be made of some individual species collected by Mr. Schlieben. These include a good specimen of *Begonia aptera* with male and female flowers. This plant has always been somewhat of a botanical curiosity with scarce and very poor material in herbaria. It was well known to Commerson and a sketch of it (now in the Paris Herbarium) was made by his artist friend Jossigny. This year, *B. aptera* has been found near the old volcanic crater Bassin-Blanc, Mauritius, the first time it has been seen here since the early nineteenth century. Mr. Schlieben's collection also contained material of *Lysimachia mauritiana* with its peculiar Mascarene — Indo-Pacific distribution; *Sophora nitida* or "Petit Tamarin", an endemic species of this interesting genus; and *Viscum triflorum*, a partial parasite formerly known in Mauritius but which has now apparently disappeared. Reference must also be made to some species of micro-florous epiphytic orchids which are such a characteristic feature of the Réunion flora. In November, Mr. France Staub visited Réunion and collected plants on the mountains in the vicinity of Cilaos and the Piton des Neiges. His material is still under examination.

In May, Mr. France Staub and the Herbarium Assistant Mr. J. Guého, made an eight-day visit to Rodrigues and obtained some sixty-five species. Included in these were flowering specimens of *Sarcostemma odontolepis*, an endemic leafless liane and a new addition to the Herbarium collections. A fine range of specimens from very young leaves to mature plants in flower of *Scyphochlamys revoluta*, "Bois Mangue", showing the remarkable heterophylly of this species was obtained from Mt. Limon. Further material was found at Cascade Pigeon of an apparently undescribed species of the family *Asclepiadaceae*, known locally as "Liane à Cornes". This is perhaps one of the plants referred to in Balfour's *Botany of Rodriguez* where he says (p. 358) : "Two species of Asclepiadaceous twiners are occasionally met with, but as I only obtained them in leaf, and they are unlike any known Mascarene or Seychelles species, it is impossible to determine them". Special attention was paid on this visit to the vegetation of the Coral Plain in the south-western region of the island, where several rare endemics were collected by Balfour, but with disappointing results. Unfortunately this area has now become much overrun by aggressive exotics such as *Lantana* and other weeds. It is hoped that an opportunity will occur in 1968 to make a further detailed study of this part of the island.

Turning now to the Mauritius sector, space precludes only a brief mention of some items and points of interest arising from field work.

A species of *Begonia* (in addition to the *Begonia aptera* already mentioned) has been discovered in the zone of indigenous vegetation on the slopes of Pieter Both Mt. and at Bassin-Blanc. It seems probable that this is an indigenous species. Many begonias are in cultivation here as ornamentals, but they do not normally become naturalised and are not found as components of the secondary succession.

From the forest of Macabé, part of the National Reserve area, an epiphytic species of *Ophioglossum* has been collected, densely mingled with other epiphytes, in the society of plants which lodge themselves between the massive boles where the first branching of the canopy species occurs. The common ribbon fern *Vittaria* with its pendulous fronds grows here in great profusion and can hardly be distinguished from *Ophioglossum* from the ground, indeed, the study of this peculiar plant community is much assisted by a good pair of field glasses.

An important discovery during the year was that of another species of palm found in Crown Land Declerc near Grand Bassin from where a new *Acanthophœnix* (?) was recorded in the Annual Report for 1966. This is the third new palm found in Mauritius in recent years, all in the same restricted area of a few square miles. Young specimens of these palms have been found and transplanted to a site near the Herbarium where they can be safeguarded and kept under observation. Eventually it is hoped that viable seed will be obtained so as to secure their propagation.

Distribution to Institutions Overseas. Following enquiries made by Mr. J. P. Durand representing the Société E. Stehlé et Cie., 4½ kg. of dried leaves and bark of *Tabernemontana mauritiana*, "Bois de Lait" (APOCYNACEAE) were collected in July and despatched to the Madagascar branch of this institution in Tananarive. Specimens of seven species of Mauritius grasses were sent to Mr. P. Morat, O.R.S.T.O.M., Tananarive. Species of brown algae were loaned to Dr. Harold E. Hackett, Bates College Division of Natural Sciences, Lewiston, U.S.A. A consignment of living indigenous Mauritius orchids were sent by air to the Director, Royal Botanic Gardens, Kew, for the orchid houses there.

Visitors. Enquiries were made in March by Mr. L. M. Fernie, Coffee Research Station, Moshi, Tanzania, when on a visit to Mauritius concerning the possibility of obtaining seed of Mascarene species of *Coffea*. Similar requests have been received from other institutions, but so far it has not been possible to obtain viable seed.

In April, Mr. Philippe Morat, Botanist, O.R.S.T.O.M., Tananarive visited Mauritius with the main object of studying Mascarene grasses. He made collections of local grasses and worked in the Herbarium studying this family. During a short stay in Mauritius in September, Mr. John H. Winslow, Dept. of Geography, University of Cambridge, made expeditions with the help of the Herbarium staff to several localities of topographical and geological interest and was provided with photostats and copies of rare memoranda and reports in the Herbarium library. Mr. D. M. Henderson, Royal Botanic Gardens, Edinburgh, arrived here in October on a tour of Botanic Gardens and Herbaria in Commonwealth countries. In Mauritius he had glimpses of our Nature Reserves, Botanic Gardens, and indigenous forests and studied certain families of plants in the Herbarium. In November, Mr. Ross H. Gast made a return visit to Mauritius searching for local species of *Hibiscus* in connection with his work for the Hibiscus project of the Los Angeles State and County Arboretum. He went to Réunion and there was fortunate in finding one of the little known indigenous species of *Hibiscus* of that island. Sir Colville Barclay Bt., during his annual tour of his sugar lands in Mauritius, made extensive collections of flowering plants and mosses both here and in Réunion. He very kindly presented the Herbaiium with a duplicate set of his gatherings. These are now being examined and a report will be prepared in the near future. Mr. A. Gille, Director, U.N.E.S.C.O. Regional Centre for Science and Technology for Africa, recently spent a few days in Mauritius. He visited the Herbarium in connection with the work being done in Mauritius on Nature Reserves and the Conservation of Wild Life. During a tour of Réunion and Mauritius in December M. Marcel Lecoufle, *Horticulteur-Orchidéiste*, *Membre Correspondant du Museum National d'Histoire Naturelle*, studied the Herbarium collection of Mascarene orchids, took colour photographs of the Cordemoy water-colour sketches of Réunion orchids in the library, and presented the Herbarium with some specimens of orchids collected in Réunion.

Royal Botanical Gardens, Pamplemousses. Early in the year, following a recommendation made by the Royal Society of Arts & Sciences, the Ministry of Agriculture, Fisheries & Natural Resources set up a Permanent Advisory Committee for the Royal Botanic Gardens, Pamplemousses, to which the Curator Mauritius Herbarium was appointed. Three meetings of the Committee were held during the year and the general policy to be pursued concerning the Gardens was discussed. It was agreed that, primarily, the Gardens, which are recognized as one of the finest and most beautiful in the Tropics, should continue their evolution as a Botanic Garden rather than a public park or pleasure ground, and that their development and the long-term planning required should be directed towards furthering this fundamental aim.

The Committee also approved a preliminary set of labels and methods for their display and security prepared by the Senior Agricultural Officer, Department of Agriculture. There is no doubt that the great advantages and benefits which the adequate naming of the plants in the Gardens would give to the public at large, and the ever increasing number of visitors from overseas, would far outweigh the inevitable depredations involving loss or interchange of labels which must be expected.

Another matter to which the Committee has given careful attention is the preparation of an illustrated Handbook to the Gardens. This would include chapters on its long and eventful history, its botanical highlights with a catalogue of the plants at present under cultivation, and the work of the nurseries in the Gardens concerning the propagation and distribution of plants of economic and ornamental value.

The naming of the few remaining unidentified trees in the Gardens is receiving the active attention of the Herbarium.

Education. Of recent years a significant and very welcome change has taken place in the type of questions set by Overseas Examination Syndicates in Botany. Hitherto a good "pass" could be obtained by a candidate having a theoretical knowledge of certain groups of plants supplemented by microscope slides purchased from biological suppliers overseas; this is not botany (that is, the study of plant *life*) but merely a device for passing an examination. Now the emphasis has shifted to testing the candidates' knowledge and first hand acquaintance with the plant life around him. However, in the absence of guide books of any kind to the vegetation of the region, it is necessary for schools and colleges to build up their own collection of plants based on ecological principles and to obtain assistance and advice from the Herbarium on programming suitable field studies. Judging from the frequent visits to the Herbarium by teachers and pupils alike during the year, it seems that these problems are now being tackled on the right lines.

Weed Flora. Work has continued on the preparation of descriptions and dissections necessary for the botanical section of the *Weed Flora* leaflets. The identity of certain species intended for inclusion in the Weed Flora has proved beyond the resources of the Herbarium, and material has been sent overseas for examination and accurate determination.

Royal Society of Arts and Sciences of Mauritius. The Curator has assisted in the restoration and classification of the archives belonging to the Society. During the course of this work many interesting documents and letters have come to light. These include autograph letters from Adrien de Jussieu, Adolphe Brongniart, the Hooker family and others, to naturalists in Mauritius. Noteworthy also is a "herborisation" diary kept by Louis Bouton during the 1830's, describing visits to forests and other areas from where the indigenous vegetation has long since disappeared.

Acknowledgements. The successful outcome of expeditions made to Réunion during recent years has been in no small measure due to the assistance received from Mr. Thérésien Cadet, *Assistant Agrégé au Centre d'Enseignement Supérieur Scientifique de la Réunion*, Saint-Denis. He has acted as guide on many occasions provided transport, and placed his wide knowledge of the country and its vegetation at the disposal of visiting botanists.

A brief glance has been taken in this report at the routine and administrative tasks of the Herbarium during the past year. All this work and much else besides has only been made possible by the help and encouragement so freely given by the Chairman and Members of the Executive Board of the Mauritius Sugar Industry Research Institute. Moreover the fine accommodation which the Herbarium enjoys in air-conditioned rooms at the Sugar Industry Research Institute has reduced to a minimum the various hazards to which all such institutions are prone, and has provided very good working conditions for the staff and visiting botanists from overseas. It can now be said with confidence that the welfare and security is now ensured, as far as possible, of this unique assemblage of Mascarene plants, which, in spite of many misadventures, has gradually been expanding during the past one hundred and fifty years.

Maps and Publications. In March the U.N. Special Fund Project presented the M.S.I.R.I. with a set of fourteen aerial photo-mosaics of Mauritius. These are stored in the Herbarium Map Cabinet and may be consulted on applicaion to the Curator. Some important additions to the Herbarium Library are given below :

GAST, Ross H. 1957. The genetic history of *Hibiscus rosa-sinensis*. *Jl. R. hort. Soc.* **92** : 353-356.

HASELWOOD, E. L. & MOTTER, G. G. 1966. *Handbook of Hawaiian Weeds*. Hawaiian Sugar Planters' Association, Honolulu, Hawaii.

Records 227 weeds, with illustrations and brief descriptions, many of which occur in the Mascarene Islands.

HUTCHINSON, J. 1957. *The Genera of Flowering Plants. Dicotyledones.* Volume II Oxford.
Orders Cunoniales to Malpighiales.

LY-TIO-FANE, Madeleine, 1967. Pierre Poivre et l'expansion française dans l'Indo-Pacifique. *Bull. Ecole franc. Extrême Orient, Paris.* **53**(2) : 453-511. 14 maps.

Discusses among other questions the search for spice plants (nutmeg & clove) in the East Indies for introduction into Mauritius, and reviews some aspects of the work of Commerson and Sonnerat during this period.

PARHAM, J. W. 1955. The Grasses of Fiji. *Bull. Dep. Agric. Fiji*, no. 30.
1958. The Weeds of Fiji. *Bull. Dep. Agric. Fiji*, no. 35.

REYNOLDS, G. W. 1966. *The Aloes of Tropical Africa and Madagascar*. Mbabane, Swaziland.

A companion volume to the author's *Aloes of South Africa* (1950). Refers to the allied Mascarene genus *Lomatophyllum*.

ROCHECOUSTE, E. 1967. *Weed Control in Sugar cane. Research and Application.* Mauritius Sugar Industry Research Institute, Réduit, Mauritius. 117 p. illus.

In this able book the author summarises the wide and valuable experience gained during thirteen years as Chief Botanist of the Sugar Industry Research Institute, Mauritius.

STEARN, W. T. 1967. *Botanical Latin*. London.

A book of profound scholarship and likely to become a classic; of much wider interest than the title implies.

STATISTICAL TABLES*

* *Grateful acknowledgment is made to the Secretary, Mauritius Chamber of Agriculture, for providing the necessary data to compile Tables II to VI.*

Table 1. 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 (1967)	431	1470	1281	1888	744
SUGAR PRODUCTION 1000 metric tons (1967)	50	159	137	208	86
SUGAR FACTORIES production in 1000 metric tons (1967)	Médine 50	Belle Vue 33 Mon Loisir 30 St. Antoine 27 Solitude 25 Beau Plan 22 The Mount 22	Union Flacq 73 Beau Champ 34 Constance 30	Savannah 30 Mon Trésor 28 Rose Belle 26 Riche en Eau 25 Union 20 Bel Ombre 20 Britannia 19 St. Felix 14 Bénarès 13 Ferney 13	Mon Désert 39 Highlands 24 Réunion 23

Table II. Area under sugar cane in thousand arpents (*1*), 1959 - 1967

Year	Area under cane Island	Area reaped					
		Island	West	North	East	South	Centre
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	205.56	194.92	12.02	51.80	43.08	62.74	25.28
1966	207.55	195.87	12.36	51.44	43.96	62.90	25.21
1967(2)	204.00	191.73	11.77	50.24	43.43	61.26	25.03

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), 1959 - 1967

Crop Year	No. of factories operating	Av. Pol.	Island	West	North	East	South	Centre
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	23	98.8	664.4	53.9	158.0	148.6	212.5	91.4
1966	23	98.9	561.8	48.4	130.0	125.8	191.7	65.9
1967(2)	23	98.9	638.3	50.4	159.3	137.3	206.2	85.1

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), 1959 - 1967

SECTORS	1959	1960	1961	1962	1963	1964	1965	1966	1967(2)
ISLAND									
Millers ...	32.5	15.3	32.2	28.0	35.1	26.2	35.7	29.5	35.3
Planters ...	19.7	10.2	20.5	19.5	23.7	18.5	25.3	19.5	24.9
Average ...	25.9	12.7	26.4	23.9	29.6	22.4	30.7	24.7	30.3
WEST									
Millers ...	34.4	21.3	35.3	31.8	37.8	32.3	43.5	35.9	40.3
Planters ...	26.4	13.5	23.4	22.7	27.8	25.0	34.7	28.5	32.6
Average ...	29.3	16.2	27.8	26.2	32.1	28.1	38.9	32.1	36.6
NORTH									
Millers ...	30.0	19.2	29.2	31.1	35.0	29.0	35.5	28.6	37.7
Planters ...	17.1	11.4	20.6	21.4	24.0	19.2	24.4	17.8	24.6
Average ...	21.5	14.1	23.5	24.7	27.8	22.5	28.2	21.5	29.3
EAST									
Millers ...	33.0	16.3	32.7	29.0	37.6	28.0	39.0	31.1	36.0
Planters ...	19.2	9.3	17.9	17.1	21.3	16.0	23.5	18.8	23.0
Average ...	24.8	12.2	24.4	22.5	28.9	21.5	30.9	24.8	29.5
SOUTH									
Millers ...	32.3	14.6	31.7	27.8	33.4	24.5	33.2	29.3	33.2
Planters ...	21.4	9.4	20.8	20.1	24.6	18.7	25.7	21.0	25.9
Average ...	28.6	12.9	28.3	25.5	30.7	22.7	30.9	26.6	30.8
CENTRE									
Millers ...	34.9	9.7	36.7	22.1	36.2	23.3	35.7	26.4	34.7
Planters ...	22.0	7.6	23.7	15.8	24.1	16.9	25.5	18.6	23.4
Average ...	29.1	8.8	30.8	19.3	30.8	20.5	31.2	23.0	29.7

NOTE : (1) *To convert in metric tons/acre, multiply by 0.959*
„ „ „ long tons/acre, „ „ 0.945
„ „ „ short tons/acre, „ „ 1.058
„ „ „ metric tons/hectares, „ „ 2.370
(2) *Provisional figures*

Table V. Average sugar manufactured % cane(1), 1958 - 1967

Crop Year	Island	West	North	East	South	Centre
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	11.10	11.52	10.82	11.15	10.98	11.61
1966	11.60	12.20	11.76	11.54	11.46	11.38
1967(2)	10.98	11.70	10.84	10.71	10.92	11.43

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, 1958 - 1967

Crop Year	Island	West	North	East	South	Centre
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	3.41	4.48	3.05	3.45	3.39	3.62
1966	2.87	3.92	2.53	2.86	3.05	2.62
1967(1)	3.33	4.28	3.18	3.16	3.36	3.39

NOTE : (1) *Provisional figures*

Table VII. Monthly rainfall in inches, 1952 - 1967. 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
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
1966	5.74	*2.87*	11.99	*5.34*	*8.60*	*4.34*	*1.78*	7.44	23.72	4.47	3.85	1.85	1.82	0.00
1967	*3.28*	12.37	15.23	*3.83*	12.21	*9.17*	*4.62*	*4.19*	11.11	*9.17*	*5.69*	2.85	*6.53*	10.84

NOTE : To convert into millimetres, multiply by 25.4

Table VIII. Monthly maximum and minimum air temperatures, 1952 - 1967. 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
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
1966	26.8	19.1	28.2	19.9	28.5	21.3	29.2	22.1	27.9	21.5	27.8	20.3	27.2	18.1	24.7	17.4	23.9	17.0	23.7	16.5	25.4	16.9	26.0	17.2
1967	27.8	19.0	28.9	21.3	29.3	22.2	29.6	21.8	29.4	22.0	28.9	20.8	25.8	18.8	24.5	17.1	23.3	17.1	23.3	16.6	24.4	16.9	25.4	17.7

Table IX. Highest wind speed during one hour in miles(*1*). Average over Mauritius

Crop Year	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
November	18	18	14	16	12	13	13	19	16	18	15	17	15	17	14
December	15	16	15	17	13	13	14	15	15	*43(2)*	24	18	17	15	16
January	18	28	13	20	20	14	17	*53(2)*	16	20	26	*60(2)*	19	*45(2)*	*39(2)*
February	15	15	*34(2)*	16	19	18	17	*74(2)*	13	*59(2)*	16	*34(2)*	15	14	14
March	15	15	29	19	18	*33(2)*	18	15	13	18	17	24	21	25	12
April	20	16	16	17	16	28	17	15	12	21	16	18	21	15	12
May	22	22	19	18	15	14	16	17	13	20	20	22	24	13	21
June	23	20	22	17	13	14	17	17	19	17	18	20	17	16	20
July	24	16	17	15	12	11	16	15	19	19	17	20	20	18	20
August	24	23	20	14	17	20	18	16	20	22	15	20	18	20	22
September	20	19	19	17	17	17	17	20	21	18	17	20	17	14	17
October	19	20	14	18	15	17	18	18	19	22	16	17	18	20	23

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
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
January 1966 *Denise*	53	52	35	44	40
January 1967 *Gilberte*	33	38	41	45	37

Table XI. Cane Varieties, 1954 - 1967.

% Area cultivated (Estate lands)

	M.134/32 (1937)	Ebène 1/37 (1951)	B.3337 (1953)	B.37161 (1953)	B.37172 (1953)	B.34104 (1956)	M.147/44 (1956)	M.31/45 (1956)	M.202/46 (1960)	M.93/48 (1960)	M.253/48 (1962)	Ebène 50/47 (1962)	M.442/51 (1964)	M.99/48 (1965)	M.409/51 (1966)	M.13/53 (1966)	M.13/56 (1966)	M.377/56 (1967)
1954	83	9	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1955	74	15	3	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1956	66	17	4	3	2	—	1	1	—	—	—	—	—	—	—	—	—	—
1957	55	21	4	3	3	1	6	3	—	—	—	—	—	—	—	—	—	—
1958	43	24	5	3	5	1	10	4	—	—	—	—	—	—	—	—	—	—
1959	33	25	5	3	8	2	15	5	—	—	—	—	—	—	—	—	—	—
1960	25	26	6	3	10	2	19	5	—	—	—	—	—	—	—	—	—	—
1961	19	24	7	2	11	2	23	5	2	1	1	1	—	—	—	—	—	—
1962	13	21	7	2	11	3	26	4	4	3	1	3	—	—	—	—	—	—
1963	9	18	6	2	11	3	29	4	6	5	2	4	—	—	—	—	—	—
1964	6	15	6	—	11	2	31	3	8	9	2	5	—	—	—	—	—	—
1965	5	11	5	—	9	2	29	4	11	12	2	6	2	—	—	—	—	—
1966	3	9	4	—	8	2	26	4	13	16	2	6	5	—	—	—	—	—
1967	2	6	3	—	6	1	23	5	14	17	2	6	7	1	—	—	—	—

NOTE: Year of release shown in brackets

Table XII. Percentage annual plantations under different cane varieties on sugar estates, 1963 to 1967

Years / Varieties	Island					West					North					East					South					Centre				
	1963	1964	1965	1966	1967	1963	1964	1965	1966	1967	1963	1964	1965	1966	1967	1963	1964	1965	1966	1967	1963	1964	1965	1966	1967	1963	1964	1965	1966	1967
M.134/32 ...	—	0.6	1.3	—	—	—	0.9	1.4	—	—	0.6	1.8	3.2	—	—	—	0.5	1.2	—	—	—	0.4	1.0	—	—	—	—	—	—	—
M.147/44 ...	31.0	22.5	3.6	2.5	2.9	55.1	40.1	13.1	10.3	16.8	68.1	56.8	13.4	0.7	5.8	30.9	22.0	1.6	6.1	2.8	23.1	14.9	—	0.8	0.3	1.0	0.4	—	—	—
M.31/45 ...	1.7	6.2	9.4	9.4	6.3	—	1.3	6.2	11.6	3.0	1.0	2.4	7.5	3.6	1.6	6.1	14.9	22.3	12.6	10.8	1.0	5.5	7.9	13.1	9.4	—	—	0.6	2.1	0.5
M.202/46 ...	14.8	21.3	21.1	16.2	8.6	23.9	28.4	29.2	30.9	30.0	12.4	22.0	23.7	15.9	4.8	19.3	23.0	23.3	13.8	8.8	15.8	25.1	24.8	19.8	9.8	7.8	4.0	0.6	3.7	1.6
M.93/48 ...	24.4	25.5	26.3	22.7	20.2	1.8	—	0.9	—	1.2	9.3	12.3	18.8	12.7	4.6	16.4	20.6	19.1	32.2	24.3	28.7	23.4	22.9	16.0	18.4	46.6	62.7	67.9	50.5	45.2
M.99/48 ...	0.1	0.4	3.4	3.6	3.1	—	0.2	1.1	4.8	2.4	—	—	0.6	—	0.3	0.3	0.6	5.7	4.9	5.8	0.1	0.5	4.4	4.8	1.7	—	0.2	1.8	3.1	5.9
M.253/48 ...	1.7	1.4	2.7	0.5	0.3	2.4	10.9	20.6	0.3	0.5	3.3	0.3	1.6	0.3	—	1.3	1.3	0.9	0.7	0.8	1.9	1.2	1.5	0.8	0.2	—	—	—	0.2	—
M.409/51 ...	—	0.1	0.9	5.9	4.9	—	—	—	1.5	7.3	—	—	0.8	1.5	1.7	—	—	—	6.7	5.3	—	—	—	9.8	7.1	—	—	—	3.4	2.3
M.442/51 ...	—	4.2	18.8	24.1	24.4	—	7.0	23.8	29.2	17.6	—	1.8	26.6	55.3	56.8	—	5.0	18.4	19.1	27.7	—	5.4	20.9	17.9	17.1	—	1.0	1.8	1.3	1.0
M.13/53 ...	—	—	—	2.5	3.7	—	—	—	6.3	4.9	—	—	—	5.3	8.4	—	—	—	1.0	3.5	—	—	—	1.9	2.5	—	—	—	0.2	0.3
M.13/56 ...	—	—	—	1.1	7.9	—	—	—	3.0	4.3	—	—	—	1.9	14.6	—	—	—	0.1	2.9	—	—	—	1.3	10.8	—	—	—	0.2	1.7
M.377/56 ...	—	—	—	—	0.8	—	—	—	—	2.3	—	—	—	—	0.6	—	—	—	—	0.7	—	—	—	—	0.9	—	—	—	—	0.2
Ebène 1/37 ...	4.5	1.7	1.7	3.4	0.2	—	—	—	—	—	—	—	—	—	—	4.1	—	—	—	—	3.6	3.6	3.4	3.9	0.6	13.5	1.3	1.5	13.3	1.0
Ebène 50/47...	9.7	7.6	4.4	2.1	0.4	0.7	—	—	—	—	4.0	2.1	1.4	1.2	—	3.5	3.5	2.4	1.5	—	9.2	8.6	7.1	3.8	0.6	26.0	20.4	5.5	1.0	—
N: Co.376 ...	—	—	—	—	0.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.0	—	—	—	—	—
Other varieties	12.1	8.5	6.4	6.0	15.5	16.1	11.2	3.7	2.1	9.7	1.3	0.5	2.4	1.6	0.8	18.1	8.6	5.1	1.3	6.6	16.6	11.4	6.1	6.1	18.6	5.1	10.0	20.3	21.0	40.3
Total area arpents	12,290	13,755	13,400	11,021	12,020	531	741	1,045	804	777	2,445	2,176	2,255	2,212	2,355	2,274	3,164	2,554	2,281	2,520	4,902	5,696	5,593	4,090	4,396	2,127	1,978	1,953	1,634	1,975

Table XIII. Percentage weight of ratoons in total cane production on estates

Year	Island	West	North	East	South	Centre
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
1966	86.7	83.6	86.2	88.0	87.5	84.8
1967	89.1	87.9	87.7	89.8	89.8	88.4

NOTE: The weight of cane produced on estates in 1967 was : virgins 389,907 tons; ratoons 3,154,769

Table XIV. Average yields of virgin and ratoon canes on estates
Tons per arpent. A: 1962 - 1966 B: 1967

Crop Cycle	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
Virgin	35.9	39.7	43.0	43.6	37.7	39.6	39.4	39.9	33.3	38.3	32.3	40.2
1st Ratoon	33.0	37.7	36.5	43.0	35.0	39.5	34.9	38.3	32.6	35.1	30.7	37.8
2nd ,,	31.4	36.1	36.4	40.6	32.3	38.4	34.2	36.6	30.8	33.8	28.6	36.2
3rd ,,	29.8	35.1	34.0	39.4	31.1	36.7	32.6	36.1	30.1	33.3	27.7	34.8
4th ,,	29.3	35.1	32.4	37.0	30.4	36.9	31.3	37.2	28.9	32.6	26.8	33.8
5th ,,	29.0	33.4	31.7	36.0	29.8	36.3	31.0	33.7	28.7	31.6	26.7	31.5
6th ,,	28.7	39.7	31.2	36.1	29.1	37.0	30.2	33.8	28.6	30.8	27.5	31.8

Table XV. Evolution of 1967 crop — Production data at weekly intervals

	Island	West	North	East	South	Centre
	22nd July					
Cane crushed (1000 m. tons)	123	18	22	157	187	59
Sugar manufactured % cane	10.11	10.87	10.12	10.03	10.01	10.14
Sugar manufactured (1000 m tons)	50.2	4.5	5.1	15.9	18.7	6.0
	19th August					
Cane crushed (1000 m. tons)	1,546	118	318	369	533	208
Sugar manufactured % cane	10.52	11.16	10.35	10.49	10.41	10.75
Sugar manufactured (1000 m. tons)	162.6	13.2	32.9	38.7	55.5	22.3
	16th September					
Cane crushed (1000 m. tons)	2,624	195	594	584	891	361
Sugar manufactured % cane	10.85	11.44	10.67	10.81	10.77	11.17
Sugar manufactured (1000 m. tons)	284.9	22.3	63.3	63.1	95.9	40.3
	14th October					
Cane crushed (1000 m. tons)	3,680	270	878	793	1,229	510
Sugar manufactured % cane	11.11	11.69	11.04	10.99	11.01	11.42
Sugar manufactured (1000 m. tons)	409.0	31.6	96.7	87.2	135.3	58.2
	11th November					
Cane crushed (1000 m. tons)	4,628	344	1,137	978	1.524	645
Sugar manufactured % cane	11.22	11.86	11.11	11.09	11.13	11.52
Sugar manufactured (1000 m. tons)	519.4	40.7	126.3	108.5	169.6	74.3
	9th December					
Cane crushed (1000 m. tons)	5,475	413	1,379	1,153	1,789	741
Sugar manufactured % cane	11.10	11.76	10.97	10.92	11.02	11.44
Sugar manufactured (1000 m. tons)	607.5	48.5	151.2	125.9	197.1	84.8

	Island	West	North	East	South	Centre
	29th July					
Cane crushed (1000 m. tons)	796	64	128	219	285	100
Sugar manufactured % cane	10.21	10.93	10.15	10.19	10.08	10.30
Sugar manufactured (1000 m tons)	81.2	7.0	12.9	22.3	28.7	10.3
	26th August					
Cane crushed (1000 m. tons)	1,835	138	393	427	630	248
Sugar manufactured % cane	10.62	11.25	10.42	10.59	10.50	10.88
Sugar manufactured (1000 m. tons)	194.8	15.5	40.9	45.3	66.2	26.9
	23rd September					
Cane crushed (1000 m. tons)	2,908	215	668	640	984	401
Sugar manufactured % cane	10.92	11.49	10.78	10.86	10.83	11.25
Sugar manufactured (1000 m. tons)	317.6	24.4	71.9	69.9	106.5	44.9
	21st October					
Cane crushed (1000 m. tons)	3,957	290	955	851	1,311	550
Sugar manufactured % cane	11.17	11.73	11.08	11.04	11.06	11.47
Sugar manufactured (1000 m. tons)	442.0	34.1	105.9	94.0	145.0	63.0
	18th November					
Cane crushed (1000 m. tons)	4,838	360	1,194	1,020	1,590	674
Sugar manufactured % cane	11.22	11.87	11.09	11.09	11.13	11.53
Sugar manufactured (1000 m. tons)	542.9	42.7	132.4	113.1	177.0	77.7
	16th December					
Cane crushed (1000 m. tons)	5,641	429	1,429	1,197	1,842	744
Sugar manufactured % cane	11.06	11.69	10.90	10.86	11.00	11.43
Sugar manufactured (1000 m. tons)	623.9	50.2	155.9	130.1	202.7	85.0

	Island	West	North	East	South	Centre
	5th August					
Cane crushed (1000 m. tons)	1,085	85	201	276	382	141
Sugar manufactured % cane	10.31	11.04	10.20	10.29	10.18	10.47
Sugar manufactured (1000 m tons)	111.9	9.4	20.4	28.5	38.9	14.7
	2nd September					
Cane crushed (1000 m. tons)	2,127	159	469	485	725	289
Sugar manufactured % cane	10.71	11.35	10.32	10.69	10.60	10.99
Sugar manufactured (1000 m. tons)	227.8	18.0	49.4	51.8	76.8	31.8
	30th September					
Cane crushed (1000 m. tons)	3,187	234	742	694	1,075	442
Sugar manufactured % cane	11.00	11.58	10.89	10.92	10.92	11.52
Sugar manufactured (1000 m. tons)	350.6	27.0	80.7	75.7	117.2	50.0
	28th October					
Cane crushed (1000 m. tons)	4,231	311	1,026	907	1,398	589
Sugar manufactured % cane	11.21	11.79	11.11	11.09	11.08	11.50
Sugar manufactured (1000 m. tons)	474.2	36.7	114.0	100.6	154.9	67.8
	25th November					
Cane crushed (1000 m. tons)	5,046	376	1,252	1,061	1,653	704
Sugar manufactured % cane	11.19	11.85	11.08	11.05	11.10	11.50
Sugar manufactured (1000 m. tons)	564.6	44.5	138.6	117.2	183.5	80.8
	23rd December					
Cane crushed (1000 m. tons)	5,743	431	1,450	1,248	1,870	744
Sugar manufactured % cane	11.02	11.70	10.85	10.75	10.95	11.43
Sugar manufactured (1000 m. tons)	633.0	50.4	158.0	134.6	205.0	85.0

	Island	West	North	East	South	Centre
	12th August					
Cane crushed (1000 m. tons)	1,298	100	254	319	452	173
Sugar manufactured % cane	10.41	11.11	10.28	10.40	10.28	10.62
Sugar manufactured (1000 m tons)	135.1	11.1	26.1	33.1	46.4	18.4
	9th September					
Cane crushed (1000 m. tons)	2,327	174	518	525	792	318
Sugar manufactured % cane	10.77	11.40	10.59	10.75	10.65	11.08
Sugar manufactured (1000 m. tons)	250.8	19.9	54.9	56.5	84.3	35.2
	7th October					
Cane crushed (1000 m. tons)	3.448	252	813	747	1,157	479
Sugar manufactured % cane	11.07	11.65	10.98	10.96	10.97	11.37
Sugar manufactured (1000 m. tons)	381.7	29.3	89.2	81.8	127.0	54.4
	4th November					
Cane crushed (1000 m. tons)	4.369	323	1,063	934	1,441	608
Sugar manufactured % cane	11.22	11.82	11.12	11.09	11.11	11.50
Sugar manufactured (1000 m. tons)	490.0	38.4	118.2	103.5	160.0	69.9
	2nd December					
Cane crushed (1000 m. tons)	5.280	395	1,320	1.109	1,727	729
Sugar manufactured % cane	11.15	11.81	11.03	10.98	11.05	11.47
Sugar manufactured (1000 m. tons)	588.6	46.6	145.7	121.8	190.9	83.6
	Total crop production (preliminary figs.)					
Cane crushed (1000 m. tons)	5,814	431	1,470	1,281	1,888	744
Sugar manufactured % cane	10.98	11.70	10.84	10.71	10.92	11.43
Sugar manufactured (1000 m. tons)	638.3	50.4	159.3	137.3	206.3	85.0

Table XVI. Evolution of cane quality during 1967 sugar crop

Week Ending	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
15th July	11.91	10.24	12.74	10.95	11.40	9.85	11.46	9.79	11.82	10.12	11.66	10.11
22nd ,,	11.85	10.17	12.58	10.82	11.86	10.16	11.80	10.31	11.71	9.92	11.87	10.21
29th ,,	11.93	10.36	12.65	11.01	11.77	10.18	11.93	10.58	11.92	10.20	12.04	10.54
5th August	12.13	10.60	13.02	11.39	11.85	10.27	12.06	10.77	12.17	10.50	12.29	10.90
12th ,,	12.36	10.88	13.19	11.52	12.05	10.60	12.42	11.08	12.30	10.71	12.61	11.28
19th ,,	12.38	10.95	13.04	11.45	12.01	10.61	12.33	11.07	12.47	10.90	12.69	11.32
26th ,,	12.56	11.14	13.19	11.72	12.25	10.79	12.51	11.21	12.59	11.07	12.87	11.56
2nd September	12.72	11.28	13.13	12.00	12.38	10.95	12.65	11.32	12.72	11.18	12.97	11.71
9th ,,	12.87	11.51	13.59	11.96	12.61	11.23	12.87	11.52	12.82	11.33	13.13	11.81
16th ,,	12.93	11.53	13.48	11.79	12.74	11.40	12.71	11.36	12.97	11.50	13.19	11.95
23rd ,,	13.00	11.59	13.64	11.93	13.02	11.63	12.72	11.35	12.93	11.50	13.20	11.88
30th ,,	13.24	11.83	14.25	12.63	13.24	11.81	12.97	11.66	13.12	11.66	13.41	12.04
7th October	13.20	11.77	14.03	12.64	13.24	11.76	12.90	11.49	13.14	11.68	13.35	11.95
14th ,,	13.23	11.78	13.78	12.20	13.26	11.73	13.01	11.59	13.17	11.72	13.37	12.11
21st ,,	13.20	11.75	13.96	12.26	13.17	11.68	13.21	11.76	13.00	11.56	13.30	12.01
28th ,,	13.25	11.79	14.26	12.58	13.11	11.67	13.17	11.77	13.15	11.64	13.29	12.03
4th November	12.88	11.43	14.16	12.68	12.76	11.20	12.54	11.17	12.80	11.37	12.91	11.66
11th ,,	12.78	11.37	13.72	12.42	12.54	11.01	12.62	11.17	12.78	11.36	12.96	11.84
18th ,,	12.60	11.07	13.72	12.24	12.40	10.78	12.27	10.65	12.59	11.08	12.89	11.15
25th ,,	12.12	10.65	12.90	11.37	12.19	10.63	11.72	10.21	12.07	10.57	12.26	11.05
2nd December	11.82	10.19	12.61	11.05	11.72	10.12	11.35	9.60	11.90	10.26	12.10	10.70
9th ,,	11.34	9.71	12.15	10.67	11.20	9.57	11.11	9.43	11.14	9.80	11.93	9.29
16th ,,	10.87	9.36	12.21	10.11	10.87	9.14	10.75	9.06	10.87	9.27	—	—

NOTE: A = Sucrose % cane

B = Sugar manufactured % cane

Table XVIII. Summary of chemical control data 1967

(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	8/7	14/7	21/7	8/7	17/7	14/7	22/7	7/7	29/6	3/7	7/7	5/7	4/7	3/7	7/7	3/7	15/7	4/7	15/7	4/7	7/7	17/7	10/7	—
	To	18/12	18/12	8/12	18/12	27/12	16/12	28/12	28/12	30/12	27/12	22/12	20/12	28/12	13/12	16/12	6/12	22/12	22/12	15/12	27/12	14/12	27/11	6/12	—
	No. of crushing days	131	122	107	130	128	122	125	140	149	144	137	134	135	131	130	126	128	139	121	143	128	102	120	130
	No. of crushing hours per day	21.15	21.13	22.74	20.45	19.71	21.06	19.52	20.57	18.28	18.18	16.03	15.51	17.84	19.14	19.19	18.02	16.90	14.80	19.77	18.54	17.40	20.56	21.26	19.07
	Hours stoppage per day	0.67	0.51	0.46	0.27	1.25	1.02	1.25	0.48	0.82	0.30	0.28	0.26	1.51	0.24	0.63	0.62	0.20	0.54	0.50	1.32	0.37	0.38	0.49	0.65
	Overall time Efficiency	97 0	97.6	98.0	98.7	94.0	95.3	93.6	97.7	95.7	98.4	98.3	98.3	92.2	98.7	96.5	96.7	98.8	96.5	97.5	93.4	98.0	98.2	97.8	96.7
CANE CRUSHED (Metric Tons)	Factory	245,681	38,163	67,338	145,334	135,216	95,134	173,838	127,427	432,554	218,000	68,520	195.514	194,601	194,504	160,877	146,975	122,092	169,997	52,820	79,318	132,204	121,807	232,308	3,550,222
	Planters	184,995	185,435	125,467	66,612	167,317	162,473	108,065	157,691	244,437	101,190	66,206	32.572	42,965	64,816	64.459	24,790	1,856	15,634	78,543	111,013	81,513	70,819	105,378	2,264,246
	Total	430,676	223.598	192,805	211,946	302,533	257,607	281,903	285,118	676,991	319,190	134,726	228.086	237,566	259,320	225,336	171,765	123,948	185,631	131,363	190,331	213,717	192,626	337,686	5,814,468
	Factory % Total	57.0	17.1	34.9	68.6	44.7	36.9	61.3	44.7	63.8	68.3	50.9	85.7	81.9	75.0	71.4	85.6	98.5	91.6	40.2	41.7	61.9	63.2	68.8	61.0
	Per day	3,288	1,833	1,802	1,630	2,364	2,112	2,255	2,036	4,544	2,217	983	1.702	1,760	1.979	1.733	1,363	968	1,335	1.086	1,331	1,670	1,888	2,814	1,943
	Per hour actual crushing	155.5	86.7	79.2	79.7	119.9	100.3	115.5	101.3	248.6	121.9	61.4	111.9	98.7	102.9	90.3	75.7	57.3	90.2	54.9	71.8	96.2	91.8	132.4	101.9
VARIETIES CRUSHED (Factory)	M.134/32 per cent	2.2	2.1	2.8	—	13.1	—	9.6	—	0.6	—	—	—	—	—	—	—	4.8	8.7	1.5	—	—	—	—	1.8
	M.147/44 per cent	28.9	24.2	45.2	31.1	47.3	56.5	57.4	55.0	16.5	31.3	21.1	38.9	25.6	13.1	0.2	10.3	11.1	15.2	32.2	32.6	11.2	—	4.2	24.1
	M.31/45 per cent	1.6	0.1	5.2	6.3	1.8	4.0	3.3	7.5	8.3	12.5	7.3	2.5	6.7	4.6	0.5	4.9	6.1	5.2	7.7	4.5	5.0	—	—	4.8
	M.202/46 per cent	19.7	37.8	23.0	19.2	10.7	7.6	3.3	14.0	15.5	17.7	15.2	12.2	18.4	17.8	25.9	9.3	14.2	10.5	8.5	14.6	13.2	1.5	2.7	14.0
	M.93/48 per cent	1.0	3.9	5.1	21.9	2.3	4.8	5.7	1.6	22.9	10.0	11.2	8.4	8.9	8.8	37.4	42.3	8.4	17.2	10.1	3.5	27.1	16.4	50.2	16.5
	M.253/48 per cent	10.8	5.6	1.2	2.2	2.0	0.4	0.2	0.2	1.9	—	—	2.0	2.4	—	0.4	—	—	—	—	—	3.3	—	0.7	1.6
	M.442/51 per cent	6.5	9.4	6.3	7.4	8.6	8.9	14.4	12.7	3.7	2.9	13.9	3.8	3.4	4.6	0.6	4.1	4.4	5.7	6.0	12.3	3.9	—	0.8	5.4
	M.409/51 per cent	0.2	0.5	0.1	0.1	0.1	0.3	0.2	—	1.6	0.5	1.9	0.8	0.7	2.7	0.4	0.1	1.9	0.3	0.2	—	—	—	0.8	0.7
	Ebène 1/37 per cent	—	—	—	1.6	—	—	—	0.3	8.1	4.8	0.7	1.9	6.5	9.7	13.5	13.2	2.2	6.1	6.5	0.3	15.0	6.0	28.3	6.7
	Ebène 50/47 per cent	1.2	4.1	1.5	5.0	1.7	—	0.7	3.3	3.2	3.5	4.5	3.5	8.0	5.5	4.4	0.7	7.3	12.9	5.4	7.7	8.0	53.9	7.1	6.3
	B.3337 per cent	—	—	—	—	—	—	—	—	8.1	0.8	4.8	11.3	0.2	2.0	15.7	5 4	0.4	4.3	1.8	—	3.5	—	0.9	3.4
	B.37172 per cent	9.9	12.2	3.4	3.8	7.9	16.6	4.6	4.7	3.4	—	5.8	9.4	7.2	—	—	—	34.8	1.5	6.6	14.6	1.2	—	—	5.3
	B.34104 per cent	13.2	—	2.6	0.2	0.9	—	—	—	—	—	7.7	—	—	—	—	—	—	—	—	—	1.1	—	—	1.1
	Other varieties per cent	4.8	0.1	3.6	1.2	3.6	0.9	0.6	0.7	6.2	16.0	5.9	5.3	12.0	31.2	1.0	9.7	4 4	12.4	13.5	9.9	7.5	22.2	4.3	8.3
SUGAR PRODUCED (Metric Tons)	Raw Sugar	50,388	24,924	21,890	22,280	32,853	18,753	30,359	30,296	73,395	33,594	5.292	24,507	27,578	29,782	26,023	19,006	4,876	19,656	13,846	19,552	23,043	23,488	38,529	613,910
	White Sugar	—	—	—	—	—	8,243	—	—	—	—	8,109	—	—	—	—	—	8,051	—	—	—	—	—	—	24,403
	Total Sugar	50,388	24,924	21,890	22,280	32,853	26,996	30,359	30,296	73,395	33,594	13,401	24.507	27,578	29,782	26,023	19,006	12,927	19,656	13,846	19,552	23,043	23,488	38,529	638,313
	Tons Sugar at 96° Pol.	51,821	25,562	22,496	22,904	33,842	27,856	31,181	31,175	75,247	34,568	13,837	25.252	28.364	30.652	26,850	19.594	13,371	20.204	14,245	20,133	23,698	24,136	39,592	656,580

Table XVIII. Summary of chemical control data 1967

(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	8.6	9.0	8.8	9.5	9.2	9.5	9.3	9.4	9.2	9.5	10.1	9.3	8.6	8.7	8.7	9.0	9.6	9.4	9.5	9.9	9.3	8.2	8.8	9.1
	,, ,, ,, ,, .. @ 96° Pol.	8.3	8.8	8.6	9.4	8.9	9.3	9.0	9.2	9.0	9.2	9.7	9.0	8.4	8.5	8.4	8.8	9.3	9.2	9.2	9.5	9.0	8.0	8.5	8.9
	Sucrose per cent	13.27	12.74	12.63	11.80	12.44	12.33	12.16	12.27	12.12	12.08	11.62	12.12	13.09	12.97	12.95	12.39	12.34	12.04	12.12	12.03	12.25	13.35	12.80	12.46
	Fibre per cent	13.67	13.54	14.13	13.23	13.79	14.34	13.84	14.58	12.71	12.62	14.12	14.18	12.79	12.69	11.93	12.55	13.26	12.12	14.11	13.85	12.20	11.23	11.52	13.13
BAGASSE	Pol. per cent	1.89	1.99	1.70	1.61	1.83	1.91	1.94	1.86	1.67	1.70	2.04	1.74	2.32	2.15	2.17	2.11	2.45	1.82	1.92	1.81	2.10	1.42	1.88	1.89
	Moisture per cent	49.8	49.8	46.0	46.9	47.4	50.7	48.7	45.4	50.2	47.0	49.9	48.0	48.6	48.6	49.2	47.3	48.9	48.5	46.0	49.3	51.1	47.5	48.7	48.6
	Fibre per cent	47.54	47.50	51.67	50.96	50.12	46.50	48.53	52.07	47.50	50.58	47.24	49.89	48.34	48.70	47.85	49.96	48.24	49.03	51.38	48.20	46.20	50.62	48.83	48.85
	Weight per cent cane	28.8	28.5	27.4	26.0	27.5	30.8	28.5	28.0	26.7	24.9	29.9	28.4	26.4	26.0	24.9	25.1	27.5	24.7	27.5	28.7	26.4	22.2	23.6	26.9
1st EXPRESSED	Brix (B_1)	18.60	18.51	18.21	16.71	18.04	18.41	17.29	17.63	16.93	17.53	16.66	17.06	18.11	17.82	17.54	17.19	17.36	16.61	16.61	16.73	17.34	17.53	17.20	17.46
JUICE	Gravity Purity	88.4	88.7	89.2	89.5	89.7	88.6	89.0	88.2	89.0	88.8	87.2	89.7	90.6	89.7	90.3	91.4	89.5	89.5	88.8	89.2	90.5	90.9	89.9	89.4
	Reducing sugar/sucrose ratio	3.3	3.1	3.4	3.7	2.7	2.8	3.6	4.3	3.7	3.3	4.5	3.1	2.6	2.4	2.7	3.1	2.7	3.2	2.6	3.5	2.5	3.2	3.0	3.2
LAST EXPRESSED JUICE	Brix	1.75	3.06	2.72	1.40	3.53	3.27	2.31	2.38	3.54	2.89	2.87	2.74	3.05	3.04	3.55	2.65	3.21	2.22	2.72	2.63	2.55	1.71	2.13	2.69
	Apparent Purity	71.5	74.7	72.8	74.7	74.5	67.8	69.6	73.7	73.2	69.6	72.1	80.3	78.4	79.3	73.8	77.0	79.1	72.1	75.0	72.7	77.0	75.8	74.8	74.3
MIXED JUICE	Brix	14.63	14.34	13.79	12.73	13.32	13.53	12.77	13.67	13.42	13.04	12.44	12.12	13.56	13.52	13.08	12.99	13.74	12.63	12.54	11.73	13.08	14.23	13.81	13.33
	Gravity Purity	87.3	86.6	87.0	86.6	87.0	86.0	87.8	86.4	87.8	86.6	85.7	88.1	88.7	88.2	88.9	89.1	87.3	87.7	86.8	86.7	88.5	89.2	88.5	87.5
	Reducing sugar/sucrose ratio	3.8	3.8	4.2	4.5	3.4	3.6	4.4	5.2	4.6	3.9	5.0	3.6	3.1	3.2	3.1	3.7	3.6	4.0	3.4	4.1	3.1	3.5	3.3	3.9
	Gty. Pty. drop from 1st expressed juice	1.1	2.1	2.2	2.9	2.7	2.6	1.1	1.8	1.2	2.2	1.5	1.6	1.9	1.5	1.4	2.3	2.3	1.8	2.0	2.5	2.0	1.7	1.4	1.9
ABSOLUTE JUICE	Brix (B_A)	17.76	17.13	17.02	15.80	16.72	16.97	16.26	16.75	15.95	16.09	15.92	16.08	17.03	16.91	16.68	16.01	16.39	15.75	16.36	16.23	15.87	16.94	16.45	16.49
	B_A/B_1	0.955	0.925	0.935	0.946	0.927	0.922	0.941	0.950	0.942	0.920	0.960	0.942	0.940	0.949	0.950	0.931	0.944	0.948	0.985	0.970	0.915	0.966	0.956	0.944
	Gravity Purity	86.5	86.1	86.4	86.1	86.4	84.9	86.8	85.8	87.1	86.0	84.9	87.8	88.1	87.8	88.1	88.5	86.8	87.0	86.2	86.0	87.9	88.8	87.9	87.0
CLARIFIED JUICE	Brix	14.83	14.73	13.35	12.63	13.30	12.89	12.12	12.97	13.87	12.97	11.94	11.84	13.61	13.46	12.52	13.01	13.97	12.51	12.64	11.71	13.09	14.16	13.96	13.14
	Gravity Purity	—	87.0	87.6	87.3	87.3	86.2	88.3	86.3	87.6	86.8	85.5	89.5	88.8	88.4	—	90.2	87.5	—	87.5	86.8	89.1	89.7	89.1	87.8
	Reducing Sugar/sucrose ratio	3.9	3.5	4.4	4.5	3.5	3.5	—	5.1	4.2	3.8	5.0	3.4	3.1	3.2	3.1	3.5	3.4	—	3.3	3.8	2.9	3.5	3.2	3.7

NOTE: All Brix values are Refractometric

Table XVIII. Summary of chemical control data 1967

(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	Pol. per cent	0.98	1.24	1.71	1.94	0.86	1.09	1.11	1.60	0.41	1.45	0.43	0.68	1.95	1.96	2.71	2.34	2.47	1.80	8.01	6.40	7.20	2.80	2.27	1.73
	Weight per cent cane	3.2	3.1	4.0	3.3	3.8	4.4	2.8	2.8	3.0	3.1	3.2	4.6	3.7	1.9	2.0	2.9	2.3	2.2	1.8	2.2	1.8	2.4	4.6	3.1
SYRUP	Brix*	58.6	57.9	57.8	57.4	56.0	63.2	59.2	56.3	59.3	55.7	56.6	63.8	58.8	58.4	67.8	63.8	56.0	61.2	54.4	54.2	52.7	58.1	65.6	58.8
	Gravity Purity	—	85.9	87.1	87.2	87.3	86.1	—	86.7	87.0	86.7	85.8	88.3	89.1	88.3	—	89.8	87.1	—	87.2	86.6	88.3	89.7	88.8	87.5
	Reducing sugar/sucrose ratio	4.1	3.7	4.4	4.5	3.9	4.2	—	5.1	4.4	3.9	5.1	3.7	3.1	3.2	3.1	3.3	—	—	3.1	4.0	3.2	3.6	3.3	3.3
pH VALUES	Limed juice	8.3	8.2	8.4	7.9	7.8	7.8	—	7.8	8.4	—	8.1	8.2	—	7.6	8.2	7.9	8.1	—	—	8.1	8.4	8.1	7.7	8.1
	Clarified juice	7.3	7.1	7.1	7.1	7.1	7.1	7.2	6.9	7.3	7.2	7.0	7.3	7.3	7.3	7.4	7.1	6.8	7.3	6.9	7.1	7.3	7.4	7.1	7.2
	Filter Press juice	—	—	9.0	—	6.9	8.0	6.9	7.0	9.2	7.7	—	8.6	7.0	7.0	—	—	—	6.6	—	—	6.6	7.7	8.0	7.6
	Syrup	—	6.9	7.0	6.5	6.5	6.7	—	6.5	6.9	6.9	6.9	7.1	6.8	6.8	—	—	5.9	6.8	—	7.1	7.1	7.1	7.0	6.8
FINAL MOLASSES	Brix**	89.7	89.2	90.2	86.5	90.2	89.2	89.5	85.5	88.2	89.1	85.4	88.7	87.3	89.8	89.2	86.5	86.4	89.5	88.1	86.3	83.5	86.6	87.5	88.1
	Sucrose per cent	33.84	34.38	31.55	29.98	34.52	34.51	34.31	31.30	34.30	34.06	30.57	32.78	31.66	33.31	33.89	32.90	35.67	36.10	33.90	33.44	33.49	33.22	34.55	33.51
	Reducing sugar per cent	17.35	12.44	18.52	16.40	14.43	13.58	13.35	18.72	16.60	15.60	17.49	12.63	14.29	13.10	15.39	16.50	12.02	12.64	11.70	13.81	12.46	15.20	14.26	15.01
	Total sugars per cent	51.19	46.82	50.07	46.38	48.95	48.09	47.56	50.02	50.90	49.66	48.06	45.41	45.95	46.41	49.28	49.40	47.69	48.74	45.60	47.25	45.95	48.42	48.81	48.52
	Gravity Purity	37.7	38.5	35.0	34.6	38.3	38.7	38.2	36.6	38.9	38.2	35.8	37.0	36.3	37.1	38.0	38.0	41.3	40.3	38.5	38.7	40.1	38.4	39.5	38.0
	Reducing sugar/sucrose ratio	51.3	36.2	58.7	54.7	41.8	39.3	39.0	59.8	48.4	45.8	57.2	38.5	45.1	39.3	45.4	50.1	33.7	35.0	34.5	41.3	37.2	45.7	41.3	44.8
	Weight per cent cane at 85° Brix	2.83	3.37	2.81	2.76	2.89	3.42	2.86	3.02	2.73	2.90	2.75	2.64	2.60	2.62	2.27	2.36	2.73	2.59	2.72	3.00	2.26	2.50	2.46	2.76
SUGAR MADE	White sugar recovered per cent cane	—	—	—	—	—	3.20	—	—	—	—	6.02	—	—	—	—	—	6.50	—	—	—	—	—	—	0.42
	Raw ,, ,, ,, ,, ,,	11.69	11.15	11.35	10.51	10.86	7.28	10.77	10.63	10.84	10.52	3.93	10.74	11.61	11.48	11.55	11.07	3.93	10.59	10.54	10.27	10.78	12.19	11.41	10.56
	Total ,, ,, ,, ,, ,,	11.69	11.15	11.35	10.51	10.86	10.48	10.77	10.63	10.84	10.52	9.95	10.74	11.61	11.48	11.55	11.07	10.43	10.59	10.54	10.27	10.78	12.19	11.41	10.98
	Average Pol. of sugars	98.73	98.46	98.66	98.69	98.89	99.06	98.60	98.78	98.42	98.78	99.12	98.92	98.74	98.80	99.04	98.97	99.30	98.68	98.77	98.85	98.73	98.65	98.65	98.75
	Total sucrose recovered per cent cane	11.55	10.98	11.20	10.37	10.74	10.38	10.62	10.50	10.67	10.40	9.86	10.63	11.46	11.35	11.44	10.95	10.36	10.45	10.41	10.15	10.65	12.03	11.26	10.84
	Moisture content of raw sugar per cent	0.33	0.35	0.32	0.43	0.21	0.41	0.32	0.30	0.34	0.34	0.43	0.31	0.34	0.30	0.27	0.30	0.30	0.38	0.34	0.35	0.40	0.63	0.37	0.35
	Dilution indicator	34.4	28.6	30.9	48.4	37.2	44.9	29.1	30.0	27.4	39.3	37.1	40.4	36.9	33.0	39.1	34.1	27.4	40.4	38.5	44.2	38.4	46.7	38.0	38.9

* *Refractometric Brix 1 : 5 w/w*

** *,, ,, 1 : 6 w/w*

Table XVIII. Summary of chemical control data 1967

(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	80.9	90.0	86.4	84.5	91.0	81.3	80.8	84.9	83.8	85.2	92.5	92.1	88.3	95.5	86.5	84.5	—	84.9	86.1	88.4	84.0	84.3	85.7	86.4
A-MASSECUITE	Brix	89.9	91.7	90.8	91.8	91.0	90.8	92.4	90.5	92.7	92.2	90.1	91.0	91.9	92.0	92.4	91.3	89.3	91.1	91.8	92.3	90.5	91.1	90.5	91.4
	Apparent Purity	86.2	83.6	85.5	83.7	85.3	84.2	80.1	82.3	81.6	87.0	86.2	89.4	88.8	83.9	90.4	85.5	87.5	88.9	86.8	86.0	85.8	89.2	85.6	85.2
	„ „ of A-Molasses	71.9	62.2	66.3	58.8	64.9	64.4	59.4	57.9	58.8	66.0	66.8	68.9	66.8	65.4	70.4	64.8	74.7	73.3	66.6	67.8	70.4	71.5	70.7	65.8
	Drop in Purity	14.3	21.4	19.2	24.9	20.4	19.8	20.7	24.4	22.8	21.0	19.4	20.5	22.0	18.5	20.0	20.7	12.8	15.6	20.2	18.2	15.4	17.7	14.9	19.4
	Crystal per cent Brix in massecuite	50.9	56.6	57.0	60.4	58.1	55.6	51.0	58.0	55.3	61.8	58.4	66.0	66.3	53.5	67.6	58.8	50.7	58.4	60.4	56.5	52.0	62.1	50.9	56.7
	Cubic feet per ton Brix in Mixed Juice	30.7	35.1	28.9	33.0	25.8	35.8	32.6	32.0	31.0	31.2	28.6	26.7	26.2	34.6	23.8	29.2	35.9	38.7	25.8	36.6	25.9	27.6	39.2	31.2
	A-Massecuite per cent total massecuite	56.1	74.1	59.0	79.1	60.2	61.5	58.5	63.8	70.7	57.6	45.6	54.4	54.0	61.5	46.3	59.6	54.0	60.0	51.4	62.0	60.2	58.7	69.1	60.8
B-MASSECUITE	Brix	90.9	—	90.3	—	92.0	92.8	92.0	91.9	93.1	92.5	90.6	92.4	92.9	93.0	93.5	92.3	90.3	92.2	91.4	93.4	91.9	91.4	92.2	92.1
	Apparent Purity	75.1	—	73.4	—	73.4	73.4	72.2	73.2	70.1	74.2	75.3	78.5	75.1	75.5	81.4	74.1	80.2	79.1	73.8	74.5	77.7	79.1	75.3	74.2
	„ „ of B-Molasses	56.3	—	52.0	—	52.0	53.8	52.2	52.2	53.9	50.3	60.5	55.4	49.3	58.4	52.4	50.5	64.6	57.3	52.8	54.3	56.1	55.5	58.2	54.0
	Drop in Purity	18.8	—	21.4	—	21.4	19.6	20.0	21.0	16.2	23.9	14.8	23.1	25.8	17.1	29.0	23.6	15.6	21.8	21.0	20.2	21.6	23.6	17.1	20.2
	Crystal per cent Brix in massecuite	43.0	—	44.6	—	44.6	42.4	41.8	43.9	35.1	48.1	37.5	51.7	50.9	41.1	60.9	47.7	44.2	51.1	44.4	44.2	49.2	53.0	40.9	43.9
	Cubic feet per ton Brix in Mixed Juice	15.6	—	11.9	—	8.4	11.8	13.8	8.8	5.1	12.8	20.5	11.4	13.9	12.4	18.6	8.4	14.9	15.9	14.3	13.0	10.2	10.9	9.8	10.8
	B-Massecuite per cent total Massecuite	28.4	—	24.3	—	19.5	20.3	24.8	18.7	11.6	23.5	32.7	23.3	28.5	22.0	36.1	17.2	22.5	24.6	28.5	21.9	23.8	23.2	17.3	21.1
	Kg. Sugar per cubic foot of A & B Massecuite	17.4	—	19.9	—	23.1	16.1	17.6	19.1	—	17.8	15.8	21.4	22.3	17.4	19.5	22.1	15.4	14.7	19.6	15.6	22.6	21.7	17.0	19 1
C-MASSECUITE	Brix	93.0	92.9	93.0	94.0	95.3	95.4	93.7	93.3	95.4	94.5	93.9	94.3	94.4	96.8	93.3	92.8	93.1	95.1	92.8	94.7	93.7	93.3	97.9	94.3
	Apparent Purity	60.2	62.2	57.9	58.9	59.8	60.2	57.6	60.1	58.2	57.5	61.7	62.1	60.7	63.3	63.0	60.7	67.7	62.8	61.3	59.4	60.2	62.8	62.3	60.7
	„ „ of final Molasses	34.0	36.1	29.3	30.5	32.0	37.1	37.8	35.5	33.1	33.6	32.2	33.7	33.3	33.2	34.4	34.1	38.2	37.1	34.6	35.7	38.2	33.6	36.3	34.6
	Drop in Purity	26.2	26.1	28.6	28.4	27.8	23.1	19.8	24.6	25.1	23.9	29.5	28.4	27.4	30.1	28.6	22.7	29.5	25.7	26.7	23.7	22.0	29.2	26.0	26.1
	Crystal per cent Brix in massecuite	39.7	40.9	40.5	43.9	40.9	36.7	31.8	38.1	37.5	36.0	43.5	42.9	41.1	45.0	43.6	36.6	47.7	40.9	40.8	36.9	35.6	44.0	40.8	39.9
	Cubic feet per ton Brix in Mixed Juice	8.5	12.3	8.2	8.7	8.7	10.6	9.5	8.6	7.8	10.2	13.6	11.0	8.5	9.2	9.2	11.4	15.6	10.0	10.2	9.5	6.9	8.5	7.7	9.3
	C-Massecuite per cent total massecuite	15.5	25.9	16.7	20.9	20.3	18.2	16.8	17.5	17.7	18.9	21.7	22.4	17.5	16.5	17.6	23.2	23.5	15.4	20.1	16.1	16.0	18.2	13.6	18.1
TOTAL	Cubic feet per ton Brix in Mixed Juice	54.7	47.4	48.9	41.7	42.9	58.2	56.5	49.5	43.8	54.2	62.7	49.2	48.0	56.7	51.6	49.0	66.4	64.5	50.3	59.1	43.0	47.0	56.7	51.3
MASSECUITE	„ „ „ „ sugar made	68.2	59.8	60.2	52.2	54.3	75.8	68.3	63.3	53.8	69.3	80.9	60.4	58.1	68.7	62.4	58.9	85.2	80.6	63.8	76.3	52.7	56.4	69.3	63.9

Table XVIII. Summary of chemical control data 1967

(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	28.4	26.5	28.7	29.2	30.6	31.7	32.0	27.5	25.9	28.1	33.1	37.3	30.1	29.9	31.6	27.6	24.8	29.4	33.8	41.9	27.5	25.0	24.7	29.3
	,, ,, % fibre	208	196	203	221	222	221	231	188	204	223	235	214	236	236	265	220	187	243	239	302	225	222	214	223
	Extraction ratio	30.0	33.0	26.1	26.8	29.3	33.4	32.8	28.8	29.1	27.8	37.5	28.8	36.5	33.9	35.0	34.0	41.0	30.7	30.9	31.0	37.2	21.0	30.1	31.2
	Mill extraction	95.9	95.5	96.3	96.5	96.0	95.2	95.5	95.8	96.3	96.5	94.7	95.9	95.3	95.7	95.8	95.7	94.6	96.3	95.6	95.7	95.5	97.6	96.5	95.9
	Reduced mill extraction	96.3	95.9	96.8	96.7	96.4	95.9	96.0	96.5	96.4	96.5	95.4	96.5	95.5	95.8	95.6	95.8	94.9	96.2	96.2	96.2	95.3	97.3	96.2	96.1
SUCROSE LOSSES	Sucrose lost in bagasse % cane	0.54	0.57	0.47	0.42	0.50	0.59	0.55	0.52	0.45	0.42	0.61	0.49	0.61	0.56	0.54	0.53	0.67	0.45	0.53	0.52	0.56	0.31	0.44	0.51
	,, ,, in filter cake % cane	0.03	0.04	0.07	0.06	0.03	0.05	0.03	0.04	0.01	0.05	0.01	0.03	0.07	0.04	0.05	0.07	0.06	0.04	0.14	0.14	0.13	0.07	0.10	0.05
	,, ,, in molasses % cane	0.91	1.10	0.83	0.81	0.94	1.12	0.93	0.94	0.90	0.94	0.84	0.83	0.80	0.83	0.73	0.76	0.96	0.89	0.89	0.99	0.78	0.82	0.83	0.89
	Undetermined losses % cane	0.23	0.06	0.06	0.14	0.23	0.19	0.03	0.27	0.09	0.27	0.29	0.14	0.15	0.19	0.19	0.08	0.30	0.21	0.15	0.22	0.13	0.13	0.17	0.17
	Industrial losses % cane	1.17	1.20	0.96	1.01	1.21	1.36	0.99	1.25	1.00	1.26	1.15	1.00	1.02	1.06	0.97	0.91	1.31	1.14	1.18	1.35	1.04	1.02	1.10	1.11
	Total losses % cane	1.71	1.77	1.43	1.43	1.71	1.95	1.54	1.77	1.45	1.68	1.76	1.49	1.63	1.62	1.51	1.44	1.98	1.59	1.71	1.87	1.60	1.33	1.54	1.62
SUCROSE BALANCE	Sucrose in bagasse % sucrose in cane	4.09	4.45	3.69	3.55	4.04	4.79	4.54	4.24	3.71	3.51	5.26	4.09	4.67	4.32	4.17	4.28	5.43	3.72	4.37	4.33	4.50	2.36	3.47	4.07
	,, ,, filter cake % sucrose in cane	0.23	0.30	0.54	0.53	0.26	0.39	0.26	0.33	0.08	0.38	0.12	0.26	0.55	0.31	0.39	0.56	0.46	0.33	1.19	1.19	1.10	0.51	0.81	0.43
	,, ,, molasses % sucrose in cane	6.84	8.67	6.62	6.88	7.56	9.12	7.65	7.66	7.43	7.82	7.21	6.84	6.09	6.40	5.64	6.13	7.78	7.37	7.37	8.20	6.40	6.11	6.46	7.15
	Undetermined losses % sucrose in cane	1.77	0.44	0.44	1.15	1.86	1.52	0.23	2.20	0.74	2.23	2.53	1.12	1.12	1.47	1.46	0.65	2.40	1.82	1.20	1.86	1.10	0.94	1.31	1.33
	Industrial losses % sucrose in cane	8.84	9.41	7.60	8.56	9.68	11.03	8.14	10.19	8.25	10.43	9.86	8.22	7.76	8.18	7.49	7.34	10.65	9.52	9.76	11.25	8.60	7.56	8.58	8.91
	Total losses % sucrose in cane	12.93	13.86	11.29	12.11	13.72	15.82	12.68	14.43	11.96	13.94	15.12	12.31	12.43	12.50	11.66	11.62	16.08	13.24	14.13	15.58	13.10	9.92	12.05	12.98
RECOVERIES	Boiling house recovery	90.8	90.2	92.1	91.1	89.9	88.5	91.5	89.4	91.4	89.2	89.6	91.4	91.9	91.5	92.2	92.3	88.8	90.1	89.8	88.2	91.0	92.3	91.1	90.7
	Reduced boiling house recovery (Pty. M.J. 85°)	88.8	88.9	90.7	89.9	88.1	87.5	89.2	88.0	89.1	87.6	89.1	88.8	88.7	88.7	89.0	88.9	86.4	87.4	88.1	86.4	87.5	88.7	88.0	88.5
	Overall recovery	87.1	86.2	88.7	87.9	86.3	84.3	87.3	85.6	88.0	86.1	84.9	87.7	87.6	87.5	88.3	88.4	83.9	86.8	85.8	84.4	86.9	90.1	88.0	87.0
	Reduced overall recovery (Pty. M.J. 85°, F % C 12.5)	85.5	85.2	87.8	86.9	84.9	84.0	85.6	84.9	85.9	84.6	85.0	85.6	84.7	85.0	85.0	85.1	82.0	84.0	84.8	83.1	83.4	86.4	84.6	85.0
	Boiling house efficiency	98.8	99.3	99.4	98.7	98.5	98.1	99.4	97.6	99.6	98.1	98.4	98.7	98.5	98.6	99.2	99.1	98.6	98.9	98.5	97.1	99.0	99.6	98.9	98.9

Table XIX. Production and utilization of molasses, 1949 - 1967

Year	Product-ion M. tons	Exports M. tons	Used for product-ion of alcohol M. tons	Other domestic uses M. tons	Available as fertilizer M. tons	N.P.K. equivalent in molasses available as fertilizer M. tons		
						N	P_2O_5	K_2O
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	483	31,141	162	78	1,588
1964	113,781	96,830	7,172	446	9,333	46	23	476
1965	151,152	105,360	7,824	454	37,514	195	94	1,913
1966	133,262	112,290	6,653	484	13,835	72	36	706
1967	154,612	111,930	7,717	542	34,423	179	86	1,775

Table XX. Importation of inorganic fertilizers, in metric tons, 1952 - 1967

YEAR	N	P_2O_5	K_2O
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
1966	8,070	4,596	7,515
1967	9,249	5,046	9,073

Table XXI. Sales of herbicides, 1965 - 1967

HERBICIDES	1965			1966			1967		
	Quantity		acid equivalent lb	Quantity		acid equivalent lb	Quantity		acid equivalent lb
	Imperial gallons	Kg.		Imperial gallons	Kg.		Imperial gallons	Kg.	
MCPA — metallic salt	9,072		36,288	9,402		37,608	8,978		35,912
2,4-D amines	23,172		116,915	15,909		83,671	15,760	2,255	82,632
2,4-D esters	7,335		37,245	6,380		38,155	12,017		61,528
2,4-D and 2,4-5T esters	6,734		33,612	6,679		29,795	4,172		21,838
Pentachlorophenol	100		300	261		783	149		447
Sodium chlorate		272,823			261,774			270,055	
Sodium trichloroacetate (TCA)		309,746			314,625			318,819	
Sodium 2,2-dichloropro-prionate (Dalapon, Basfa-pon, Unipon)		2,261			931			608	
Substituted ureas (Herban, DCMU, Linuron)		38,922			53,611			50,200	
Substituted triazines (Simazine, Atrazine)		42,643			30,495			37,544	
Unclassified	450	544		1,359	874		1,143		2,537

Table XXII. Importation of major herbicides, 1957 - 1967

YEAR	Inorganic chemicals		Hormone type		Aliphatic acids derivatives		Substituted phenols	Substituted ureas	Substituted triazines
	Sodium chlorate Kg.	Sodium arsenite Kg.	2,4-D; 2,4-5T; MCPA		TCA Kg.	Dalapon Kg.	PCP Imp. gall.	Linuron D.C.M.U Herban Kg.	Simazine Atrazine Kg.
			Imp. gall.	Kg.					
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	29,210
1964	398,053	—	48,249	—	389,449	6,670	595	35,312	37,594
1965	272,823	—	45,330	—	309,746	2,261	100	38,922	42,643
1966	261,774	—	38,370	—	314,625	931	261	53,611	30,495
1967	270,055	5,186	36,755	2,255	318,819	608	149	50,200	37,544

Table XXIII. List of combinations sown in 1967

(i). Early nobilisations of *S. spontaneum*, *S. robustum* **and** *S. sinense*

Reference Cross No.	PARENTAL COMBINATIONS Female		Male	No. of germinated crosses	No. of Pots*	No. of non-germinated crosses
3003	B.5650	x	S. *spont.* Tabongo	3	15	0
3001	Fotiogo	x	Mol.5904	1	3	1
3315	M.134/32	x	57 N.G. 208	2	50	0
3020	M.409/51	x	Mol. 5843	1	50	1
3059	M.409/51	x	51 N.G. 140	3	50	0
3088	P.R. 1000	x	51 N.G. 140	4	50	0
3523	Uba	x	M.99/34	2	6	2
Total	7			16	224	4

* *All seedlings potted singly*

(ii). Further nobilisations of *Saccharum robustum*

Reference Cross No.	PARENTAL COMBINATIONS Female		Male	No. of germinated crosses	No. of Pots*	No. of non-germinated crosses
3026	C.P.34-120	x	58 B.38	3	56	0
3402	Ebène 50/47	x	M.1173/63	2	4	0
3217	M.33/19	x	M.679/63	1	80	1
3359	M.134/32	x	M.614/63	2	20	2
3389	M.112/34	x	M.1160/63	4	25	1
3053	M.409/51	x	M.679/63	6	554	1
3396	M.409/51	x	M.1295/63	1	60	0
3168	N : Co.376	x	53 B.45	2	42	1
3030	N : Co.376	x	58 B.38	2	18	2
Total	9			23	859	8

* *All seedlings potted singly except cross No. 3053 which has been potted 3 sdlg/pot*

Table XXIII. List of combinations sown in 1967

(iii) (a) Combinations having produced more than 300 seedlings

Reference Cross No.	PARENTAL COMBINATIONS Female		Male	No. of germinated crosses	No. of Pots*	No. of non-germinated crosses
3449	B.3337	x	M.147/44	9	519	0
2543	Co. 281	x	C.B. 41-35	3	286	0
3196	Ebène 50/47	x	Vesta	6	251	0
3148	F.149	x	M.147/44	4	473	0
3257	H.32-8560	x	M.147/44	5	597	1
3133	I.216	x	M.147/44	5	414	0
3129	I.216	x	M.69/56	3	1581	0
3153	I.216	x	R.47/2777	6	448	0
2389	M.112/34	x	M.109/26	4	1011	2
3046	P.R.1000	x	M.69/56	6	1287	0
1523	P.R.1000	x	M.241/59	3	380	0
2206	S.17	x	M.147/44	10	841	1
3079	S.17	x	M.69/56	3	412	1
3083	S.17	x	R.47/2777	3	587	2
Total		14		70	9087	7

* *All seedlings potted singly except cross Nos. 3449, 2543, 3196 & 3133 which have been potted 3 seedlings/plot*

Table XXIII. List of combinations sown in 1967

(iii) (b) Combinations having produced between 16 & 300 seedlings

Reference Cross No.	PARENTAL COMBINATIONS Female		Male	No. of germinated crosses	No. of Pots*	No. of non-germinated crosses
3461	B.3337	x	C.B. 41-35	3	24	1
2424	B.4362	x	M.202/46	4	79	1
2238	B.5650	x	M.69/56	2	27	4
3141	C.P. 53-18	x	M.147/44	2	66	1
3172	C.P. 53-18	x	M.55/55	3	30	1
3202	Ebène 50/47	x	C.B.45-6	6	190	0
3385	,, 50/47	x	M.55/55	3	54	0
3208	,, 50/47	x	P.T.43-52	5	18	0
3331	,, 50/47	x	R.47/4066	4	294	0
3159	F.149	x	R.47/2777	5	190	0
2527	H.50-7209	x	M.147/44	3	74	0
2535	H.50-7209	x	M.69/56	4	29	1
3383	H.50-7209	x	P.T.43-52	4	27	0
2338	M.134/32	x	B.3337	7	132	5
2506	M.134/32	x	M.109/26	3	141	2
3134	M.134/32	x	Trojan	5	157	0
2385	M.112/34	x	D.74	4	173	1
3371	M.112/34	x	R.47/4066	4	94	5
2419	M.409/51	x	D.109	3	47	1
2453	M.107/55	x	B.3337	4	279	1
2539	M.107/55	x	B.34104	5	74	1
2264	M.435/59	x	M.147/44	3	40	0
2411	M.Q.39/832	x	Re.366	8	230	0
490	N : Co.376	x	B.34104	3	190	1
3225	N : Co.376	x	B.42231	5	190	0
3182	N : Co.376	x	Co.1007	4	50	0
11	N : Co.376	x	C.P.48-103	3	16	3
699	N : Co.376	x	M.202/46	3	26	0
737	N : Co.376	x	Q.58	6	45	2
3231	N : Co.376	x	Trojan	5	160	1
3104	P.R.1000	x	B.49119	4	18	2
3075	Q.47	x	P.T.43-52	3	37	0
3070	Q.47	x	R.47/2777	3	30	2
2314	Q.56	x	M.147/44	5	29	0
2201	S.17	x	M.9934	5	30	2
Total	35			143	3290	38

* *All seedlings potted singly*

Table XXIII. List of combinations sown in 1967

(iii) (c). Combinations having produced less than 16 seedlings

Reference Cross No.	PARENTAL COMBINATIONS Female		Male	No. of germinated crosses	No. of Pots*	No. of non-germinated crosses
3444	B.3337	x	M.69/56	3	14	2
3006	B.5650	x	N : Co.310	2	3	4
2354	B.37161	x	Senneville	2	3	1
2408	Co.281	x	D.109	3	5	0
3176	C.P.53-18	x	M.196/31	2	2	1
3407	Ebène 1/37	x	M.305/51	2	2	3
94	,, 1/44	x	B.34104	1	1	5
1190	,, 50/47	x	B.34104	2	5	3
3213	,, 50/47	x	M.292/55	1	2	5
2060	M.23/16	x	B.34104	1	1	2
2403	M.23/16	x	M.144/36	1	1	3
2031	M.33/19	x	B.34104	2	5	2
2465	M.134/32	x	M.27/16	3	6	2
3144	M.134/32	x	Q.50	1	1	3
2035	M.134/32	x	Senneville	2	7	2
3429	M.112/34	x	F.150	1	1	3
2491	M.112/34	x	M.35/17	2	12	1
3529	M.241/40	x	B.34104	2	6	2
3012	M.409/51	x	C.P.44-101	2	4	2
3412	M.409/51	x	M.305/51	3	4	1
2301	M.409/51	x	M.Q.27/1124	2	7	1
3219	M.13/54	x	B.42231	3	8	3
3339	M.Q.39/832	x	C.B.45-6	1	10	4
687	N : Co.376	x	Ebène 50/47	6	13	2
3164	N : Co.376	x	F.150	2	6	1
3417	N : Co.376	x	M.305/51	1	1	3
3038	N : Co.376	x	Sabre	2	3	2
907	P.O.J.2364	x	Ebène 50/47	2	3	2
3186	Q.70	x	M.202/46	1	10	1
Total	29			58	146	66

* *All seedlings potted singly*

Table XXIV. List of Approved Cane Varieties, 1968

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.409/51
M.442/51
M.13/53
M.13/56
M.377/56
Ebène 1/37
Ebène 50/47
*B.H.10/12
**B.3337
**B.34104
B.37161
B.37172
N : Co. 376

---

* *To be uprooted before 31st December, 1969*

** *To be uprooted before 31st December, 1970*

*** *To be uprooted before 31st December, 1973*