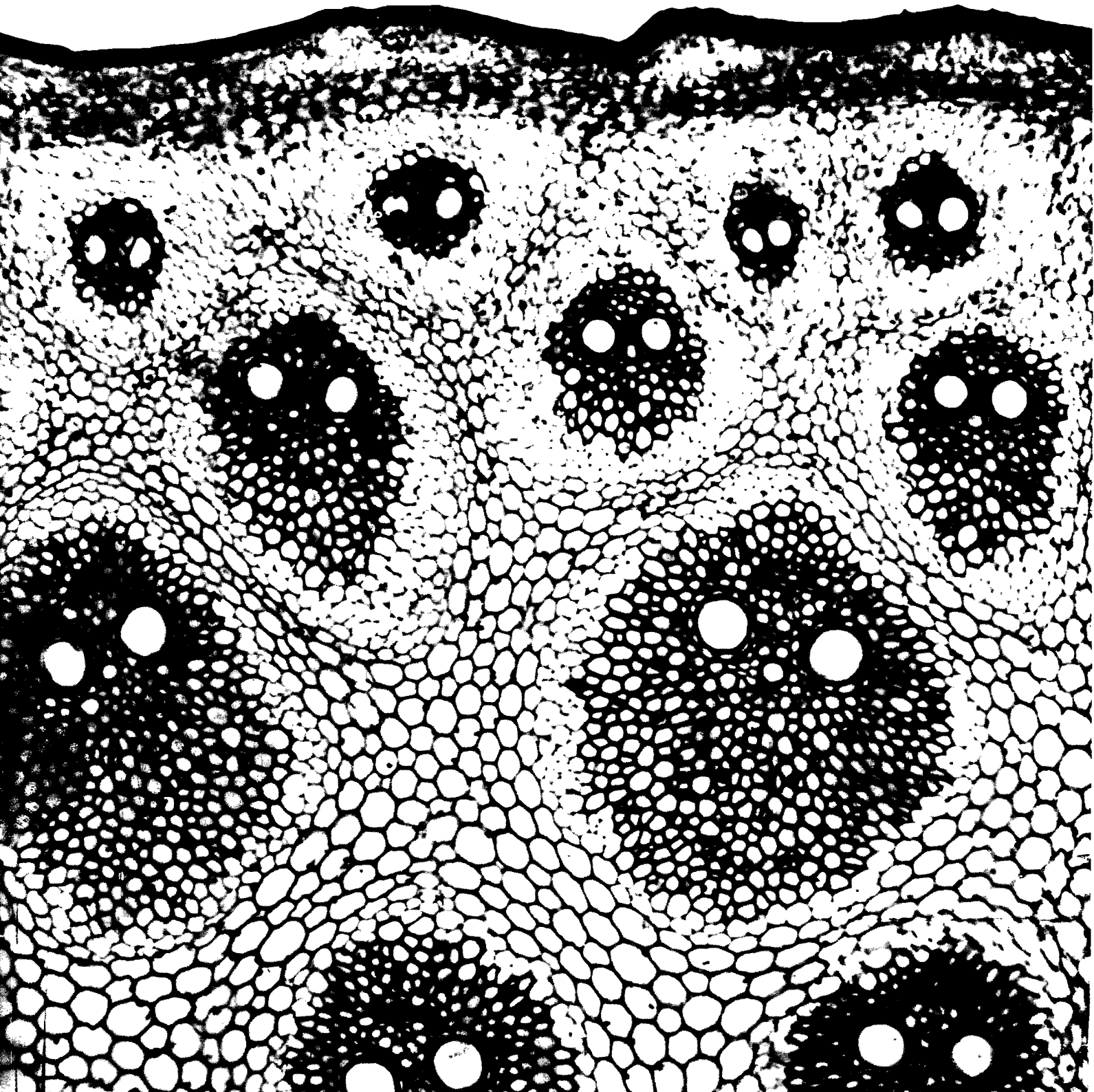
MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE

ANNUAL REPORT 1964



MAURITIUS SUGAR INDUSTRY

RESEARCH INSTITUTE

ANNUAL REPORT 1964

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1965

CORRIGENDA

MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE

Annual Report 1964

p. 17, 2nd column, line 15, read *parents* instead of *parts.*

p. 19, 1st column, line 4, read *1965* instead of *1964.*

p. 53, 2nd column, line 25, read *tri-phenyl tetrazolium chloride.....0.005%* instead of *0.05 %.*

p. 75, 1st column, line 3, read *Uracyl* instead of *urea.*

p. 87, Table 28, lines 5 and 6, 4th column read 0.4 / 4.0 } normal

p. 88, Table 31, line 4, delete *normal* after *1958.*

Table 32, lines 3 and 4, 1st column read 1957 / 1958 } normal

p. 93, Table 40, 1st line, 4th column, read *E* instead of *C.*
6th line, 6th column, read *99.2* instead of *9.92.*

p. 99, Table 44, 1st line, and 1st column, 4th line read *area cultivated* instead of *area harvested.*

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The use of trade names in this report is not an endorsement of products named.

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Asst. Chemists	Y. Wong You Chong, B.Sc., B. Agr. (Q.U.B.), appointed 1.1.64.
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	C. Cavalot
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	R. Ng. Ying Sheung, Dip. Agr. (Maur.)
	G. Mc Intyre, Dip. Agr. (Maur.), appointed 1.5.64.
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Laboratory Asst.	M. A. Rajabalee
Geneticist	E. F. George, B.Sc., (Lond.), A.R.C.S., resigned 1.8.64.
Plant Pathologist	R. Antoine, B.Sc., (Lond.), A.R.C.S., Dip. Agr. Sc. (Cantab), Dip. Agr. (Maur.), *in charge Plant Breeding & Pathology Divisions* as from 1.8.64.
Plant Breeder	W. de Groot, M.Sc. (Wag. Holland)
Senior Asst. Plant Breeder ...	L. P. Noël, Dip. Agr. (Maur.), resigned 30.4.64.
	P. Hermelin, Dip. Agr. (Maur.), as from 1.5.64.
Asst. Plant Pathologist ...	C. Ricaud, B.Sc., (Lond.), D.I.C.
Asst. Plant Breeders	J. A. Lalouette, Dip. Agr. (Maur.)
	M. Pérombelon M.Sc. (Aberdeen), Dip. Agr. (Maur.), appointed 1.9.64.
Sugar Technologist	J. D. de R. de Saint Antoine, B.S. (L.S.U.), Dip. Agr. (Maur.)
Associate Chemist (S.T.) ...	E. C. Vignes, M.Sc., (Lond.). A.R.I.C., Dip. Agr. (Maur.)
Associate Sugar Technologist ...	H. F. Wiehe, B.S. (L.S.U.), Dip. Agr. (Maur.), resigned 1.4.64.
	E. Piat, B.Sc., (Glasgow), Dip. Agr. (Maur.), appointed 1.8.64.
Asst. Sugar Technologists ...	R. H. de Froberville, Dip. Agr. (Maur.)
	F. Le Guen, B.Sc. (Lond.)., D.N.C.L.
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	J. Desjardins, appointed 1.4.64.
Clerks	Mrs. A. d'Espagnac, resigned 31.7.64.
	Mrs. A. Baissac
	Mrs. M. Rae
	Mrs. J. R. Williams
	Miss. J. Desvaux de Marigny, appointed 1.8.64.

THE MAURITIUS HERBARIUM

Honorary Curator	R. E. Vaughan, O.B.E., D.Sc., (Lond.), F.R.I.C.

REPORT OF THE CHAIRMAN

EXECUTIVE BOARD 1964

THE Board held 13 meetings during the year, three of which jointly with the Research Advisory Committee. The changes on the Board were the replacement of Mr. Philippe Espitalier-Noel as Chairman by myself, and of Messrs. A. Harel, M. Kisnah and H. Lallmahomed by Messrs. L. H. Garthwaite, B. D. Purmanun and S. Gaya.

ESTABLISHMENT

Five officers of the Institute resigned in 1964 : Messrs. E. F. George, L. P. Noel, H. F. Wiehe, M. M. d'Unienville and Mrs. A. d'Espagnac. The departure of Mr. E. F. George, the Geneticist, led to a reorganisation involving the merge of the Divisions of Pathology and Plant Breeding under Mr. R. Antoine, the Pathologist; a second post of Assistant Plant Breeder was created and filled by Mr. Pérombelon, a former laureate of the College of Agriculture while Mr. Ricaud was promoted on his return to Mauritius in December to the post of Associate Pathologist. Mr. Hermelin, formely a Senior Field Officer had already been appointed Senior Assistant Plant Breeder on the resignation of Mr. L. P. Noel. Mr. H. F. Wiehe was replaced by Mr. E. Piat, another laureate of the College of Agriculture as Associate Sugar Technologist and Mr. J. Desjardins took over from Mr. M. M. d'Unienville as Assistant Secretary Treasurer. Finally, Mrs. A. d'Espagnac who had been employed as typist since 1953 was pensioned off for reasons of ill-health and was replaced by Miss J. Desvaux de Marigny.

I.S.S.C.T. MEMORIAL BUILDING

In May the building erected to house the world sugar exhibition was officially handed over to the Institute by the sugar millers. This building which incidentally provides a Mess Room for the Staff will be a permanent reminder and a tribute to the organisers of the highly successful 11th Sugar Congress held in Mauritius in 1962.

CESS ON SUGAR EXPORTED

After negociations and discussions which have been going on since 1962, the rate of cess was increased by 50 cents to Rs 3.50 per ton of sugar exported as from 25th November 1964. The revenue from this increased cess should, with a normal crop, just about suffice to cover expenditure, but will not enable us to create the reserve which would have tided us over years of short production. It is regrettable however that the total increase of 75 cents applied for by the Institute was not accepted as no less was required to stabilize the finances of the Institute and enable it to meet inescapable future commitments.

It is my pleasant duty in concluding this report to record my gratitude to my Colleagues on the Board for their unfailing help and cooperation and my full appreciation of the excellent work of our Director and his Staff. It is specially gratifying for one who served in the earliest years of the Institute to see for himself how well the initial hopes have been more than fulfilled.

Chairman

12th February 1965

REVENUE AND EXPENDITURE ACCOUNT

YEAR ENDED 31st DECEMBER, 1964

Running & Administrative Expenses ...	1,644,006.33	Cess on Sugar exported	1,714,700.15
Herbarium Expenses...	5,287.92	Miscellaneous receipts	83,744.99
Interest Paid	25,467.06	Excess of Expenditure over Revenue for	
Leave and Missions Fund	100,000.—	the year, deducted from Accumulated Funds	125,043.90
Depreciation	148,727.73		
Rs.	1,923,489.04		1,923,489.04

BALANCE SHEET

AS AT 31st DECEMBER, 1964

ACCUMULATED FUNDS	1,340,468.97	FIXED ASSETS (at cost less Depreciation and amounts written off)		
REVENUE FUNDS	98,966.30	Land & Buildings ...	1,565,307.19	
AIME DE SORNAY FOUNDATION ...	25,000.—	Equipment & Furniture : Laboratories, Houses & Offices ...	50,888.67	
LOAN FROM ANGLO MAURITIUS ASSURANCE SOCIETY LTD. ...	208,611.—	Agricultural Machinery & Vehicles ...	56,242.—	1,672,437.86
GOVERNMENT OF MAURITIUS (Purchase of Buildings)	127,719.50	CURRENT ASSETS		
		Sundry Debtors ...	46,478.86	
		Aimé de Sornay Foundation Account ...	25,000.—	
		Cash at Banks & in Hand	56,849.05	128,327.91
Rs.	1,800,765.77	Rs.		1,800,765.77

(sd) A. L. NAIRAC
(sd) D. H. FFRENCH MULLEN } *Board Members*

(sd) E. ROCHECOUSTE *Ag. Director*

AUDITORS' REPORT

We have examined the Books and Accounts of the Institute for the year ended 31st December 1964, 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 1964, 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.

p.p. de CHAZAL DU MÉÉ & Co.

Chartered Accountants

Port Louis,
Mauritius,
20th March, 1965.

INTRODUCTION

THE work of the Sugar Industry Research Institute is reviewed in this Introduction to the 11th Annual Report with emphasis on an event of major consequence to cane cultivation in Mauritius and to the research programme of the Institute. The dreaded bacterial disease — *gummosis* — which had been under control in the island during the last 35 years reappeared with extreme virulence and was diagnosed during the month of June. This outbreak, caused by a strain of the bacterium different from the one which existed hitherto creates a serious problem for the sugar industry inasmuch as susceptible cane varieties, covering approximately 60% of the cultivated area, will have to be replaced by resistant ones during the next few years.

In the past, gummosis caused grave setbacks to cane planters and was probably responsible for retarding the progress and development of the sugar industry until better knowledge of its nature was acquired. In this connection it is important to stress that since 1958 the Institute had laid much emphasis on a study of bacterial diseases of the sugar cane and of gumming disease in particular. Co-operative investigations with the Commonwealth Mycological Institute and with the agricultural research departments of neighbouring islands have provided invaluable information in the present emergency. This affords an excellent illustration of the long term value of certain research projects which, even if they appear to be of little immediate interest when they are initiated, may prove of considerable moment for the future.

THE 1964 SUGAR CROP

Climatic conditions were on the whole unfavourable to growth. A major cyclone, *Danielle*, passed near the west coast of the island in January. Gusts of 135 m.p.h. were recorded in the South where the highest wind speed during one hour exceeded by 7 miles that experienced in February 1960 (see table IX of Appendix). About four weeks later another cyclone, *Gisele*, caused significant damage to the cane crop which was showing signs of recovery in most districts. To aggravate matters, rainfall was deficient from February to June and temperature was well below normal during that period, while wind speed exceeded the average. As a consequence of these adverse factors, cane yield per arpent was 7.1 tons below that of 1963. During the grinding season which started on the 1st day of July, weather conditions were favourable in July and August, but heavy rains in September and October caused a marked lowering in sucrose content.

A combination of negative factors, dominated once more by the occurrence of two cyclones were thus responsible for an overall sugar production of approximately 520,000 tons, which was below that of the previous year by 24.2%.

Essential data for the 1964 crop are compared to those of 1963 in the following table.

	1964	*1963*
Area cultivated, arpents	205,000	204,200
Area harvested		
Estates	99,205	100,060
Planters	95,665	94,020
Total	194,870	194,080
Weight of canes, met. tons	4,375,014	5,746,677
Tons cane per arpent :		
Estates	26.2	35.1
Planters	18.7	23.7
Average, island	22.5	29.6
Sugar recovered % cane	11.87	11.93
Tons sugar per arpent :		
Estates	3.11	4.19
Planters	2.22	2.83
Average, island	2.67	3.53
Duration of harvest, days	121	153
Tons cane per hour	95.4	97.8
Tons cane crushed weekly	252,900	263,300
Sucrose % cane	13.45	13.47
Fibre % cane	13.85	13.11
Molasses % cane	2.60	2.67
Purity mixed juice	86.4	86.3
Reduced mill extraction	96.2	96.0
Sucrose % bagasse	2.03	2.08
Reduced boiling house recovery	90.0	90.2
Reduced overall recovery	86.5	86.6
Total sucrose losses % cane	1.73	1.70
Tons sugar 98.7 pol.	519,900	685,500

Reference to figures 1 to 8 illustrate some of the important features of the crop year under review.

Fig. 1 Rainfall, maximum and minimum temperatures in 1964 compared to normal. Deficient rainfall during the growth period and excess rainfall during the harvest season combined with low maximum and minimum temperatures throughout the year characterised the 1964 crop.

Fig. 2 Elongation of cane stalks is determined in the 10 final variety trials of the 1960 series on M. 147/44 in the West, North, East and South and on M. 93/48 in the Centre. The curves are an average for these sectors in 1964 and 1963. They show clearly the large discrepancies in growth in 1964.

Fig. 3 Cane yields of virgins and ratoon crops are shown in these curves in comparison with the five-year average (1958-1963, excluding 1960). The percentage area cultivated in each ratoon is indicated.

Fig. 4 Percentage reduction in sugar yields in 1964 for each sector in relation to the sector's average in 1963. It is interesting to note that in spite of the fact that highest wind speeds were recorded in the South, the central sector showed the largest reduction.

Fig. 5 Variations in sucrose content in 1964 indicate clearly the adverse effects of heavy rains in September and October.

Fig. 6 Cane yields, recoverable sugar % cane, and sugar per arpent are shown for each sector in relation to the island's average in 1964. Planters and estates yields are shown separately for each sector and for the island as a whole. On the average, planters' yields were 33% below those of estates in 1964.

Fig. 7 The varietal composition of the 1964 crop is illustrated for each sector and for the island as a whole in 1964. M. 147/44 was responsible for a third of the sugar crop and was dominant in all sectors except the Centre where the most important variety is still Ebène 1/37. The three Barbados varieties : 3337, 34104, 37172, produced 19 % of the total cane weight, an amount approximately equivalent to that contributed by the three new M 202/46, 93/48 and 253/48 and by the two Ebène varieties 1/37 and 50/47.

Fig. 8 This figure shows the deviations in cane yield of each commercial variety from that of the sector's and of the island's average in 1964. These data which relate to estates only, confirm the poor performance of Ebène 1/37 and B. 3337 in cyclone years. The somewhat erratic performance of M. 93/48 is disappointing as previous information had indicated promise of cyclone resistance. In 1964 this variety performed relatively well in the wetter parts of the North and the Centre but poorly in the East and South. On the other hand, M. 202/46 has produced yields well above the average in all sectors, while the meritorious performance of M. 253/48 must be considered in relation to its intrinsic low sucrose content and to the relatively small area harvested.

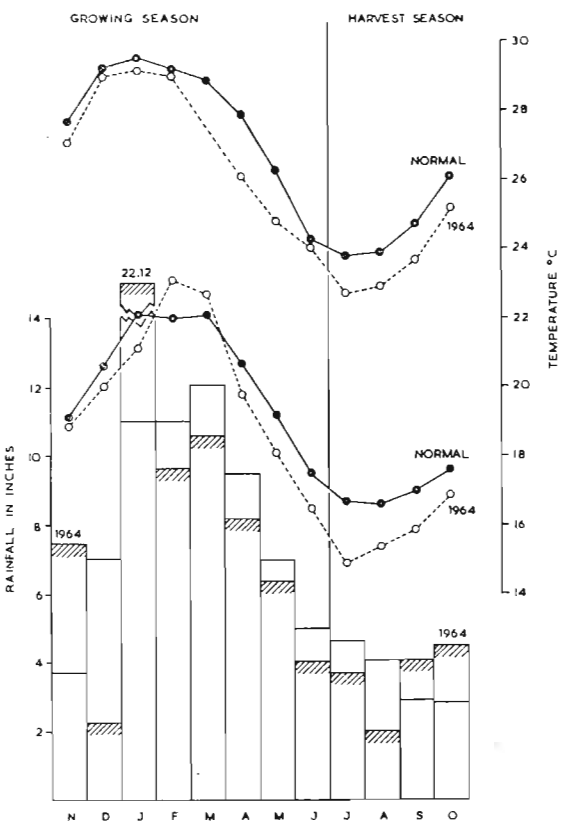

Fig. 1. Rainfall and temperature during November 1963 to October 1964 (Shaded) compared to normal.

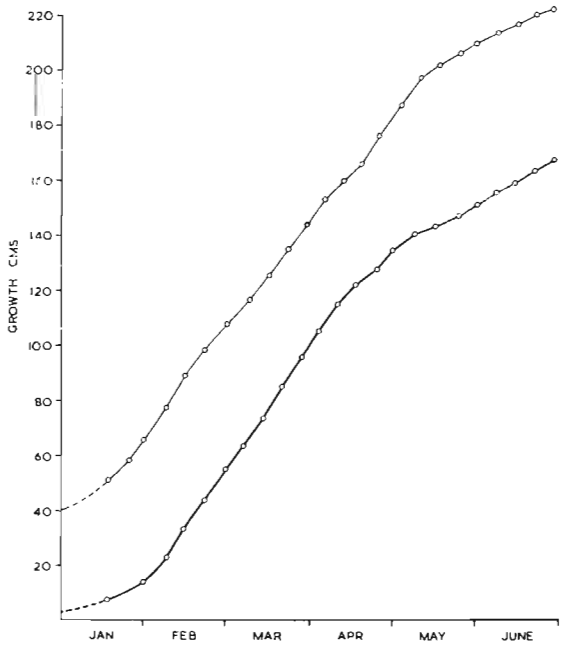

Fig. 2. Cane growth (island average) in 1964, (thick line) compared to 1963 (thin line).

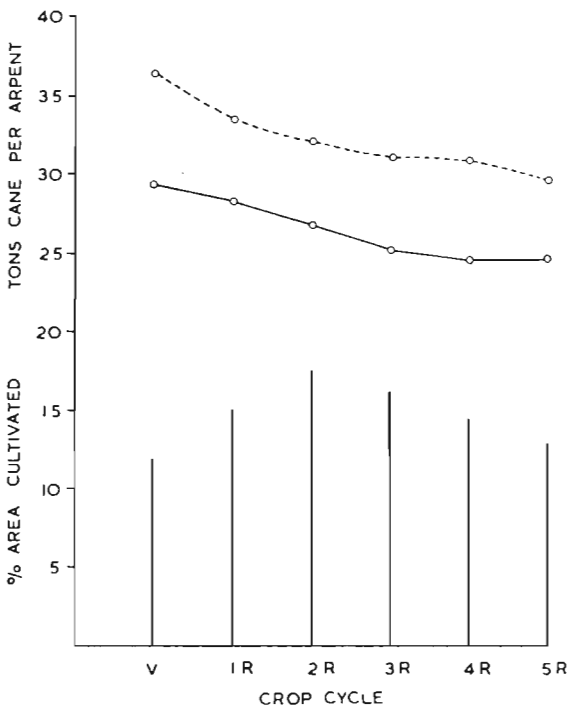

Fig. 3. Yield of virgins and ratoon canes in 1964 (plain line) compared to average 1958-1963 (dotted line). The relative area of each ratoon in columns.

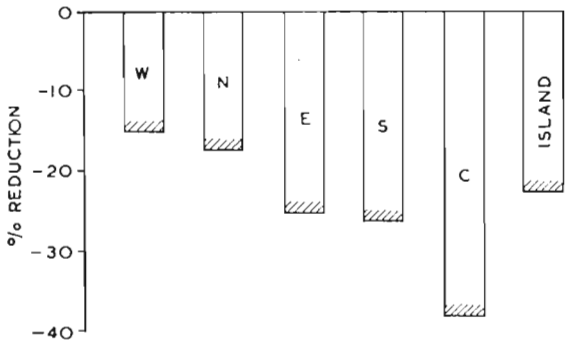

Fig. 4. % reduction in sugar yields per arpent on sector's average in 1963 (W: 4.06, N: 3.42, E: 3.34, S: 3.51, C: 3.83, Island 3.53).

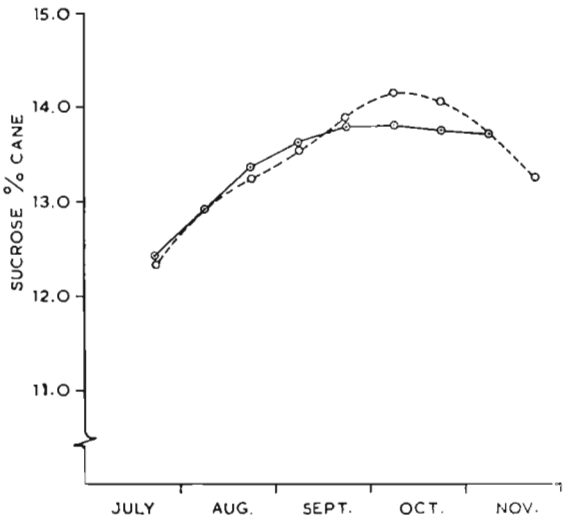

Fig. 5. Variation in sucrose during 1964 (plain line) average 1958-1963 (1960 excluded) shown by dotted line.

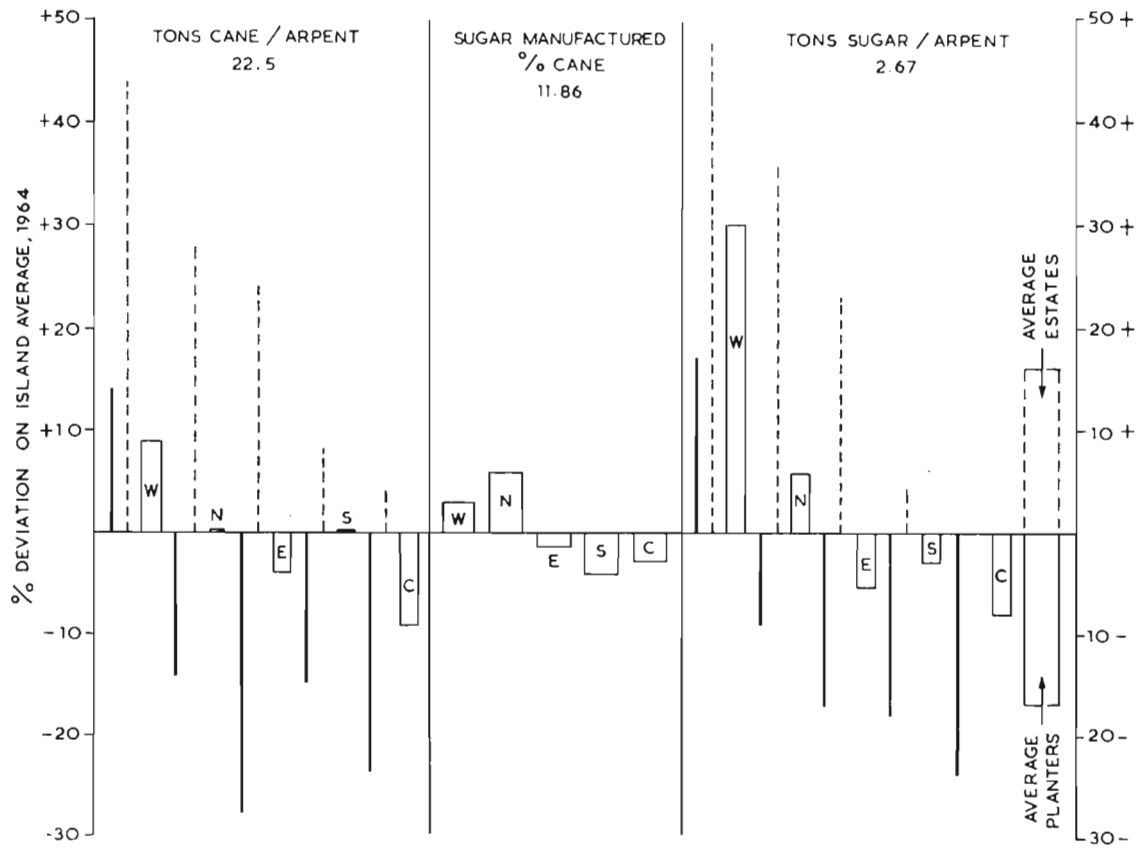

Fig. 6. Variations in cane and sugar yields in different sectors in relation to the island average in 1964. Plain line: planters, broken-line: estates, columns: sector average.

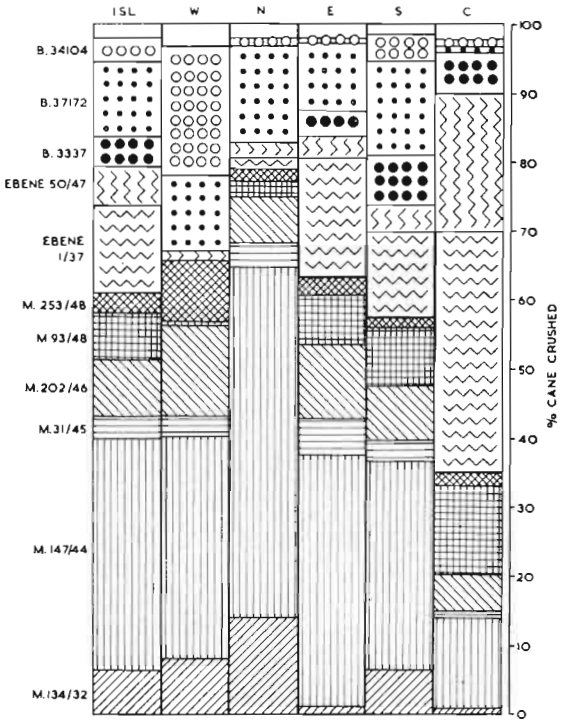

Fig. 7. Varietal composition of the 1964 crop in different sectors of the island.

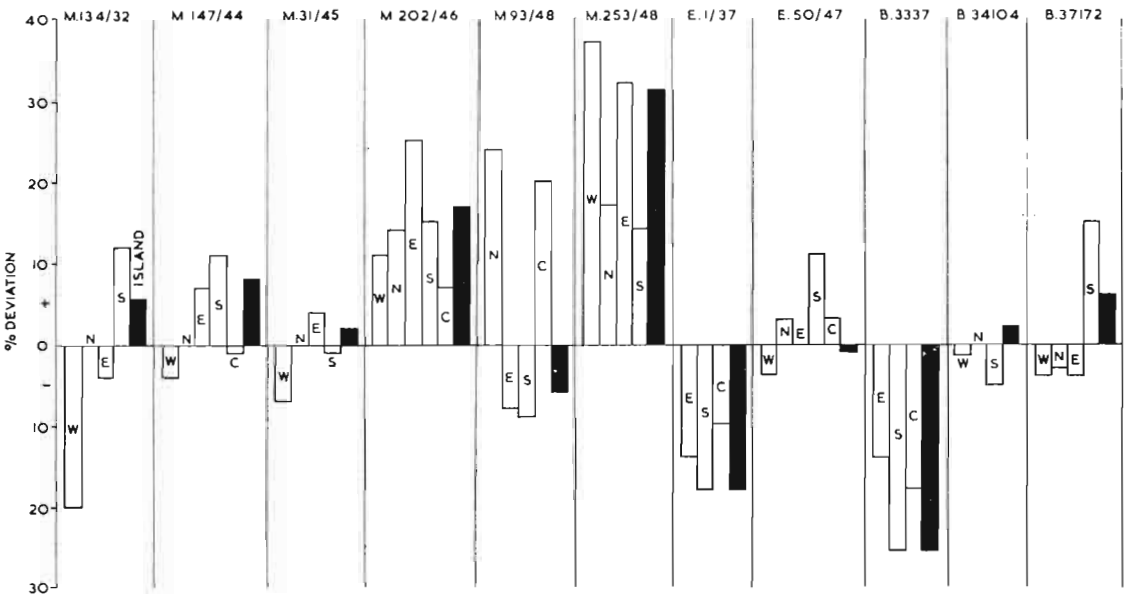

Fig. 8. Varietal deviations in cane yield for each sector.

THE CANE VARIETY PROBLEM

The dominating consideration in this problem of capital importance to the sugar industry is that of varietal reaction to gumming disease. This negative factor had been efficiently disposed of in the past by screening all promising varieties early in the selection programme so that only resistant canes would be released for commercial cultivation. The appearance of a different and more virulent strain of the causal organism has suddenly upset the programme of varietal recommendation to the industry on the one hand, while necessitating a complete re-orientation of the selection programme on the other. Furthermore, M. 147/44 which was the unchallenged standard of field trials in the sub-humid and humid areas will not be available in the future because of its susceptibility to gummosis.

Further information on the nature of this disease and its control is given in another section of this introduction and in the chapter on cane diseases, but it is useful to indicate at this stage the reactions of commercial varieties which are as follows :

(i)	Very highly susceptible varieties which show systemic infection and which must be replaced	M. 147/44, B. 3337, B. 34104, Ebène 88/56*
(ii)	Susceptible varieties, on which leaf symptoms only have been observed	Ebène 1/37, B. 37172
(iii)	Moderately susceptible varieties :	M. 93/48, M. 99/48**
(iv)	Moderately resistant variety :	M. 442/51
(v)	Resistant varieties :	M. 134/32, M. 31/45, M. 202/46, M. 253/48, Ebène 50/47

Cane varieties falling in group (i) are condemned and must be replaced by less susceptible varieties. Fig. 9 which shows the present distribution of varieties in the island in relation to their susceptibility and resistance to the disease depicts graphically the magnitude of this undertaking.

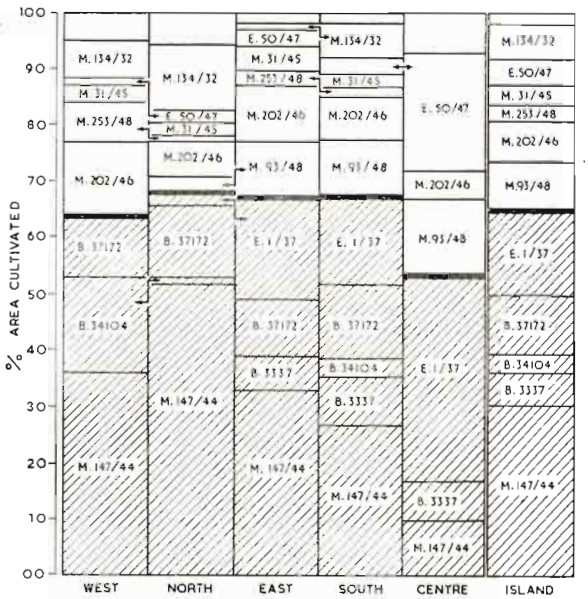

Fig. 9. Area under different cane varieties in each sector. Susceptibilities to gumming disease indicated by cross hatching.

It is fortunate, however, that the majority of commercial varieties have shown an index of resistance which is acceptable in the present emergency. A varietal replacement programme can therefore be designed which should not adversely affect the present sugar potential of the island. The only variety which can replace M. 147/44 in the sub-humid area where no irrigation is available is M. 442/51 which is a medium to late maturer. Elsewhere, it can be replaced by M. 202/46, M. 253/48, M. 31/45 and Ebène 50/47. In the super-humid zone where it is cultivated, B. 3337 should be replaced by M.93/48. In addition the release of M.99/48 has been recommended with a view to replacing B. 3337 as well.

* An unreleased variety which showed much promise and which had been under observation on a field scale on several estates.

** A variety which has been recommended for release.

M. 99/48 is well adapted to high rainfall areas and although its performance is slightly inferior to that of M. 93/48, the variety is fairly resistant to gummosis. B. 34104, being grown on a limited scale sets no replacement problem.

As the only resistant cane, M. 442/51, capable of replacing the most susceptible variety, M. 147/44, in the dry areas without irrigation, is a medium to late maturer, special emphasis has been placed upon selection for adaptation to a sub-humid, non-irrigated environment. With that object in view, several experiments involving the more promising varieties now in variety trials, numbering about 100, will be laid down in the sub-humid area early in 1965 in order to obtain as rapidly as possible resistant varieties adapted to dry conditions for the replacement of M. 147/44.

The more important economic characteristics of cane varieties available at present have been summarised and tabulated on page 18.

CANE BREEDING AND SELECTION

Although flowering was heavy in 1964, male parents were lacking, which made the execution of a comprehensive crossing programme difficult. It is thought that the low temperature occurring early in the year caused this lack of male fertile arrows.

A total of approximately 1000 crosses was made but the number of different combinations decreased from 577 in 1963 to 460 in 1964. More marked was the decrease in the number of different male parents used, from 105 in 1963 to 60 in 1964. Crosses made in the cubicles of the new green house were less successful as a result of the use of a wider range of varieties, from which several could not be kept alive in the preservation solution.

Once again the fuzz was dried and stored in the deep freeze. A total of 1117 crosses were sown comprising those kept over from last year as well as most of those made this year. From these, 223 did not germinate and 514 were discarded because the number of seedlings obtained from them was too low. The 380 sown crosses kept for transplanting in the field gave 120,000 seedlings. Fuzz from a small number of crosses, of no interest for selection, were kept in the deep freeze for experimental purposes.

Potting of seedlings was carried out in December at both Réduit and Pamplemousses experiment stations. The seedlings are to be planted in the field in February/March 1965.

Experiments on inheritance of parental characters were continued, while a start was made with the evaluation of crossing records of previous years to ascertain the value of different parts. A programme of transferring all data available since 1954 on punch cards and subsequent mechanical analysis was started and, in this connection, the assistance given by the Manager of the Cyclone & Drought Insurance Board is gratefully acknowledged.

Other experimental lines of selection efficiency are continuing and include : the performance of seedling populations in virgins and ratoons, selection in bunch plantings, and competition studies.

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

(i)	seedlings from 1962 and 1963 crosses planted in March 1964 (bunches of 3)	80,450
(ii)	1961-1962 series. Varieties in bunch selection plots	8,667
(iii)	1959-1962 series. Varieties in propagation plots for selection in 1st ratoons	4,903*
(iv)	1957-1960 series. Varieties in 1st selection trials to be selected in 2nd ratoons	474**

* 2389 varieties are planted in two environments and the remaining 125 in only one.

** From this total 57 varieties are tested in two environments, making a total of 417 different varieties.

Varietal replacement programme. Economic characteristics of commercial cane varieties available at present :

Variety	Reaction to gummosis	Suitable zone for cultivation	Sucrose content	Maturation behaviour	Other characteristics
M.134/32	resistant	Low to medium elevation, sub-humid to humid.	high	early & mid season	Less productive than newer varieties. Susceptible to ratoon stunting disease.
M.31/45	resistant	Medium elevation, humid.	high	early & mid season	Susceptible to stalk borer — erratic performance.
M.202/46	resistant	Wide adaptation range	moderate	mid & late season	Susceptible to leaf scald — Inspection and rogueing of plantations essential. Probably the most productive variety available at present when adequate Nitrogen is provided.
M.93/48	moderately susceptible	Medium to high elevation, humid to super-humid.	moderate to low	mid & late season	Susceptible to ratoon stunting disease. High fibre.
M.99/48	moderately susceptible	High elevation, humid to super humid.	low	mid & late season	Probably a useful substitute in areas where B.3337 is cultivated at present.
M.253/48	resistant	Low elevation, irrigated	low	mid-season	Very low fibre, very susceptible to chlorotic streak.
M.442/51	moderately resistant	Low to medium elevation, sub-humid to humid	low	mid & late	Susceptible to rust and chlorotic streak
Ebène 1/37	susceptible	Medium to high elevation, humid to super-humid	high	early & mid season	Susceptible to cyclones. In humid regions does not grow well in gravelly soils.
Ebène 50/47	resistant	Medium elevation, humid	very high	early & mid season	Erratic performance
B.37172	susceptible	Low to medium elevation, sub-humid to humid	moderate	mid & late season	Susceptible to root disease. High fibre.

(v) 1956-1958 series. Varieties in multiplication plots at Médine S.E. for establishing field trials in 1964 — 27

(vi) Varieties in trials on estates

1951-1958 series	128	
Ebène varieties	9	
Foreign varieties	11	
	——	148

At Mon Désert-Alma seedlings were planted for the first time this year, and the valuable cooperation of those responsible is appreciated. It has been decided that in future only later stages of selection will be planted there.

Of the varieties approaching commercial status several show a high sucrose content together with other desirable features but their release will only be considered in July 1965 after their resistance to gummosis has been ascertained.

The summarised performance of these varieties in terms of deviation from the standard is indicated in the table below.

Comparative data for two other varieties are also included : M. 442/51, released in 1964 and M. 99/48 recommended for release in 1965 more particularly because it may prove a useful substitute for B. 3337.

	STANDARD VARIETY M. 147/44			STANDARD VARIETY Ebène 1/37		
	Number of observations in ratoons	Deviations from Standard		Number of observations in ratoons	Deviations from Standard	
		I.R.S.C.*	Profitable sugar**		I.R.S.C.*	Profitable sugar**
M. 39/49 ...	2	+ 1.2	— 0.53	5	+ 1.4	+ 0.37
M.409/51 ...	8	+ 1.0	— 0.03	2	+ 0.8	+ 0.44
M.423/51 ...	11	+ 0.8	— 0.48	7	+ 0.8	+ 0.09
M.13/53 ...	4	+ 1.7	+ 0.74	1	— 0.4	+ 0.09
M.359/53 ...	4	+ 1.3	0.00	—	—	—
M.361/53 ...	4	+ 1.5	— 0.09	2	+ 0.8	+ 0.42
M.442/51 ...	12	+ 0.4	+ 0.22	7	— 1.6	+ 0.03
M.99/48 ...	3	+ 0.1	— 0.13	5	— 0.2	— 0.14

* Industrial recoverable sugar % cane.

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

CANE DISEASES

As indicated already 1964 has, from the pathological angle been one of the most inauspicious years in the history of sugar cane culture in Mauritius. Weather conditions were favourable to the development of pathogens, while four new problems were encountered in the plantations. Two major diseases, gummosis and leaf scald, which had been totally eradicated from commercial fields, reappeared in epidemic form and are believed to be caused by new and more virulent strains of the pathogens. Furthermore, two minor diseases, yellow spot and rust, have been identified for the first time in the island.

The last two diseases are not expected to become of economic importance and no control measures have been recommended. Indeed, yellow spot was of very restricted distribution and associated with the presence of excess moisture. Only two varieties have shown susceptibility, B. 3337 and Ebène 50/47. Later in the year the disease had disappeared, before harvest, even in fields where spectacular attacks had been recorded. Rust was observed on the following commercial canes : M. 442/51, M. 147/44 and M. 202/46. The disease is now all over the island due to the easy dispersal of spores of the fungus by wind. Although there is still no cause for alarm a close watch on progress of the disease is being kept.

The appearance of new and more virulent strains of the gummosis and leaf scald pathogens sets an arduous problem. A survey has shown that gummosis is now distributed practically all over the island, the pathogen being easily spread by wind and rain, and systemic infection is already common. However, the South and East sectors of the island are more severely affected.

As widespread systemic infection was observed in M. 147/44, B. 3337 and B. 34104, the planting of these varieties has been prohibited as from 1st July 1965 and their compulsory eradication should be completed by 31st December 1970.

From observations made in variety trials exposed to natural infection, it was at once apparent that the new strain of the organism was much more virulent than the original one inasmuch as, several varieties already tested to the old strain had contracted infection. It was therefore necessary to put emphasis on varietal resistance to gummosis which is now the major limiting factor in selection work. Consequently, gumming trials will be conducted early in the selection programme i.e. at the propagation plot stage, at a time when some three thousand seedlings can be tested instead of the usual forty to fifty. The advantage to be derived from the new procedure, quite apart from screening resistant canes at an early stage of selection will, in a few years, be the accumulation of data which, it is hoped, will throw some light on inheritance of resistance to the disease. In addition resistance trials to the old and new strains were established immediately after the discovery of the new outbreak, the two strains of the pathogen having been isolated in culture. It is essential to establish whether the difference between the two organisms is confined to their degree of virulence on host reaction.

Laboratory work has shown that the two strains can be differentiated by the degree of viscosity of the slime produced by the bacteria, a characteristic which is further enhanced when the organisms are grown on a medium containing triphenyl tetrazolium chloride. Research work on bacteriophage sensitivity testing is being conducted. In addition a rapid method for the inoculation of cane to provide infection in large resistance trials has been developed.

Immediate control measures against gummosis include :

(a) A varietal replacement programme for future plantings as outlined in the previous chapter.

(b) Periodic survey of estates and planters fields, rogueing of diseased stools or uprooting, depending on the extent of infection. A scheme for the control of the disease in small planters' fields has been submitted to the Government and approved.

(c) Accelerated programme of testing varieties in relation to both disease resistance and agronomic performance.

To be successful, the campaign against gummosis has to be conducted on an island-wide basis and all necessary steps have been taken in that connection. But there remains the problem of the sceptical planter — one of the most difficult tasks which confronts the Pathologist. A word of warning and caution has to be issued here. It is a fact that the effects of the disease may not always be apparent under certain conditions, yet the large scale cultivation of susceptible canes hangs like a sword of Damocles over the planter's head inasmuch as heavy losses may be experienced when environmental conditions favour the spread and intensity of the disease. The sceptical or uncooperative planter therefore assumes the serious responsibility which he has no right to shoulder in relation to the industry as a whole. It must be remembered in this connection that gummosis is not only a disease which may cause severe reductions in yields but it may also set serious problems in the factory : the presence of gum in the extracted juice interferes with clarification and boiling, reduces overall recovery and affects adversely the quality of sugar produced.

The occurence of this new form of gumming disease has been rendered even more complex by the almost simultaneous outbreak of a leaf scald epidemic. Only two varieties are so far susceptible to what appears to be a new strain of the latter organism, M. 202/46 and M.147/44. The susceptibility of M. 202/46 sets a problem. It is not contemplated at this stage to prohibit the cultivation of the variety. Rogueing and destruction of diseased stools have been recommended and it is hoped that provided the work is properly done and weather conditions are favourable, the position will not deteriorate until other varieties are available.

It follows from the foregoing that emphasis both in research and in control work in the field has to be placed on gummosis and leaf scald; yet, such emphasis should not be detrimental to the positive results already obtained in the campaign against ratoon stunting and chlorotic streak. It is with that object in mind that the whole planting programme of the Central Nursery had to be revised in order to give priority to varieties resistant to gummosis. The same evidently applies to secondary nurseries on estates.

Also, the trend which had led, through a better understanding of the nature and effects of chlorotic streak, to the installation of more efficient treatment tanks on estates, should continue. Varieties resistant to gummosis, yet highly susceptible to chlorotic streak, such as M. 442/51 and M. 253/48, will have to be grown and this can be successfully achieved provided the planting material, through a proper hot water treatment, is freed from the chlorotic streak virus.

CANE PESTS

The scale insect. Intense attacks by the scale insect (*Aulacaspis tegalensis*) occurred during the year at the Central Cane Nursery and led to the initiation of studies on the significance of this insect when present on canes which are to be used as planting material. Infestation of cane at the nursery developed early in the year and at the end of April a field-to-field survey revealed that 25 out of 86 fields were appreciably or heavily infested, at least in part. The nursery is situated, unfortunately, in an area where environmental factors are favourable to the insect and its appearance there from time to time is a factor which must be accepted since no preventive control method is known. Investigations to elucidate the importance of scale infestation in nursery cane were vigourously pursued and are described in a subsequent part of this report. The factors to be considered are possible dissemination of the insect during transport of infested material, the development of foci of infestation in fields as a result of planting setts which bear the insect, and the possibility of reduced or retarded growth following use of infested canes as planting material. The insect is naturally limited in its distribution to the low-rainfall belt around the coast (the «infective region») and all three

factors can be of consequence in this belt; otherwise, in the more humid regions outside the infective zone, only the last named factor can be of any significance.

Investigations, which are still in progress, have shown that use of infested planting material can result in reduced germination and retarded early growth while removal or destruction of the scales on infested setts before planting minimizes and sometimes eliminates the depressive effect of the insect. Otherwise, in the infective zone, the presence of live scales on the planted setts may result in foci of infestation in the resulting stand of cane owing to the survival and multiplication of the insects on the setts and on the underground part of young shoots which develop therefrom. It is thus advisable to use clean canes for planting whenever possible; failing this, lightly infested canes or cane setts which have been treated to remove or destroy the scales should be used. Time/temperature combinations for hot-water treatment of cane setts to destroy the scale insect have been determined; at 52°C and 50° C, minimum periods of immersion for complete destruction of all stages of the insect were found to be 11 minutes and 15 minutes, respectively. When HWT is not practicable, the alternatives of washing the setts clean or of using an insecticidal dip are advocated in that order of preference.

Cane Borers. Another attempt to establish *Diatraeophaga striatalis* Sn., the Javanese parasite of *Proceras sacchariphagus*, was made in July-August. Through the co-operation of the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières, which had organized collection of this Tachinid parasite in Java for dispatch to Madagascar and Réunion, approximately 8000 puparia were received. Many of the puparia were unfortunately — and unavoidably — in poor state on arrival but they yielded nearly 1500 adults for field release as opposed to about 850 released during earlier work with the fly in 1961. The outcome of the 1964 liberations is awaited but, should it be negative, further attempts to establish the insect will be undertaken since it is considered a species of considerable potential as an agent of biological control of *Proceras*. Close co-operation with Madagascar and Réunion, where *Proceras* is also an important problem, is proving of mutual advantage in connection with work on *Diatraeophaga* : apart from exchange of technical data, the establishment of the parasite in any one of the three countries will mean a ready source of material for further work in the other two. This aspect is of particular importance in view of present difficulties in obtaining material from Java and in culturing the insect in the laboratory.

Other parasites released against *Proceras* were *Trichospilus diatraeae* C. & M., *Trichogramma japonicum* Ashmead, and *T. australicum* Gir., all obtained from India through the Commonwealth Institute of Biological Control.

The depredations of *Proceras* are familiar to all cane growers but assessment of the incidence of the insect and of the extent of crop loss for the island as a whole are difficult to make owing to climatic, seasonal, and cane varietal factors which complicate sampling procedure and the derivation of representative estimates. During the 1964 harvest, however, data on incidence of attack were obtained from fields on six estates representing different climatic regions by taking a random sample of 50 canes per field and counting the number of canes bored and also the number of internodes bored. A total of 205 fields were sampled and the average figure for canes attacked per field was 37.9%. The average for internodes attacked per field was 4.7%. It will undoubtedly be useful to acquire further data of this nature each season and to derive from it an appreciation of crop loss and of the influence of environmental factors such as variety and weather on the insects' abundance.

Locusts. Renewed outbreaks of the red locust, which had been feared during December 1963 — February 1964, did not materialize on any scale despite the great abundance of adults observed in may areas during the cool months of 1963. This is attributed to the very dry conditions prevailing in November of 1963 which probably caused a high mortality of the eggs in the soil. A few limited attacks, some necessitating application of insecticide, did

occur however. One of these, on 10 arpents of M. 31/45, illustrated the considerable influence of cane variety on the insect for, despite nearly complete defoliation of the field in question and the presence of a locust population estimated at between half to one million, the surrounding Ebène varieties (Eb. 1/37 & 50/47) were virtually untouched. Another observation of interest in connection with this particular attack was that cyclone *Danielle* (Jan. 17-19), which occurred before spraying could be carried out, had no discernable effect of any kind on the locust population in the field. It is now considered that locust activity has subsided and no outbreaks of any magnitude are expected in the near future.

SOILS AND CLIMATE, FERTILIZERS

Descriptive notes on the 1:100,000 soil map were completed during the year and a publication setting out the main results of the soil survey is in press at the time of writing

Detailed studies on the soils of two factory areas in the South of the island were initiated while the soils of the 600 permanent sampling units for foliar diagnosis were sampled for determining their phosphate status.

An agro-climatic map based on Thornwaite's classification was also completed in collaboration with the Director of Meteorological Services. Twenty six climatic types have been delineated varying in extent from 40 to 107,000 acres and the climates of the zonal and intrazonal soil groups have been localized.

Field trials started several years ago on the relative value of urea and sulphate of ammonia were terminated during the year. The main conclusions to be drawn from these experiments are that burying or watering the fertilizers improves their efficacy while that of urea is enhanced and approaches that of sulphate of ammonia when it is used in split doses and covered with soil.

Mention should be made of the influence of heavy dressings of sulphate of ammonia on the manganese content of the cane plant. This study was based on data obtained in the series of final variety/fertilizer trials harvested in 2nd and 3rd ratoons in 1963 and 1964. Results were grouped in two series according to soil properties : (a) well buffered soils with high soluble silica and low soluble manganese, (b) slightly buffered soils with high soluble manganese and little soluble silica. In the first group it was shown that the annual application of 300 kgs of sulphate of ammonia per arpent during four consecutive years has not altered the manganese content of the leaf sheaths while in the second case manganese had increased to a level which is probably detrimental to growth. It appears therefore that in such cases the acidifying properties of sulphate of ammonia should be counteracted by liming or that another source of nitrogen should be used.

The response to nitrogen fertilization in Mauritius has been estimated from the combined results of the trials referred to above. In a normal year (1963) the average response of six commercial varieties to the standard dose of 30 kgs N per arpent was 700 kgs of recoverable sugar per arpent while in cyclone years (1962, 1964) the response was only 370 kgs of recoverable sugar per arpent.

As indicated in previous reports response to nitrogen varies considerably with varieties and is also affected by the date of reaping. Thus when 30 kgs additional N were applied (i.e. 60 kgs N per arpent), M. 202/46 produced 200 kgs more sugar when harvested early and 270 kgs when harvested late. In the case of Ebène 50/47, which is also a N tolerant variety, 30 kgs additional nitrogen produced 200 kgs more sugar at early harvest but there was no response to late harvest. Ebène 1/37 and M. 147/44 did not produce more sugar with an additional dose of nitrogen while in the case of M. 93/48 and M. 253/48 additional nitrogen caused a reduction in sugar yield.

Results of these variety/fertilizer trials are further discussed in a special article of this

report. They show that when specific nitrogen requirement is fully satisfied four of the six varieties studied : M. 147/44, M. 93/48, M. 253/48 and Ebène 1/37 are most productive at mid season harvesting while one variety Ebène 50/47 at early harvesting and another, M. 202/46 at late harvesting.

These trials have also shown that the variety with the highest sugar potential in Mauritius at present is M. 202/46 when provided with additional nitrogen fertilization.

WEED CONTROL

Substituted Uracils. Investigations on Bromacil and Isocil weed killers were continued this year and from the results obtained both from logarithmic and field trials it was concluded that these chemicals were too phytotoxic to be used in pre-emergence treatment of plant canes. Crop damage was found to be closely related to rainfall distribution and when examined from that angle it was observed that crop injury resulted either when excessive rainfall occurred in the first fortnight following herbicide application, or when a drought lasting several weeks followed the herbicidal spray. Yield trials laid down in first ratoon canes with Bromacil and Isocil herbicides at rates of application ranging from 0.5 lb to 3.0 lb active ingredient per arpent were harvested this year. From the results obtained it was established that rates of 0.5 lb and 1.0 lb did not affect cane yield and that at higher rates of application these chemicals may prove toxic particularly in the superhumid areas. On the other hand, no effect on sucrose content was observed at all concentrations used in those trials.

Investigations on the comparative effectiveness of certain herbicide mixtures consisting of DCMU, Bromacil, Isocil, sodium chlorate and an ester of 2, 4-D were carried out in ratoon canes this year both in humid and superhumid areas. The herbicidal spray was applied one week after the lining up of trash, at a time when only a few weeds had emerged. Of the different formulations tested, the one consisting of DCMU (2,4 lb a.i.) plus Bromacil (0.8 lb a.i.) gave the best results.

In another series of trials conducted along the same lines, but in which the herbicide mixtures were applied four to six weeks after lining of trash, that is, when weed growth was 4-6 in. high, the combination DCMU (2.4 lb a.i.) plus Bromacil (0.6 to 0.8 lb) gave the more consistent results. It is interesting to note that no visual adverse effect on cane growth was observed in these trials, thus suggesting that this formulation may find a place in our weed control practice, particularly in the super-humid regions.

Cynodon dactylon. Owing to the tolerance of the Constance biotype of that grass to TCA and Dalapon, other trials were laid down with a view to investigating the response of this biotype to the substituted Uracils, Bromacil and Isocil. From the results obtained it has been established that these chemicals applied at 8-12 lb a.i. per arpent were appreciably more effective than TCA or Dalapon at rates of application varying from 40 to 200 lb per arpent. Formulations consisting of DCMU, Simazine, Paraquat and sodium chlorate proved less satisfactory.

Paederia foetida. Experimental work on the control of that vine growing in stone walls was started this year. Excellent results were obtained with methyl bromide fumigated under a plastic sheet at 1 lb per 90 sq. ft. However further experiments are necessary before any recommendations can be made concerning this method. Other chemicals, Tordon, Weedazol TL, Pesco 18/15, Trysben, at rates of applications of 2 and 4 lb a.i. per arpent of surface covered were also tested in comparison to an ester of 2, 4-D and 2,4,5-T. From preliminary data obtained herbicides which gave very promising results were Tordon and Weedazol TL.

SUGAR MANUFACTURE

In 1964 the Research activities of the Sugar Technology Division were handicapped by the large amount of advisory work that had to be carried out at the request of corporate bodies or individual factories. It was possible, however, to study a number of projects, priority being given to raw sugar quality and to protein extraction from cane juice.

A brief account is given hereunder of the topics which received special attention.

(a) Raw Sugar Filterability. It is highly probable that the unfavourable weather conditions referred to earlier in this report have been conducive to the formation of more starch and non-sugars by the cane plant. As a result raw sugar filterability was adversely affected, especially during the early weeks of the crop. As soon as this situation was observed, a number of measures, additional to those adopted previously, were taken to face the situation. In a talk delivered at this Institute the Sugar Technologist made several recommendations to the Sugar Syndicate and to the Sugar Producers to improve matters. It is gratifying to note that these recommendations have since been generally adopted.

The facilities and assistance of the Sugar Technology Division were also placed at the disposal of the Sugar Syndicate for additional analytical work. Thus sugar samples from all the factories were analysed weekly for filterability by the Nicholson method and for ash. The filterabilities were determined before and after affination in the laboratory in order to obtain a measure of the amount of troublesome non-sugars occluded in the grain.

A number of tests were also conducted in the factories to study the influence, on raw sugar filterability, of various modifications to normal processing techniques. It was thus shown that by double-curing the C sugar used as footing for the A and B strikes it was possible to decrease the starch content of the bagged raws by about 30% and increase their filterability by about 50%. Good results were also obtained by remelting all the C sugar instead of using it as footing.

Preliminary trials were conducted on the effect of hot versus cold liming on starch removal. Starch balances were carried out in five factories by analysing composite weekly samples of mixed juice, scums, final molasses and raw sugar. By calculating the percentage elimination of starch in the products it was possible to correlate, to a certain extent, starch removal with processing techniques.

During his mission overseas the Sugar Technologist was requested by the Sugar Syndicate to contact several refiners and to discuss with them problems of mutual interest. These goodwill visits have no doubt proved very useful.

However, the most important aspect of the problem of raw sugar filterability in Mauritius is the fact that the sugar producers of the island are nowadays much more quality conscious than they were in the past. In 1964 they took several measures to improve the quality of their product whilst they have adopted still more drastic measures for the 1965 crop. As a result there is no doubt that the filterability of Mauritius raws will be considerably improved next year. It is even hoped that the reputation of these raws on the market will soon be as good as it was some years ago when Oliver Lyle* could say (1950): «Mauritius (raws) and British beet are easy to work. The recovery house is lightly loaded and filtration easy..... All that we can do is to try to keep a silo full of Mauritius or beet to help things out when (other sugars) are being particularly cumbersome».

It is also pertinent to mention here that, in the research programme for 1965, priority has been given to the study of various factors that may affect sugar filterability; special emphasis will be placed upon starch.

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* Lyle, O. (1950). Technology for Sugar Refinery Workers, Chapman and Hall, London, p. 302.

(b) **Protein Recovery from Cane Juice.** Little headway was made in 1963 on the recovery of protein from cane juice. The Sugar Technologist, whilst on mission in Europe, discussed again with Messrs. Westfalia Ltd. in Germany the choice of the continuous machine best suited to the industrial recovery of protein from cane juice. In the light of recent experience in the production of glucose from corn starch, the conclusion was reached that it would be very difficult to separate cane protein industrially and continuously from mixed juice, because of its relatively lower density.

On the other hand, it appears from recent investigations carried out at the Institute and published in this report, that, in order to be of value as a feeding stuff, the cane juice coagulate must be dewaxed. In view of the high content of fats and waxes from the coagulate prepared to date, it follows that some form of dewaxing is needed before an adequate digestibility of the material can be obtained. Trials were therefore conducted at Mon Loisir sugar factory with two SKIG Westfalia separators to ascertain whether these nozzle-type machines could be used for dewaxing the juice. Both conventional and small bore nozzles were tried, but with no success.

It has therefore been decided to start investigations anew in the laboratory, in an endeavour to separate the protein from syrup instead of from juice. To this end two laboratory centrifuges have been ordered, and trials will be resumed as soon as the equipment arrives.

(c) **Commonwealth Sugar Agreement.** Following the decision by the Ministry of Food and Agriculture to review in 1964 the price fixing formula contained in the Commonwealth Sugar Agreement, the Chamber of Agriculture requested Messrs. Forges Tardieu Ltd., in collaboration with the Sugar Technologist, to :

(i) Carry out a survey of plant and machinery of the 23 factories as existing in 1962, and hence to establish the type, size and replacement value of all plant and machinery of an «average typical» factory having a crushing capacity of 100 TCH.

(ii) Determine the life years of each factory asset and consequently, the rate of depreciation.

(d) **Particle Board Factory.** The Sugar Technologist sat on a technical committee which studied the possibility of manufacturing particle board from bagasse in Mauritius by a new process patented by Ingenio G. Rossi of Milan. Following the conclusions arrived at in a preliminary report issued by the Committee, Mr. de Saint Antoine formed part of a small delegation which included the promoter of the project, Mr. Jean Espitalier Noël, and Mr. J. P. Lamusse. They spent two weeks at the works of Mr. Rossi, near Milan, in order to study the project in detail. The conclusion was reached that particle board can be profitably produced in Mauritius by the process studied.

(e) **Cane Sampling.** At the request of the Central Board, the Institute studied the sampling of cane from the cane carrier after its preparation by a shredder and/or cane knives. This study became desirable following the adoption by the Central Board of the Jeffco Cutter Grinder for the determination of fibre in planters' cane, as recommended by this Institute in 1963. A cane sampler was devised by Mr. E. Piat, Associate Sugar Technologist, for installation at Médine Sugar factory. Although this sampler was only a prototype constructed for the set up of one particular factory, it worked satisfactorily and should, with a few modifications, provide a good tool for sampling shredded cane in factories where conditions are similar to those at Médine.

(f) **Miscellaneous.** Various studies were also conducted during the crop and are reported upon in the Sugar Technology section of this report. They included the power consumption of cane knives and shredders; the Fletcher-Leclézio crystallizer; trials on the use of «magox» as a clarifying

agent and the advisability of using load cells for checking Maxwell Boulogne scales.

The Instrumentation Engineer was kept fully busy with the checking, calibration and repairs of a large number of indicating, recording and controlling instruments, thus emphasizing the value of the services of a qualified Instrumentation Engineer to the industry.

LIBRARY

Owing to the expansion of the Library's collections, the space occupied by the library was enlarged this year by the addition of a new room. 656 new accessions brought the collection to a total of 7,839 bound volumes. The periodical and serial publications currently received through subscriptions or exchange now number 349 titles.

It was possible through the list of duplicate periodicals which was circulated at the end of 1963, to present to many libraries an important collection of journals ; the library benefited likewise from the co-operation of many libraries, and the gaps in the collection were filled. I would like to record the grateful appreciation of the M.S.I.R.I. to the many librarians who responded to our request, and in particular the librarians of the following :

The British National Book Centre;
Kungl, Lantbrukshögskolan Biblioteket, Uppsala, Sweden;
The United States Book Exchange;
Experiment Station of the Hawaiian Sugar Planters' Association, Hawaii;
Centro de Investigaciones Agronomicas; Maracay, Venezuela;
National Library of Peking : People's Republic of China;
Department of Agriculture, Kawanda Research Station, Kampala, Uganda;
South African Sugar Association, Experiment Station, Mount Edgecombe, South Africa;
Institute for Agricultural Research, Samaru, Zaria, Northern Nigeria.

Further progress in the compilation of the *Union List of Scientific Periodicals* received in Mauritius was made. This year, a revised catalogue of the collection of periodicals of the M.S.I.R.I. was completed and typed. A copy was placed in the Library of the Department of Agriculture and the Mauritius Institute.

A ten-year *Index of the Annual Reports* of the M.S.I.R.I. from 1954 to 1963 was also prepared by the Senior Staff of the Institute in collaboration with the Librarian. This Index is printed in Appendix to the present Annual Report.

PUBLICATIONS

Annual Report 1963. 153, XXXII., 38 figs.
French summary in *Rev. agric. sucr. Maurice* **43** (2) 1963 : 80-112.

Occasional Paper

No. 18. ROCHECOUSTE, E. Botanical and agricultural characters of Sugar Cane Varieties of Mauritius. 2) M. 202/46, M. 93/48, M. 253/48 and Ebène 50/47. 18 pp. 13 figs.

Leaflet

No. 9. ROCHECOUSTE, E. *and* VAUGHAN, R. E. Weeds of Mauritius.
13. *Plantago lanceolata* Linn. (Herbe Caroline, Plantain). 5 pp. 1 pl.

Technical Circulars

No. 22. HEMMING, C. F. 1) Red Locusts in Mauritius (*Nomadacris septemfasciata* Serville); 2) The Anti-Locust Research Centre. 40 pp.

No. 23. WIEHE, P. O. *and* ANTOINE, R. Nouvelle apparition de la Gommose à l'Ile Maurice 35 pp. 1 fig.

Private Circulation Report

No. 18 NG YING SHEUNG, R. The Taiwan Sugar Industry and its Experiment Station. 95 pp. 5 figs.

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

ANTOINE, R. Les maladies de la canne à sucre à Maurice **43**(3) : 184-188.

ANTOINE, R. Nouvelles maladies de la canne à sucre en 1964. **43**(4). : 373-375.

GEORGE, E. F. Development in cane breeding in Mauritius over the last ten years. **43**(3) : 153-162.

HARDY, M. Expérience lysimétrique et perspective d'avenir pour l'irrigation par aspersion **43**(3) : 216-218.

LE GUEN, F. Notes sur les installations d'instruments de mesure et de contrôle. **43**(3) : 313-315.

MAZERY, G. L'évolution de l'irrigation à Maurice pendant la dernière décade. **43**(3) : 209-215.

PARISH, D. H. A review of work on cane nutrition in Mauritius. **43**(3) : 163-183.

ROCHECOUSTE, E. Désherbage chimique. 43(3) : 195-200.

ROUILLARD, G. Histoire des domaines sucriers de l'Ile Maurice. 1) Aperçu général de l'industrie sucrière. **43**(1): 5-21.

ROUILLARD, G. Les engrais organiques. **43**(3) : 201-208.

SAINT ANTOINE, J. D. de R. de. Evolution de la recherche en technologie sucrière et observations sur le contrôle chimique. **43**(3) : 288-303.

VIGNES, E. C. Utilisation des sous-produits de la canne à sucre. **43**(3) : 304-312.

WIEHE, P. O. Les dix premières années de l'Institut de Recherches de l'Industrie Sucrière. **43**(3) : 147-152.

WILLIAMS, J. R. A review of the work of the Entomological Division. **43**(3) : 180-193.

Articles in Foreign Journals

WIEHE, P. O. La recherche scientifique appliquée au sucre à l'Ile Maurice. *La Revue Française de l'Elite Européenne*, no. 167, 1964 : 42-46.

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

6. *Eudorylaimus sundarus* n. sp. (Dorylaimidae) *Nematologica* **10,** 1964 : 319-322.
7. Species of *Thornenema* (Dorylaimidae) *Nematologica* **10,** 1964 : 345-352.

THE MAURITIUS HERBARIUM

The work of the Mauritius Herbarium in 1964 is reviewed hereunder by Dr. R. E. Vaughan, its Honorary Curator.

During the year, just over 1,000 sheets of specimens were added to the Herbarium. These included important material from the other Mascarene Islands, Réunion and Rodrigues. At the end of October 1963, Mr. France Staub visited Rodrigues and brought back from there a collection of 98 different species including good representatives of the endemic plants of the Island; in addition, some further Rodrigues specimens were received from the Forest Department Officer, Mr. G. P. Appassamy. There remains much to be done in Rodrigues to fill in the many gaps in our knowledge of the indigenous flora especially as some of the native plants have not been seen again since Balfour made the first botanical survey of the Island in 1874.

In May, Mr. Staub had the opportunity of visiting Réunion and collected 64 species from there including some of the little known indigenous orchids. A further collection of Réunion plants was obtained by Dr. P. O. Wiehe in December, and among these were some species of much interest. It is hoped that in future regular expeditions may be arranged to Réunion

and Rodrigues where so much of botanical interest still remains to be studied.

Mr. Staub has also been able to make two trips to the Cargados Carajos group, or St. Brandon, as the islets are usually called in Mauritius. In the second visit, made with the Herbarium Assistant, Mr. J. Guého, it was possible to compile a census and enumeration of the plants growing on all the different islets and to bring back extensive material for the Herbarium. No proper botanical survey has been made of this group of islets, and our somewhat scanty knowledge of their vegetation is based on a short visit made in 1905 by the Sealark Expedition to the Indian Ocean under Stanley Gardiner.

During a short mission to Madagascar, Dr. E. Rochecouste was able to obtain for the Herbarium some species of plants, mostly grasses, found in the vicinity of Brickaville.

From the Director, Botanical Gardens, Singapore, we received a batch of marine algae, upon which a report was prepared here concerning their relation to Mascarene species.

From the Botany School, Cambridge, we were glad to have a specimen of the heath-like plant *Phylica arborea* (Rhamnaceae) collected on Tristan da Cunha by Mr. J. H. Dickson, member of a team organized by the Royal Society, London, to study the recent volcanic outbreak. *P. arborea* is restricted to islets in the South Indian and Atlantic Oceans, but there is evidence to suggest that it formerly occurred in Mauritius.

Early in June, we suffered a heavy loss in the premature death of Forest Ranger, Y. Duljeet. Mr. Duljeet was keenly interested in Mascarene plants, and through his untiring efforts many carefully annotated specimens were added to the Herbarium. Just before his death, Mr. Duljeet had completed a very useful compendium of local plants based on their vernacular names, with their scientific equivalents and uses.

Turning now to material sent overseas by the Herbarium, we have attempted to meet the requirements of institutions and research workers so far as our resources and the availability of the particular species permit. Our main work in this direction may be summarized as follows : living material of three species of *Zingiberaceae* to the Botany Department, Sir John Cass Institute, London, for cytological research on this family; a collection of Mascarene species of *Carex* to the Herbarium of the Botanic Garden of Kassel; a consignment of dried leaves of *Tabernaemontana* (Bois de lait), a relation of *Rauwolfia*, to the Department of Pharmaceutics, University of Singapore; spirit material of the rare genus *Astelia* (Liliaceae) to the Jodrell Laboratory, Royal Botanic Gardens, Kew, for anatomical studies; a collection of living Mascarene orchids to Prof. Rolf L. Bolin, Director of the Te Vega Expeditions, made during his visit to Mauritius in June this year.

A general collection of 24 plants made by Dr. George R. Cooley of the Gray Herbarium, Harvard, who visited us in November 1963, was named and dispatched to him early in the year. A report was prepared for the Department of Botany, University of Strathclyde, on a small collection of plants made by surgeon-botanist John Scouler during a brief visit to Mauritius in 1829.

We are indebted to several overseas specialists for the determination of material from the Mascarene Islands and, in particular, would like to mention the following : a collection of Mascarene ferns determinated by Mme. Tardieu-Blot, Museum National d'Histoire Naturelle, Paris; indigenous species of the family *Loranthaceae* by Mme. Simone Balle, Université Libre de Bruxelles ; eight species, both indigenous and naturalised of the difficult genus *Ipomoea* by Dr. S. J. van Ooststroom, Rijksherbarium, Leiden; some ornamental shrubs in the Royal Botanic Gardens, Pamplemousses, in the families *Acanthaceae* & *Rubiaceae* by Dr. C.E.B. Bremekamp, State University of Utrecht.

Some fifty species have been sent overseas to various institutions and are awaiting determination. Gifts of books, prints, and photostats, have been made by the Royal Botanic Gardens, Kew, the Arnold Arboretum, Harvard and the Rijksherbarium, Leiden.

During the year, work on the weed flora has continued and one leaflet was issued on *Plantago lanceolata* (Herbe Caroline).

It is with deep regret that we record the

sudden death of Charles Baehni, the distinguished Director of the Conservatoire et Jardin Botanique de Genève, with whom the Mauritius Herbarium has been in correspondence for a long period. The writer worked at the Herbarium of the Conservatoire in 1957, when studying Mascarene plants in the de Candolle Herbarium.

In conclusion, we may cite hereunder some of the more important papers related to our region which have been acquired by the Herbarium Library during recent months.

BALLE, S. 1964. Les Loranthacées de Madagascar et des Archipels voisins. *Adansonia*, N. S. 4: 105-141.

HARTOG, C. den 1964. An approach to the taxonomy of the Sea-Grass genus *Halodule* Endl. (Potamogetonaceae). *Blumea*, **12**: 289-312. (Includes the two Mascarene species.)

LY-TIO-FANE, M. 1963. Joseph Hubert and the Société des Sciences et Arts de de l'Isle de France (1801-1802). *Proc. R. Soc. Arts Sci. Mauritius*, **2**: 221-246, 1961-1962. (Contains original material concerning the work of Hubert.)

SAUER, J. 1964. Revision of *Canavalia*. *Britonnia*, N. Y. **16**: 106-181. (Describes and gives distribution of the widely spread Mascarene species, *C. maritima* (Aubl.) Thouars).

STEENIS, C. G. G. J. van. 1962. The land-bridge theory in botany with particular reference to tropical plants. *Blumea*, **11**: 235-372. (A critical contribution of great significance with a valuable bibliography).

STEENIS, C. G. G. J. van. 1964. On the origin of Island Floras. *Advanc. Sci. Lond.* May, 1964: 79-92.

TARDIEU-BLOT, Mme. M.L. 1960. Les Fougères des Mascarcignes et des Seychelles. *Notulae systematicae* **16**: 151-201.

TAYLOR, P. 1964. The genus *Utricularia* (*Lentibulariaceae*) in Africa, South of the Sahara. *Kew Bull.* **18**: 1-245.

WOODWARD, B.B. 1900. Dupetit-Thouars. Bibliographical Notes No. XXIII, *J. Bot.* **38**: 392-406.

GENERAL

1. **Meetings**. The *Société de Technologie Agricole et Sucrière* held its 4th Conference from the 18th to the 21st of May, three days being devoted to the presentation of papers, the main theme of which was a review of ten years' progress of the Sugar Industry. Twenty five papers were presented of which twelve were contributed by the Staff of the Institute. This Conference was also well attended by delegates from Madagascar & Réunion. The proceedings were published in Vol. 43 of *La Revue Agricole & Sucrière*.

Lectures primarily designed for Extension Officers of the Department of Agriculture and Field Staff of Sugar Estates were held at monthly intervals.

Meetings held at the Bonâme Hall during the year are listed below :

27th January — C. F. HEMMING. (Anti-Locust Research Centre). Locust Control and the Anti-Locust Research Centre.

17th February — P. HALAIS. Fertilization Problems.*

9th March — R. ANTOINE. Les moyens de la lutte contre deux maladies importantes de la canne à sucre à Maurice : les stries chlorotiques et le rabougrissement.*

23rd March — Meeting on the occasion of the International Meteorological Day.

20th April — E.F. GEORGE. Cane Varieties.*

27th April — R. ANTOINE. Le «Yellow Spot», une nouvelle maladie de la canne à Maurice.

4th May — Professor H. BRUNICHELSEN. Cane Diffusion.

14th May — P. O. WIEHE. A review of the work of the M.S.I.R.I. in 1963.

18th-20th May — *Société de Technologie Agricole et Sucrière de l'Ile Maurice* — Congress, 1964. Review of ten years' progress of the Sugar Industry.

15th June — Professor R. L. BOLIN. (Hopkins Marine Station, Stanford University). Oceanographic Research in the Indian Ocean.**

22nd June — G. ROUILLARD. Cane Cultivation.*

9th July — P. O. WIEHE *and* R. ANTOINE. Une nouvelle apparition de la maladie de la gomme à Maurice.

20th July — J. D. de R. de SAINT ANTOINE. Sucrose content of canes.*

14th September — Mauritius Sugar Syndicate — Sugar Quality

21st September — D. H. PARISH. Fertilization*.

19th October — E. ROCHECOUSTE. Herbicides.*

23rd November — J. R. WILLIAMS. Infestation by the scale insect (*Aulacaspis*) of canes to be used as planting material.*

3rd December — I.S.S.C.T. Meeting of the Regional Section to discuss questions related to the XIIth Congress to be held at Puerto Rico in 1965. Pierre HALAIS. Porto Rico et son industrie sucrière.

22nd December — A. BANNISTER (Johannesburg). The use of closeup photography in nature.***

2. Comité de Collaboration Agricole Maurice-Réunion-Madagascar. Visits of the staff to Réunion and Madagascar under the auspices of the C.C.A.M.R.M. included :

(i) *to Madagascar* : Mr. Antoine in April (Fiji disease), Dr. Rochecouste in March (Weed Control), Mr. Williams in October (borer parasite), Mr. Cavalot in October (field course in soil science, organized by UNESCO).

(ii) *to Reunion* : Dr. Wiehe and Mr. Antoine in May and November to attend meetings of the pathology subcommittee and the annual meeting of the Committee at which the Secretary of the Institute, Mr. P. G. du Mée, was also present. Mr. Y. Wong spent several days at I.R.A.T. in August to study the Chaminade method of pot experiments.

(iii) *from Madacascar* : Messrs. J. Têtefort & D. Wintrebert from the *Station de Recherches Acridienne* spent several days in Mauritius in December for observations on locusts.

3. Visit of Mr. C. F. Hemming. By arrangement with the Director of the Anti-Locust Research Centre, London, Mr. C. F. Hemming spent the month of January in Mauritius, and Mr. P. Simmons visited the island for a shorter period in November. Both these visits were made in connection with the outbreak of locust which was observed in several areas in 1963.

4. Staff Movements. The following officers went on overseas leave in 1964 : Messrs. P.G. du Mée, J. A. Lalouette, M. Mamet, R. Ng, C. Cavalot, P. R. Hermelin, Drs. E. Rochecouste and P. O. Wiehe.

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* Talks specially prepared for the Extension officers of the Department of Agriculture and for the field staff of sugar estates.

** Joint meeting with the *Royal Society of Arts and Sciences*, Mauritius, and the *Société de Technologie Agricole et Sucrière de l'Ile Maurice.*

*** Joint meeting with *Association of Former Agricultural Students* and *Société de Technologie Agricole et Sucrière de l'Ile Maurice.*

By arrangement with Rothamsted Experimental Station and I.C.T. Ltd., Mr. J. A. Lalouette spent a period of three months studying statistical methods and programming for computers.

Mr. Mamet attended a course on pesticides in May, while Mr. Ng spent about a month at the Taiwan Sugar Experiment Station. Mr. Cavalot worked some time with soil survey workers in England.

By arrangement with the Mauritius Sugar Syndicate, Mr. J. D. de R. de Saint Antoine spent several weeks in the U.K. and Canada in September in connection with sugar quality. He also studied the production of particle board manufacture in Italy.

While in the U.K. Dr. Wiehe attended a meeting of the I.S.S.C.T. Committee established to make recommendations on co-ordination in sugar research and co-operative research projects between sugar cane research stations.

Grateful acknowledgement is made to the various organizations concerned for the facilities granted to the officers.

Mr. E.F. George left the island on leave in August prior to resigning his post as Geneticist.

Messrs. C. Mongelard and C. Ricaud who had benefited from Commonwealth Fund Scholarships returned from U.K. in August and December respectively, after the conclusion of one year's study at the Imperial College.

5. **Miscellaneous**. Courses of lectures were given by several members of the staff at the College of Agriculture, while third year College Students spent several weeks of their long vacations in the different divisions of the Institute. Close contact was maintained with planters, producers and the Department of Agriculture; 1,642 visits to sugar estates were made by the staff.

The four field stations of the Institute were visited on frequent occasions by individual planters and by the Board and Research Advisory Committee. Cane production on those stations during the year was as follows : Réduit 253, Pamplemousses 477, Belle Rive 315 and Union Park 176 tons.

In conclusion I should like to express my gratitude to all members of the staff for their co-operation and in particular to Dr. E. Rochecouste who acted for me while I was away on leave from August to November.

Director

30th January, 1965.

CANE BREEDING

W. de GROOT & J. A. LALOUETTE

1. ARROWING

THE season on record has been favourable to flowering. Once again, it was observed that in years with a high percentage of arrowing stalks, all flowers emerge during a relatively short period, such period occurring early in the year. As a result, the execution of a pre-established breeding programme being limited to a short period, sets a stress for labour during crossing time.

One small experiment on leaf-lopping was established, but cyclone «*Danielle*» destroyed most of the experimental plots and no results were obtained.

The usual assessment of percentage of arrows in various varieties on estates was not conducted this year. Continuation of the analysis of data obtained in previous years did not lead to new findings. The problem of flowering in sugar cane will have to be tackled more vigorously if the desired results are to be obtained.

2. CROSSING

(i) Programme

A large number of combinations between female and male parents has been attempted over the years in the normal crossing programmes. Most of these combinations were proven crosses, while in others at least one of the parents was known to give a good progeny. In all cases, the number of seedlings produced was of great importance in estimating the value of the parents.

As a result, many combinations were effected over and over again, producing many seedlings each year, although the possibilities of these progenies had already been exhausted. A population of two to three thousand seedlings is sufficiently large to allow the selection of varieties of value from within a cross. The repeating of such crosses therefore, does not seem to be justified. (George (1962), Walker (1962).)

Many test crosses between new parents and proven ones have also been attempted, some with success. Many parents however were tried once or twice and then discarded because of their inability to produce seedlings. It is thought that these parents should be tested once more with as wide a range of proven parents in order to assess whether discarding is justified either through their continued failure to produce seedlings or their giving rise to a progeny of little value.

A preliminary screening of all results obtained in crosses made since 1953 was started in 1963. It was hoped at the time to have the work completed before planning the programme for 1964. Unfortunately, that was found to be impossible on account of the amount of work involved and no reliable information could be obtained. It was therefore decided to limit crosses with proven parents such as: M.134/32, M. 99/34, M. 112/34, M. 63/39, M. 213/40 and M. 147/44 as far as possible and rather try new parents and combinations. Since the start of the larger crossing programmes in 1960, the number of different combinations has increased (Table 1) although many of these were repeated each year.

The production of over 100,000 seedlings annually does not set real problems, but an improvement in quality of the progeny obtained each year can only be achieved through the use of new parental lines. Therefore, the importation of new varieties, especially wild varieties, to be used in the breeding work; research into the control of flowering and induction of male fertility, as well as studies on seed development, are of the utmost importance when an improvement in the quality of the progeny is the goal.

(ii) 1964 results

The year on record, as already stated, was favourable as far as flowering was concerned. However, male fertile parents were lacking and to obtain a fair amount of seedlings it was once again necessary to use the old proven males almost exclusively. The execution of the proposed crossing programme was therefore hampered.

During flower development, temperatures were below normal and that factor has undoubtedly prevented the formation of pollen in many varieties which are usually male, under more favourable conditions. Induction of male fertility was attempted on a limited scale following the method used in 1960 (George & de Groot (1961)), but results were once more negative. The need of a suitable method to induce male fertility in years during which adverse weather conditions prevail is rendered evident by the following figures for 1964. A total of 460 different combinations was made, for which 174 parent varieties were used. The number of different male parents however was only 60, compared to 105 in 1963.

The majority of cane stalks used for crossing were kept alive in SO_2 – solution. To prevent wind damage to ripening flowers and to protect the solution against dilution by rainwater, a ripening area was constructed. The preservative solution in the containers inside the greenhouse and the ripening area was changed every other day. However, some difficulties were still encountered in keeping the stalks alive long enough for the seeds to mature. A few counts made, indicated that only 2% of the flowers on an arrow formed viable seeds. There is room for much improvement at this stage.

Fuzz, after ripening, was once again stored in the deep-freeze for sowing 3-4 months later. All left-over crosses made in 1963 were sown and, once again, it was found that seeds germinate well after storage at – 15°C for over 15 months. In order to obtain the number of seedlings desired nearly all the seeds of 1964 crosses had to be sown so that fuzz obtained from 50 crosses only is left for next year's sowing.

Following the results obtained in 1963 (George & de Groot (1964)) soil for sowing purposes was sterilized with methyl bromide only. The greenhouses were disinfected before sowing started and kept as clean as possible. This resulted in a marked decrease in disease incidence compared to last year. Most of the seedlings were potted in bunches of 3, while a proportion of seedlings from 5 crosses were potted singly for experimental purposes.

A summary of crossing and sowing work is given in Tables 2. (a, b).

Table 1. Relationship between number of crosses made, number of different combinations used and number of seedlings obtained during the last twelve years.

Year	*Number crosses*	*Number different combinations*	*Number seedlings obtained*
1953	232	116	69,879
1954	269	115	44,812
1955	181	86	30,466
1956	390	159	32,383
1957	305	141	40,475
1958	341	147	15,397
1959	366	146	40,826
1960	780	393	174,400
1961	701	322	106,018
1962	948	521	103,125
1963	1033	577	132,548
1964	976	460	*

* Not yet available.

Table 2. (a) Summary of crossing work 1964.

Number of crosses made

Station	*For experimental purposes*	*In the greenhouses*	*In the fields*	*Solution crosses*	*Total*
Réduit ...	33	530	15	284	862
Pamplemousses ...	—	—	114	—	114
Total	33	530	129	284	976

Table 2. (b) Results of sowing 1964.

Number of crosses

	Sown for experimental purposes	*Stored*	*Not germinated*	*Discarded*	*Kept*	*Total*	*Number of seedlings obtained*
1963 - crosses ...	—	—	52	94	84	230	32,211
1964 - crosses ...	33	56	171	420	296	976	91,056
Total	33	56	223	514	380	1206	123,267

3. SELECTION

Cane growth in the southern and central sectors of the island was badly influenced by the cold and wet weather conditions and by cyclone «*Danielle*». Especially at Union Park Experiment Station yields were very low and selection there was nearly impossible. On the other stations work could be completed without much difficulty.

Selection in seedlings planted in the field in March 1962 was carried out in May and June before the start of the harvesting season. As sugar content is not considered at this stage, this early start could be made without loss of information. As land had been kept fallow for the purpose of planting the first selections it was possible to start selection-work early. In future this practice will be continued and one arpent will be kept fallow on each station for the purpose of planting selections before the start of the crop. In this way the waiting time for the preparation of land during the selection period will be kept to a minimum.

A summary of selection work is given in Table 3 while the selection schedule is represented in fig. 10. The procedure had to be altered and adapted to new requirements resulting from the appearance of the new and more virulent strain of the gumming disease organism and findings in recent experiments on selection. One of these was that selection in Bunch Selection Plot could be conducted in virgins, thus resulting in a gain of one year.

Selections from First Selection Trials were again planted for rapid multiplication at Médine S.E. The sub-stations established for selection purposes at F.U.E.L., Médine and Mon Désert-Alma facilitate the work of the division. The kind co-operation of the managements concerned is gratefully acknowledged.

Among the 27 varieties selected from first selection trials and planted at Médine the following are promissing :

M. 194/57 was originally selected at Réduit from the cross M. 134/32 × M. 147/44 for its good sugar content. After passing through later stages of selection it again showed a good sugar content this year in a first selection trial. Yield at Réduit was nearly the same as that of M. 147/44. Stalks are fairly thick and flowering seems to be sparse.

M. 248/57 (P. O. J. 2727 × M. 147/44) was selected from First Selection Trial at Belle Rive where this variety had been selected originally. Yield in this trial was far better than the standard Ebène 1/37, which suffered from the adverse weather conditions. Sugar content was high. Stalks are thin and the variety did not flower under Belle Rive conditions.

M. 100/58 is derived from the cross B. 3439 × M. 147/44 made at Pamplemousses Experiment Station and selected there. The variety flowered sparsely in the trial. Sugar content was high, while yield was about the same as that from M. 147/44. The variety is fairly thin-stemmed.

During the year, experiments on selection efficiency were continued, especially in bunches; while, in another series of experiments, competition in small plots was estimated. The bunch planting experiments were harvested and although results still have to be analysed fully, there are indications that the adopted method of planting bunches of 3 seedlings is best for Mauritius conditions.

Results of the competition experiment are to be presented at the forthcoming XIIth. Congress of the I.S.S.C.T. From these studies it was concluded that selection, especially in Seedlings and Bunch Selection Plots, should be very liberal in order to exclude variation due to competition.

Table 3. Summary of selection work in 1964.

Station	*No. of stalks planted in B.S.P.*	*No. of varieties planted in Prop. Plots*	*No. of varieties planted in 1st. Select. Trials*	*No. of selections made in 1st. Select. Trials*
Réduit	1,252	77	—	8
Pamplemousses	1,172	853	34	6
Belle Rive	—	511	37	6
Union Park	—	367	30	7
F.U.E.L.—Union ...	1,316	—	33	—
Minissy	4,309	—	—	—
Total . ..	8,049	1,808*	134**	27

* From these, 878 varieties are planted in two regions and 52 in only one, making a total of 930 different varieties.

** From these 18 varieties are planted in two regions, making a total of 116 different varieties.

SELECTION SCHEME

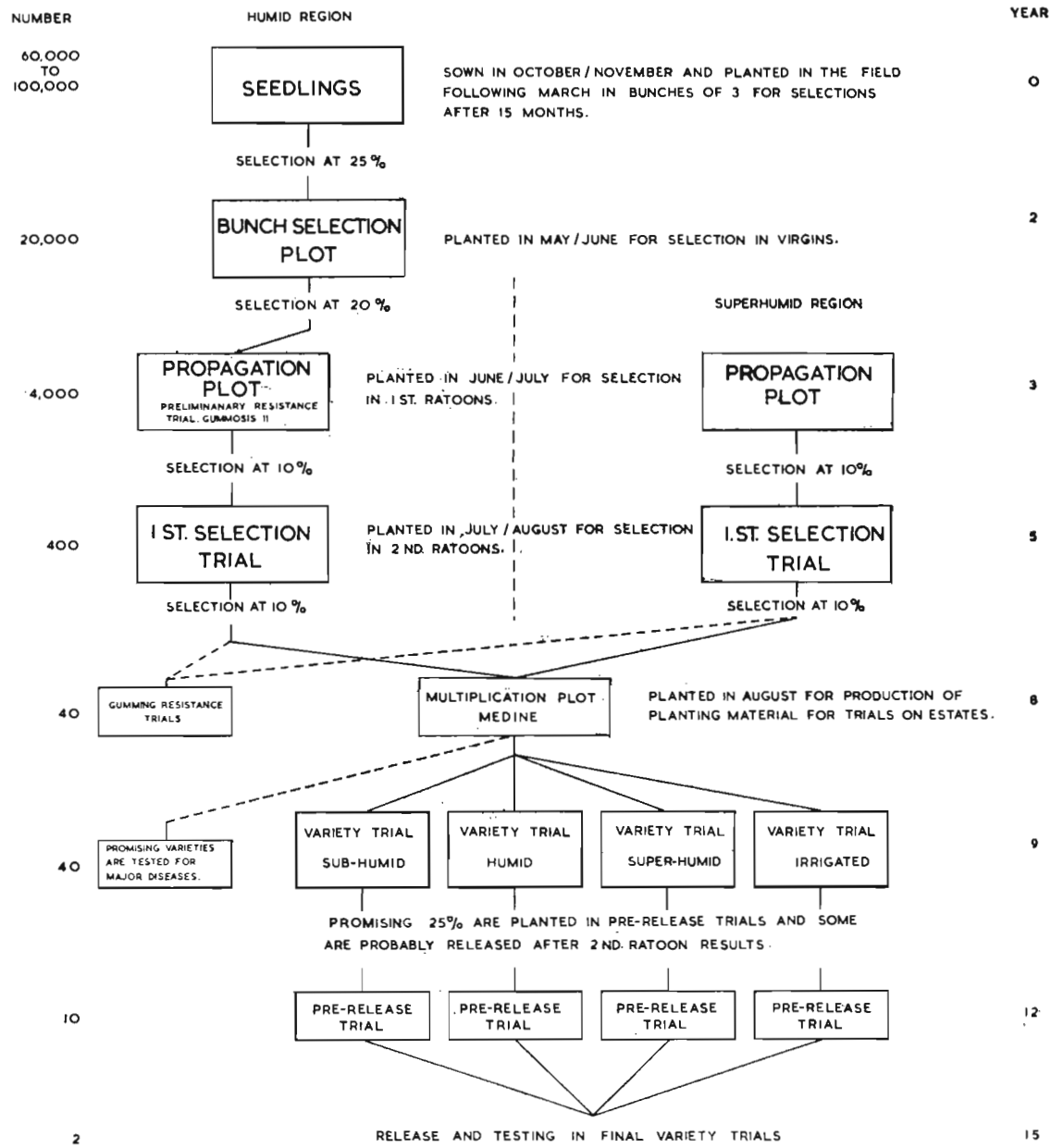

Fig. 10

4. VARIETY TRIALS ON ESTATES

The occurrence of the new strain of the gumming disease pathogen in Mauritius has a profound influence on the testing of varieties in trials on estates. In one trial situated in a highly infected area out of 12 varieties only *one* proved to be resistant. The Pathologist has established a resistance trial in which all varieties at present in trials on estates and varieties under rapid propagation at Médine, for planting the 1965 trials, are represented. Preliminary results will be obtained in June 1965 after which promising resistant varieties are to be propagated rapidly for eventual release to replace the susceptible varieties cultivated at the moment. Special efforts are being made to accelerate the determination of varietial adaptation in the dry areas where M. 147/44 alone can be grown.

This year, the first results were obtained from the new variety trials in which varieties are tested in the four cane-growing regions simultaneously. Although the trials were reaped in virgins, interesting information was obtained, especially on sugar content. An additional 27 trials were planted, while 10 were discarded, bringing the total to 82 trials in which 148 varieties are tested. (Tables 4 and 5)

Table 4. Distribution of trials

Year of planting	*Sub-Humid*	*Humid*	*Super-Humid*	*Irri-gated*	*Total*
1961	2	5	3	2	12
1962	5	6	2	3	16
1963	6	7	7	7	27
1964	7	6	6	8	27
Total ...	20	24	18	20	82

Table 5. Varieties tested in trials on estates

Series	*No. of varieties*
1951	6
1952	2
1953	6
1954	14
1955	31
1956	34
1957	32
1958	3
Sub-total	128
Ebène varieties	9
Imported varieties	11
Total	148

The performance of the most promising varieties is given below :

M. 442/51 was released early in 1964 but is still represented in the trials. Results once again confirmed that this variety is a mid-season to late-maturer and thus should not be harvested before the middle of the crop. This is clearly indicated by the following table in which results of 4 pre-release trials are combined.

	I.R.S.C.		
	Early	*Middle*	*Late*
M. 442/51 ...	9.4	11.4	11.3
Standard (M.147/44)	10.3	11.1	11.1

This variety gave interesting results particularly in the sub-humid zone and can therefore be considered, with the above proviso, as a good replacement for M. 147/44 in that region.

Results of variety trial in sub-humid zone :

	T.C.A.%	*I.R.S.C.%*	*T.S.A.%*
M. 442/51	34.9(102)	12.8(103)	4.47(105)
M. 147/44	34.3(100)	12.4(100)	4.25(100)

M. 99/48 This variety is being considered for release in 1965. It was selected in virgins at Hermitage Experiment Station from the cross B. 34104 × M. 213/40 and planted in a second trial at the same station.

It was selected for its good yield from the second trial and subsequently planted at Beau Climat together with M. 93/48 Results obtained in this trial (means of virgin, 1st, 2nd, 3rd, 4th & 6th ratoons) were as follows :

	T.C.A.%	*I.R.S.C.%*	*T.S.A.%*
M. 99/48	29.74(120)	11.6(100)	3.45(120)
M. 93/48	32.43(131)	11.7(101)	3.80(132)
B. 3337	24.73(100)	11.6(100)	2.87(100)

From this trial, M. 93/48 was selected as the superior variety and released after further testing. Other results obtained in pre-release trials have shown that M. 99/48 is almost as good as M. 93/48. On present knowledge, the variety is moderately resistant to the new strain of the gumming organism and is therefore acceptable for cultivation in the super-humid region, particularly as it may prove to be a useful substitute in the replacement of B. 3337.

M. 99/48 is a medium-thick variety with stalks of a reddish colour. Trashing is not difficult, flowering is moderate. It germinates better than M. 93/48. The reactions of M. 99/48 and M. 93/48 to major diseases are similar. It does not seem to be susceptible to borer attacks.

M. 39/49 which has been mentioned in these notes last year seems to be adapted to the super-humid zone. Its yield in T.S.A. fell short of that of M. 93/48 but was superior to that of Ebène 1/37.

M. 409/51 is a promising variety for the humid and sub-humid zones, except in coastal areas where irrigation is not practised. Although yields are not as good as those of M. 147/44, sugar content is higher. Results obtained so far are summarized below.

Four harvests in ratoons M. 147/44 area

	M. 409/51	*M. 147/44*
T.C.A. ...	34.4	39.9
I.R.S.C. ...	11.7	10.9
T.S.A.	4.02	4.35
Relative benefit ...	2.65	2.75

M. 423/51 has been described in this section, for the last years as promising. Again, in 1964, sugar content was very good, but yields were variable.

M. 658/51 was planted originally in a variety trial in the humid zone with M. 134/32 as standard. In 1961 and 1962 it was planted in pre-release trials in various parts of the island but results obtained from these trials are not as promising as expected. A summary of results obtained for two trials in 1st ratoons in M. 147/44 areas and one in 2nd ratoons in M. 93/48 areas is given below :

	T.C.A.	*I.R.S.C.*	*T.S.A.*	*Relative Benefit*
M.658/51	32.6	11.4	3.60	2.41
M.147/44	35.4	11.1	3.93	2.51
M.658/51	31.0	10.3	3.16	1.95
M.93/48	33.2	10.4	3.41	2.12

Although sugar content is fairly good, yields are below standards. In one trial in the sub-humid zone, results were good and the variety is to undergo further testing in that region.

M. 110/52 has been planted recently, Results obtained in virgins indicate that it is a rich variety, although yield is not as good as in M. 147/44

M. 13/53 has given good results in virgins and seems to be a promising variety with a good sugar content. One trial in the irrigated zone has been harvested up to 5th ratoons and there, M. 13/53 has given better yields than M. 147/44. However, further information has

to be obtained before its value can be assessed. The same is true for **M. 356/53**, **M. 359/53** and **M. 361/53** which seem to be adapted to the super-humid region and are all derived from the same cross (Ebène 1/37 × Co 290).

Several varieties from the 1956 series appear to be promising and so does **Ebène 118/56**. The last one named, is a rich variety. **Ebene 88/56** cannot be considered for release as it is highly susceptible to the new strain of gumming disease, although results in various trials were very good.

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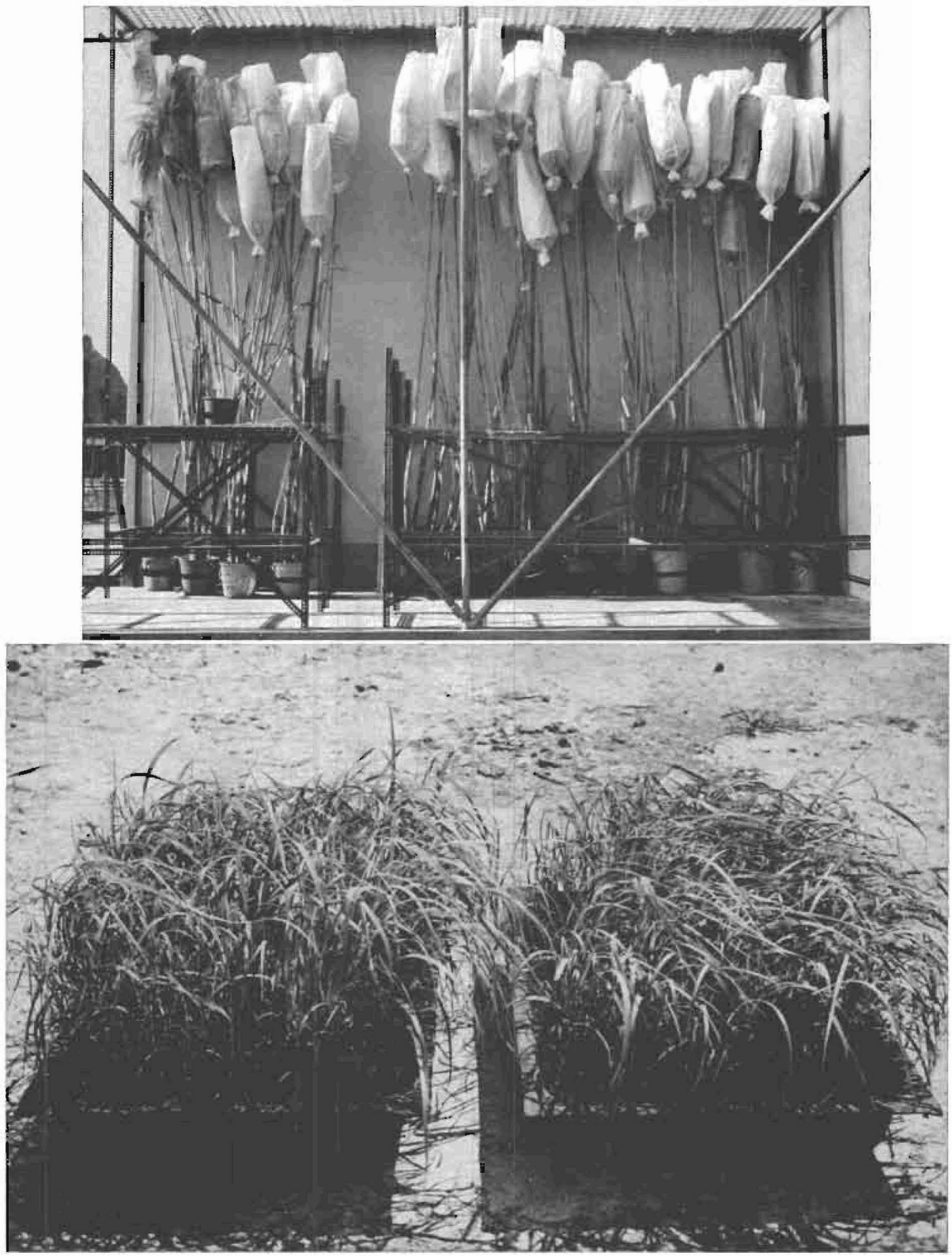

Plate I

Top. Ripening area for flowering cane stalks kept in SO_2 solution.
Bottom. Seedlings in iron flats prior to transplanting into pots.

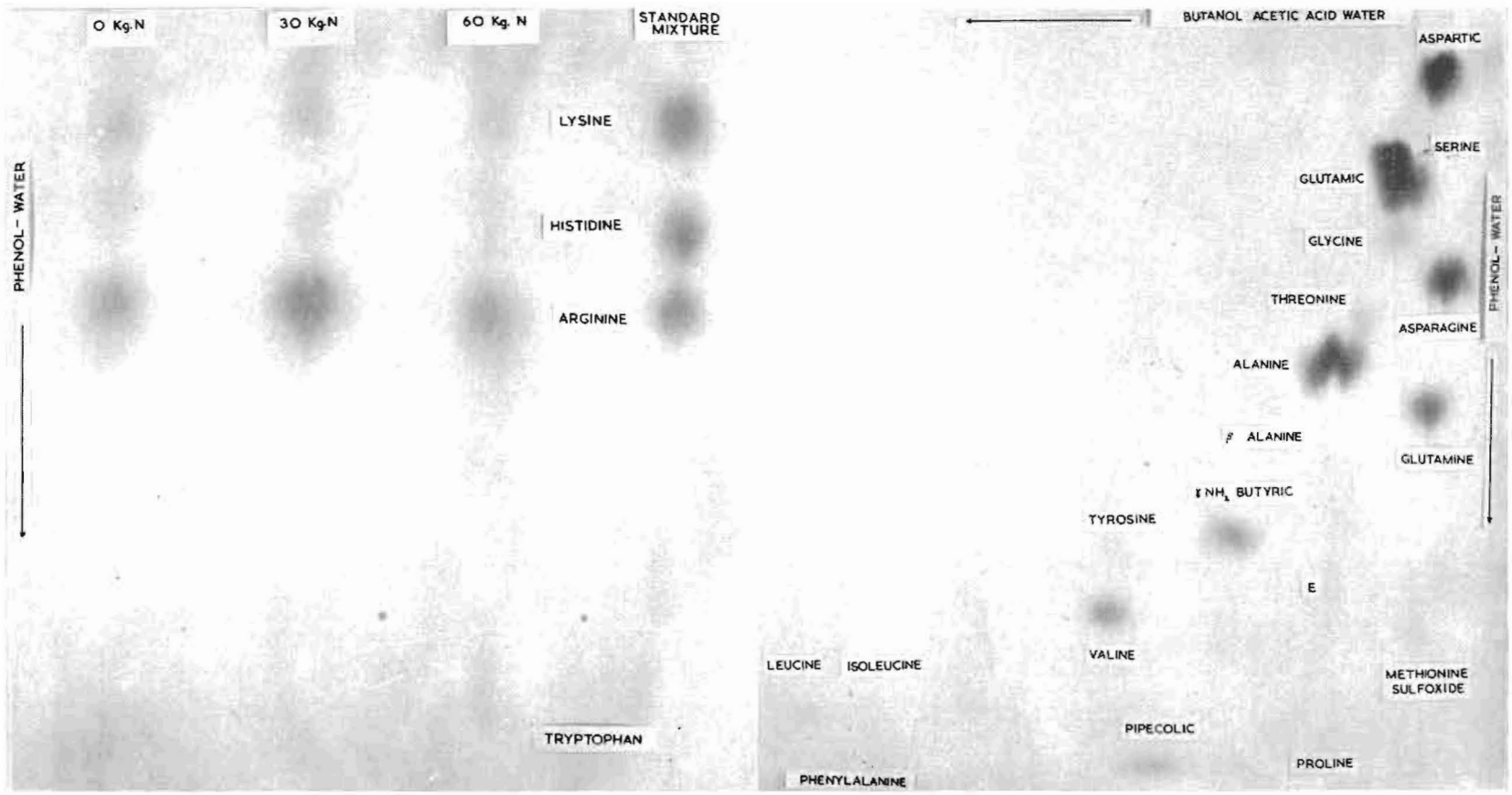

Plate 2.

Left Basic amino-acids of 80% alcohol-soluble fraction of sugar cane juice (variety M.147/44).

Right Neutral and acidic amino-acids of 80% alcohol-soluble fraction of sugar cane juice (variety M.147/44 30, Kg N/Arpent).

NUTRITION AND SOILS

1. THE COMPOSITION OF CANE JUICE — VI AMINO ACIDS

D. H. PARISH

SEVERAL workers have studied the amino-acid composition of cane-juice, notably Zerban (1912), Pratt and Wiggins (1949), Brinkley and Wolfrom (1953) and Martin (1960). These workers isolated many of the common amino-acids which occur in both the free state and in the combined state as protein but pipecolic acid which occurs widely in the plant kingdom had not been reported and as none of these workers studied the effects of factors such as fertility on the qualitative and quantitative distribution of amino-acids, further studies were needed.

The work of Nickell and Kortschak (1964) on the stimulation of cane germination and growth by arginine, and the doubts cast by these authors on the existence of arginine in cane-juice added to the need for having a full examination of the amino-acid composition of this material.

Because of the low levels of amino-acids and the high levels of sucrose occurring in cane-juice a preliminary separation of the amino-acids is needed before good paper chromatographic work can be carried out. The method of Thompson, Morris and Gering (1959) was chosen for this work as the preliminary absorption of the amino-acids on ion-exchange resins enables pure extracts to be prepared.

Methods and materials

Mature canes of the variety M 147/44, grown under three levels of nitrogen fertilization, viz. : 0, 30 and 60 Kgs nitrogen per acre, were passed through a cane chipper and the juice was extracted by hydraulic press, filtered through cotton wool, brought to 80% v/v ethyl alcohol content and allowed to stand overnight. The precipitated protein was filtered off and the alcoholic solution evaporated to a small volume under reduced pressure below 40°C. The liquid was again filtered and diluted to volume with water and isopropyl alcohol to give a solution of the free amino-acids of the cane juices in 10% v/v isopropanol. The method of Thompson loc. cit. was used for the analyses of the amino-acids.

Results and discussion

Photographs of typical chromatograms obtained during this work are shown in Plate 2.

The results show that twenty-three amino-acids occur in juice in detectable quantities.

The presence of pipecolic acid, ,3 - alanine methionine (measured as methionine sulphoxide) and tryptophan was demonstrated for the first time, as also was the occurrence of a substance F provisionally identified as 5 hydroxy-pipecolic-acid (Parish, 1964).

The chromatogram of the basic amino-acids shows clearly that arginine, which so far had been detected only in trace amounts (Martin *et al* 1960) occurred in measurable quantities in the juices examined.

This occurrence of arginine in the cane-juice of varieties grown in Mauritius accounts for the fact that the author has been unable to obtain a growth stimulating effect when arginine is added to germinating cane setts. During the work on germination it was observed that the

rate of development of setts from plots which had received high levels of nitrogenous fertilization was slower than with setts from the low nitrogen treated plots.

Taken in conjunction with the work of Nickell and Kortschak *loc. cit.* there is evidence that the degree of nitrogenous fertilization, by affecting the nitrogen composition of juice, affects the germination and initial elongation of shoots, albeit in a transitory manner.

No work on the effect of nitrogenous fertilization on the levels of growth inhibitors or accelerators in any plant has yet, so far as the author is aware, been carried out, but, as tryptophan is now known to occur in cane-juice, and as nitrogenous fertilization affects the levels of free amino-acids, then some changes in indoleacetic-acid levels may also be occurring.

The most important amino-acid in juice is the amide asparagine and fig. 11 shows the effects of increasing levels of nitrogenous fertilization on this substance and on the total amino-acid content. The storage of nitrogen as asparagine in the cane stalk is typical of many plants which store asparagine in the vegetative storage tissue.

The marked sensitivity of asparagine levels in juice to applied nitrogen is striking, but the difficulties of extending this fact to rational nitrogenous fertilization is beset with all the difficulties involved in establishing critical levels for a material which undergoes marked changes in composition with age and environment.

The metabolic effects of nitrogenous fertilization are seen to be very complex. Further work on the quantitative levels of the amino-acid in both leaf and cane and the effect of nutritional stress and environmental conditions on these levels is in progress.

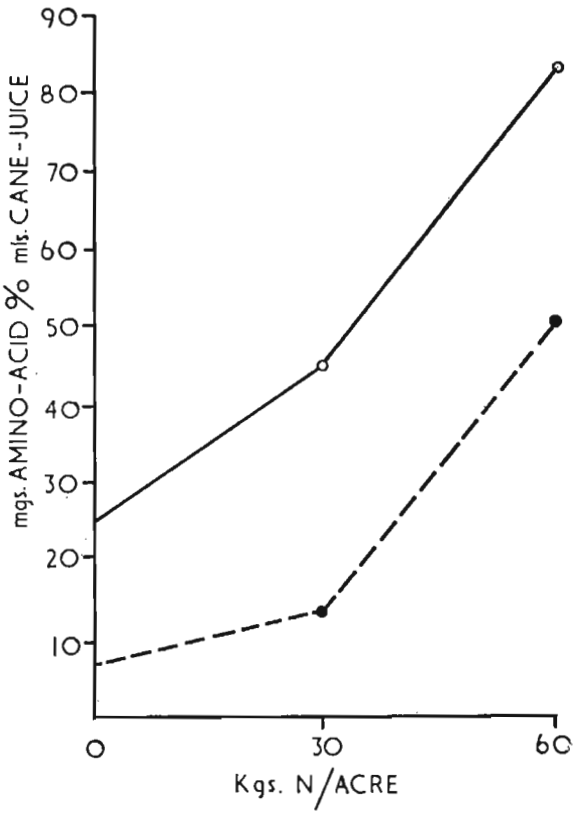

Fig. 11. Effect of N fertilization on total and asparagine levels of 80% alcohol-soluble amino-acids of sugar cane juice.
Plain line = Total amino-acids
Broken line = Asparagine

Summary

The free amino-acids occuring in cane-juice have been studied. Pipecolic acid, 3-alanine, methionine and tryptophan occur in juice as does a substance resembling 5 hydroxy-pipecolic acid; the presence of arginine is confirmed.

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2. EFFECT OF SULPHATE OF AMMONIA APPLICATIONS ON MANGANESE LEVEL IN THE PLANT

PIERRE HALAIS

Sulphate of ammonia when applied year after year without corresponding care of the proper soil amendments inevitably increases soil acidity, loss of exchangeable bases, mainly calcium, and solubility of toxic heavy metals which may have more detrimental repercussions on certain crops than on others. The sugar cane is known to be fairly tolerant to such changes, nevertheless there must be a limit beyond which cane growth is hindered. It is to be expected however that some soil types through their pronounced buffering capacities resist more than others to this acidification.

The occasion has been offered to assess whether cane tissue analysis could be used with advantage to detect at an early stage the changes following heavy applications of sulphate of ammonia, the manganese content of leaf sheaths being taken as te physihological index of increased soil acidity and of the solubility of heavy metals in general.

A series of ten variety fertilizer trials — AGRO/60 — initiated in 1960 with plant canes and carried on for four crops to the third ratoons in 1964 contains amongst the different treatments studied, two contrasted ones : no nitrogen at all and 300 kg of sulphate of ammonia applied annually. The basic fertilizer treatment consists of liberal amounts of phosphatic guano and triple superphosphate, and of potassium chloride. Otherwise, no amendment of any sort was used, such as liming, the return of factory scums, etc.

Cane leaf blades and sheaths were repeatedly sampled on the O N and 2 N plots (heavy application) of the ten trials in 1963 — 2nd ratoons — the variety selected being M. 93/48 and in 1964 — 3rd ratoons — with M. 202/46 and Ebène 50/47 varieties. Regular N P K foliar diagnosis was carried out on the 3rd leaf blades and Ca, Si and Mn were also determined on the 3 - 6 leaf sheaths samples.

The ten trials of the series were separated into two contrasted groups. The first group represents the following locations : Mon Désir, St. Antoine (2), Sauveterre, Bénarès, Unité and Trianon, and the second group the locations : Rivière des Créoles, Beau Bois (St. Aubin) and Valetta.

Table 6 gives the average results for sheath and blade analysis for each group separately as well as the corresponding sugar production in tons of recoverable sucrose per arpent for the two treatments : no nitrogen and the annual application of 300 Kg of sulphate of ammonia (60 N) per arpent for four consecutive years.

For the first group of seven locations, with well buffered soils on which the cane sheaths show high SiO_2 and normal Mn contents, the use of heavy dressings of sulphate of ammonia has resulted, after four years of repeated applications, in no change of cane tissue composition apart from the obvious rise of N in the leaf blades with corresponding increase of production of 3.60 — 2.88 = 0.72 of tons of recoverable sucrose per arpent.

For the second group of three locations with poorly buffered soils on which the cane sheaths show low SiO_2 and very high Mn contents, the use of heavy dressings of sulphate of ammonia has resulted, after four years of repeated applications, in a notable rise of the Mn content from 126 ppm to 160 ppm, and of the Mn/SiO_2 ratio from 62 to 82, as well as a rise in the N content of the leaf blades, with corresponding increases of production 2.11 — 1.88 = 0.23 of tons of recoverable sucrose per arpent.

It must be added that the soils of the seven locations forming Group I with high silica and normal Mn in the leaf sheaths of the canes grown on them produce much heavier crops — 3.60 tons of recoverable sucrose

Table 6. The influence of four years' heavy dressings of sulphate of ammonia on the mineral composition of leaf sheaths and blades expressed as % d. m., Mn in ppm. Average results for 2nd & 3rd ratoons 1963 and 1964.

		Group I		*Group II*	
		Seven locations		Three locations	
		Mon Désir, St. Antoine(2), Sauveterre, Bénarès, Unité & Trianon.		Rivière des Créoles, Beau Bois (St. Aubin) & Valetta.	
		ON	*60 Kg N/arp.*	*ON*	*60 Kg N/arp.*
Leaf Sheaths	SiO_2	3.97	3.73	2.02	2.00
,,	Mn	*68*	*67*	*126*	*160*
,,	Mn/SiO_2 ...	17	18	62	82
,,	Ca	0.187	0.190	0.184	0.185
Leaf Blades	N	*1.56*	*1.90*	*1.93*	*2.04*
,,	P	0.197	0.196	0.205	0.207
,,	K	1.31	1.41	1.54	1.54
Tons recoverable sucrose/arpent ...		*2.88*	*3.60*	*1.88*	*2.11*

per arpent — than the other group of three with low silica and very high Mn, producing only 2.11 tons. Such a grouping represents real differences in permanent soil fertility (Shine, 1964) which can now be easily detected in Mauritius by means of leaf sheaths testing.

The conclusion is that heavy dressings of sulphate of ammonia may, in the course of a few years, bring notable changes in the mineral composition of critical tissues collected on canes grown on certain naturally poor soils with low buffering capacities. This will certainly bring detrimental effects to cane growth if left to go on unchecked. Consequently, for such, either a change should be made in the nature of nitrogenous fertilizer selected, or recourse must be regularly made to such amendments as the return of factory scums on a liberal scale, the proper use of liming material or even massive application of powdered basalt as already shown (Halais, 1964).

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3. FOLIAR DIAGNOSIS, VARIETY CORRECTIONS

PIERRE HALAIS

In the M.S.I.R.I. report for 1962 variety corrections for foliar diagnosis were published for six varieties, namely M. 134/32, Ebène 1/37, B. 3337, B. 34104, B. 37161 and B. 37172, derived from six widely located final variety — fertilizer trials (Series Agro/54) the leaves of canes being comparatively analysed for the 1st, 2nd and 3rd ratoons in 1956, 1957 and 1958 respectively.

For the last ten final variety-fertilizer trials (Series Agro/60) comprising six varieties namely Ebène 1/37, M. 147/44, M. 202/46, Ebène 50/47, M. 93/48 and M. 253/48, the leaves were also analysed for the 2nd and 3rd ratoons in 1963 and 1964 respectively.

Ebène 1/37 being included in both Series 54 and 60 provides for the necessary continuity as a running check on the validity of the corrections in general.

Tables 7, 8 and 9, given below for N, P & K foliar diagnosis respectively have been worked out on comparative data collected on similarly treated plots — NPK treatments — for each of the ten locations of Series Agro/60.

Table 7. Foliar diagnosis — N % d.m. — of six varieties at ten locations 2nd & 3rd ratoons analysed comparatively in 1963 and 1964.

Locations	*Ebène 1/37*	*M. 202/46*	*Ebène 50/47*	*M. 147/44*	*M. 93/48*	*M. 253/48*	*Location Averages*
8/60 Sauveterre ...	1.50	1.52	1.50	1.48	1.62	1.68	*1.55*
6/60 St. Antoine ...	1.49	1.48	1.47	1.55	1.66	1.69	*1.56*
13/60 St. Antoine ...	1.54	1.62	1.66	1.63	1.67	1.73	*1.64*
5/60 Bénarès ...	1.66	1.67	1.69	1.81	1.78	1.59	*1.70*
9/60 Trianon ...	1.57	1.60	1.66	1.80	1.76	1.82	*1.70*
14/60 Mon Désir ...	1.58	1.65	1.69	1.80	1.74	1.88	*1.72*
11/60 Beau Bois ...	1.79	1.78	1.76	1.74	1.74	1.86	*1.78*
7/60 Riv. des Créoles	1.87	1.72	1.71	1.75	1.88	1.90	*1.80*
12/60 Valetta ...	1.87	1.90	1.91	2.03	1.93	1.95	*1.93*
10/60 Unité ...	1.89	1.94	1.90	1.98	2.10	1.98	*1.97*
Variety Averages ...	*1.68*	*1.69*	*1.70*	*1.76*	*1.79*	*1.81*	*1.74*
Variety corrections	*+ 0.06*	*+ 0.05*	*+ 0.04*	*— 0.02*	*— 0.05*	*— 0.07*	

Table 8. Foliar diagnosis — P % d.m. — of six varieties at ten locations 2nd & 3rd ratoons analysed comparatively in 1963 and 1964.

Location	*Ebène 50/47*	*Ebène 1/37*	*M. 147/44*	*M. 93/48*	*M. 202/46*	*M. 253/48*	*Location Averages*
6/60 St. Antoine ...	0.180	0.182	0.186	0 186	0.201	0.207	*0.190*
7/60 Riv. des Créoles	0.176	0.195	0.180	0.204	0.200	0.207	*0.193*
8/60 Sauveterre ...	0.175	0.184	0.191	0.196	0.210	0.203	*0.193*
5/60 Bénarès ...	0.176	0.183	0.195	0.185	0.218	0.202	*0.193*
13/60 St. Antoine ...	0.187	0.190	0.196	0.194	0.210	0.210	*0.198*
10/60 Unité ...	0.181	0.190	0.200	0.199	0.222	0.204	*0.198*
14/60 Mon Désir ...	0.190	0.182	0.191	0.206	0.205	0.223	*0.198*
9/60 Trianon ...	0.193	0.192	0.199	0.202	0.209	0.218	*0.202*
11/60 Beau Bois ...	0.191	0.199	0.204	0.200	0.219	0.216	*0.205*
12/60 Valetta ...	0.205	0.204	0.219	0.220	0.222	0.235	*0.219*
Variety averages ...	*0.185*	*0.190*	*0.196*	*0.199*	*0.212*	*0.213*	*0.199*
Variety corrections	*+ 0.016*	*+ 0.009*	*+ 0.003*	*0.000*	*— 0.013*	*— 0.014*	

Table 9. Foliar diagnosis — K% d.m. — of six varieties at ten locations 2nd & 3rd ratoons analysed comparatively in 1963 & 1964

Locations	*M. 93/48*	*M. 147/44*	*Ebène 50/47*	*M. 202/46*	*Ebène 1/37*	*M. 253/48*	*Location Averages*
6/60 St. Antoine ...	0.95	1.02	1.09	1.14	1.16	1.21	*1.09*
13/60 St. Antoine ...	1.18	1.16	1.28	1.31	1.42	1.42	*1.30*
8/60 Sauveterre ...	1.23	1.23	1.25	1.28	1.32	1.47	*1.30*
9/60 Trianon ...	1.22	1.25	1.32	1.44	1.44	1.54	*1.37*
10/60 Unité ...	1.36	1.35	1.29	1.45	1.46	1.37	*1.38*
5/60 Bénarès ...	1.25	1.38	1.38	1.52	1.48	1.54	*1.42*
7/60 Riv. des Créoles	1.32	1.32	1.35	1.57	1.44	1.58	*1.43*
12/60 Valetta ...	1.43	1.45	1.48	1.49	1.57	1.63	*1.51*
14/60 Mon Désir ...	1.45	1.44	1.46	1.52	1.59	1.60	*1.51*
11/60 Beau Bois ...	1.42	1.46	1.48	1.53	1.57	1.65	*1.52*
Variety Averages ...	*1.28*	*1.31*	*1.34*	*1.43*	*1.44*	*1.50*	*1.38*
Variety corrections	*+ 0.10*	*+ 0.07*	*+ 0.04*	*— 0.05*	*— 0.06*	*— 0.12*	

The three above-mentioned tables give definite proof that no variety-location interaction is operative. Consequently, variety corrections are fully justified as shown by their consistency. The aim of variety correction is to adjust FD observed for any variety already studied to a common denominator, sugar cane in general, as otherwise the true nutritional status of the cane could be masked.

For Ebène 1/37 the corrections agree very well with those observed in the earlier comparison made on Series Agro/54 with five varieties and on the present Series Agro/60 with five other varieties.

	Series Agro/54	*Series Agro/60*
Variety corrections for Ebène 1/37...	... N + 0.08	N + 0.06
,, ,, ...	... P + 0.009	P + 0.009
,, ,, ...	... K — 0.09	K — 0.06

Table 10 shows the relative importance of the three variables, location, variety, and fertilizer treatment, for the extreme cases observed in the series of ten trials — Agro/60.

Table 10. Extreme values of NPK foliar diagnosis for location, variety and fertilizer treatment. Ten trials series Agro/60 analysed as 2nd & 3rd ratoons in 1963 and 1964.

		N% d.m.		*N% d.m.*
Location NPK plots	Sauveterre	1.55	Valetta	1.97
Variety NPK plots	Eb. 1/37	1.68	M. 253/48	1.81
Fertilizer Treatment at 6/60 St. Antoine ...	No N	1.39	With 2N	1.85
		P% d.m.		*P% d.m.*
Location NPK plots	St. Antoine	0.190	Valetta	0.219
Variety NPK plots	Eb 50/47	0.185	M. 253/48	0.213
Fertilizer Treatment at 14/60 Mon Désir ...	No P	0.172	With P	0.189
		K% d.m.		*K% d.m.*
Location NPK plots	St. Antoine	1.09	Beau Bois	1.52
Variety NPK plots	M. 93/48	1.28	M. 253/48	1.50
Fertilizer Treatment at 6/60 St. Antoine	No K	0.86	With K	1.15

The logical conclusion is that the differences in NPK contents of leaves (observed between different varieties planted in the same location) being of the same magnitude as the differences resulting from the application of a nutrient, variety corrections are essential before attempting to interprete correctly any NPK foliar diagnosis on the sugar cane plant.

The search for the necessary variety corrections does not ask for the running of special field trials for this purpose, because the final variety trials, which constitute the essential pre-requisite to valid recommendations of new varieties for commercial plantings, can also be used in this connection through comparative leaf analysis carried out according to the prescribed sampling rules.

It is advisable to include in any new series of trials the same standard variety, in this case, Ebène 1/37, as a permanent check.

Cane varieties with normally low or high values of N, P or K in their leaves do not necessarily show corresponding low or high exportation rates of those plant foods per unit of sugar produced.

4. M. 202/46 REQUIRES ADDITIONAL NITROGEN FERTILIZATION

PIERRE HALAIS

The results of ten variety-fertilizer trials (Series Agro/60) harvested as 1st, 2nd and 3rd ratoons in 1962, 1963 and 1964 respectively, have shown that variety rating is influenced to a large extent by the basic nitrogen treatment applied, namely, 0, 30 or 60 Kg of N per arpent. Consequently, the A values of Mitscherlich corresponding to the theoretical maximum yield obtainable from nitrogen fertilization have been calculated using the following equation :

$$A = \frac{Y_1^2 - Y_2 Y_0}{2Y_1 - Y_0 - Y_2}$$

where Y_0 = profitable sucrose per arpent for 0 kg N treatment

Y_1 = profitable sucrose per arpent for 30 kg N treatment

Y_2 = profitable sucrose per arpent for 60 kg N treatment

Profitable sucrose per arpent = 0.01 TCA (IRSC-4)

Of course, when there is a drop in sucrose yield between Y_2 and Y_1 treatments, as it happens for M. 93/48 and M. 253/48, the equation is not applicable.

Table 11. Tons profitable sucrose per arpent for 1st 2nd & 3rd ratoons of ten variety — fertilizer trials (Series Agro/60) for different dates of harvesting E,M,L, and nitrogen fertilization.

Fertilization	*Ebène 1/37*			*M.147/44*			*M. 202/46*		
Kg N/arpent	*E*	*M*	*L*	*E*	*M*	*L*	*M*	*M*	*L*
0 N	1.40	1.98	1.52	1.64	1.89	1.62	1.49	1.70	1.65
30 N	1.76	2.14	1.72	1.95	2.29	1.98	1.83	2.16	2.08
60 N	1.82	2.17	1.73	1.96	2.36	2.02	2.03	2.31	2.35
A values	1.83	2.18	1.73	1.96	2.45	2.03	2.32	2.38	2.81

Fertilization	*Ebène 50/47*			*M. 93/48*			*M. 253/48*		
Kg N/arpent	*E*	*M*	*L*	*E*	*M*	*L*	*E*	*M*	*L*
0 N	1.47	1.69	1.45	1.58	1.97	1.47	1.43	2.22	1.74
30 N	1.96	2.05	1.98	1.82	2.33	2.00	1.79	2.38	1.93
60 N	2.16	2.16	1.98	1.78	2.41	1.88	1.70	2.08	1.85
A values	2.30	2.21	1.98	(1.82)	2.43	(2.00)	(1.79)	(2.38)	(1.93)

NOTE : 0 N and 60 N figures are the means of 30 plots cane-weighings and analysis ; 30 N figures the means of 60 plots.

The results of Table 11 prove that the highest profitable sucrose production for each level of nitrogen fertilization and for each date of reaping corresponds to different varieties as stated below.

Table 12. Best profitable sucrose return variety out of the six tested harvesting dates.

N Fertilization	*E*	*M*	*L*
0 N ...	M. 147/44	M. 253/48	M. 253/48
30 Kg N/arp.	M. 147/44	M. 253/48	M. 202/46
60 Kg N/arp.	Eb. 50/47	M. 93/48	M. 202/46
A Value ...	M. 202/46	M. 147/44	M. 202/46

It should be noted that the regular nitrogen fertilization rate is at present about 40 Kg N per arpent in Mauritius on an average.

M. 202/46 is thus shown to posses exceptional potentialities as regards profitable response to additional nitrogen fertilization when reaped late in the season at the standard age of 12 months for ratoons. Consequently, a more detailed study of the economics of the response to nitrogen for M. 202/46 compared to that of the two standard varieties M. 147/44 and Ebène 1/37, has been undertaken for late reapings exclusively.

At present average prices, the cost of an application of 30 Kg of N (150 Kg of sulphate of ammonia) is approximately Rs. 40 roughly covered by a response of at least 100Kg. (0.10 tons) of profitable raw sugar.

Profitable sucrose yields for N doses above those experimented, that is for 90 and 120 Kg of N per arpent, were calculated by means of Mitscherlitch extrapolation. For M. 202/46, a Baule unit of 45 Kg N per arpent (107 Kg N per ha.) derived from actual yield results for O N, 30 N and 60 N treatments was observed with this same variety.

Table 13. Tons of profitable sucrose per arpent derived from ten trials (Series Agro/60) reaped as 1st, 2nd and 3rd ratoons.

		Late reapings	
Treatments Kg. N/arpent	*M. 202/46* *Response*	*M. 147/44* *Response*	*Ebène 1/37* *Response*
0 N	1.65	1.62	1.52
30 N	2.08 + 0.43	1.98 + 0.36	1.72 + 0.20
60 N	2.35 + 0.27	2.02 + 0.04	1.73 + 0.01
90 N	2.52 + 0.17		
120 N	2.63 + 0.09		
Value	2.81		

To be economical, the response to an additional dose of 30 Kg N per arpent should exceed by a good margin 100 Kg (0.10 tons) of profitable sugar. The net return in Table 13 is definitely in favour of M. 202/46 as proved below.

	Optimal N Treatment	*Corresponding cost in tons of sugar*	*Gross Yield*	*Net Yield*
M. 202/46	90 Kg N/arpt.	0.30	2.52	2.22
M. 147/44	30 „	0.10	1.98	1.88
Ebène 1/37	30 „	0.10	1.72	1.62

The extra profit ascribed to M. 202/46 will be 2.22 — 1.88 = 0.34 tons of profitable sugar per arpent and of 2.22 — 1.62 = 0.60 tons when compared to M. 147/44 and Ebène 1/37 respectively.

The recommendations concerning the additional N fertilization required for M. 202/46 to be reaped late in the season as 12 months ratoons are :

(1) The total application of nitrogen should approximately be 90 Kg N per arpent, the first dose to be given as early as possible after ratooning and the second dose before the canes reach the age of 4 months.

(2) The amount of N fertilization should correspond approximately to 3 Kg N per ton of cane reasonably expected.

(3) Foliar diagnosis of M. 202/46 should range between 1.90 and 1.95 N % d. m. for 5 months old ratoons not suffering from moisture stress or from earlier cyclone damage to the leaves.

Plate 3. New strain of Gumming disease.

Top left : Systemic infection in a field of M.147/44.
Bottom left : Close-up of M.147/44 stool showing systemic infection.
Top right : Young chlorotic plants derived from infected cuttings.
Bottom right : Gum exudation from cut end of infected stalk, at harvest.

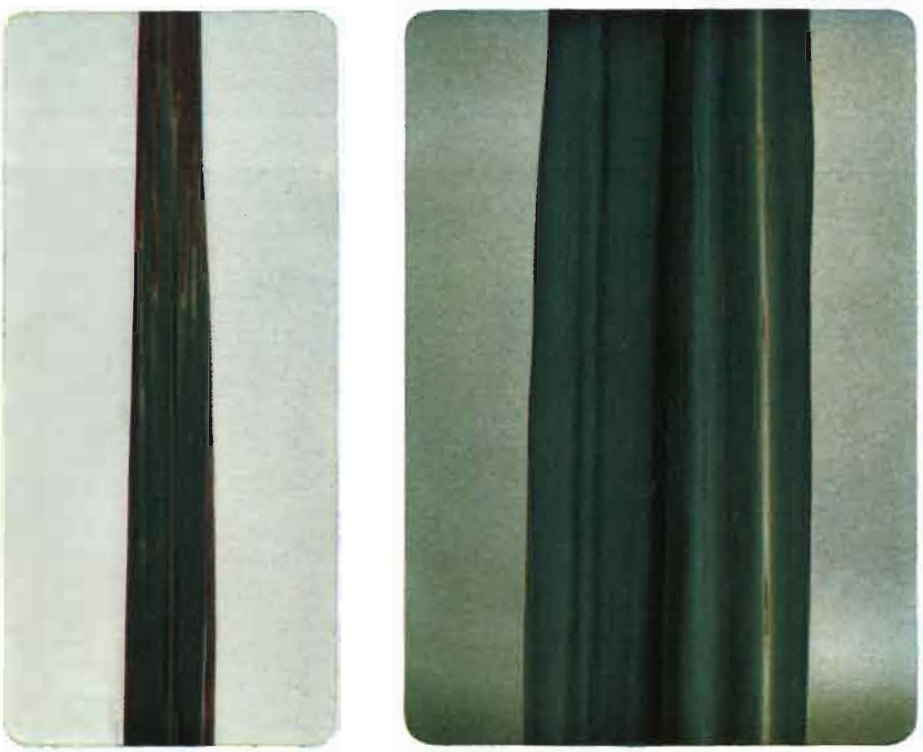

Plate 4.

Foliar symptoms of Gumming disease (*Left*) and Leaf scald (*Right*).

CANE DISEASES

R. ANTOINE

1. GENERAL CONSIDERATIONS

THE year under review has been one of the most eventful in the history of sugar cane pathology in Mauritius. Indeed, unfavourable conditions, starting by a drought during the growing season, the occurrence of two cyclones early in the year followed by a prolonged wet and cold winter, reduced the vitality of the cane which was thus more liable to invasion by pathogens.

Unfortunately in this same year, four new problems were encountered in the plantations. Gummosis and leaf scald, two serious diseases, which had been totally eradicated from commercial fields, reappeared in epidemic form and are believed to be caused by new and more virulent strains of the pathogens. In addition, two minor diseases, yellow spot and rust, have been identified for the first time in the island.

Although emphasis both in research and in control work in the field had to be placed on gummosis and leaf scald, the problems set by the other two major diseases, ratoon stunting and chlorotic streak had to be attended to. Thus, apart from continuing the assessment of varietal reaction to ratoon stunting, the whole planting programme at the Central Nursery as well as secondary nurseries on estates had to be reshuffled in order to give priority to varieties resistant to gumming disease. In addition, investigations on the transmission of chlorotic streak were actively pursued and interesting findings were obtained.

Visits were paid, as usual, to the neighbouring islands, in connection with gumming disease and leaf scald in Réunion and Fiji disease in Madagascar.

2. GUMMING DISEASE

R. ANTOINE & M. PÉROMBELON

(a) Introduction

The first record of gummosis in Mauritius probably dates back to 1848. This dreaded bacterial disease, which was positively diagnosed in 1893, was responsible for extensive damage in the past in commercial plantations at a time when the so-called «noble» canes were under cultivation.

The policy of testing all promising varieties, locally-bred or imported, in resistance trials was initiated in 1932. Such a policy paid high dividends inasmuch as by 1947 gummosis had been totally eradicated from all plantations in the island.

In the neighbouring island of Réunion the history of gumming disease was very similar to the one recorded in Mauritius. However,

in 1958 the disease reappeared in epidemic form and several varieties highly resistant in Mauritius proved to be susceptible in Réunion. Experimental evidence was obtained showing that a new and more virulent strain of the organism had appeared in the neighbouring island.

In June this year, the characteristic striping associated with the disease was observed in a variety which had hitherto proved to be highly resistant. It was at once suspected that a new strain of the pathogen had either arisen through mutation of the old strain, still present in the cane variety collection and in the resistance trials, or had gained access to the island from Réunion, that country being only just over hundred miles away from Mauritius. A survey revealed that varietal reactions in the two islands were similar thus indicating that the new outbreak could in fact be attributed to the presence of a new and more virulent strain of the organism.

By the end of 1964, the disease, which is easily propagated by wind and rain, had spread over practically all the island and systemic infection was already widespread. The South and East sectors are however more severely affected.

(b) Varietal reaction

The reactions of varieties cultivated at present in Mauritius were assessed and the results are given in Table 14, together with their share in the crop.

The three varieties M. 147/44, B. 3337 and B. 34104 rated as very highly susceptible, rapidly develop systemic infection, with gum in the stalks and chlorosis of the leaves. Indeed, a symptom which is commonly observed in cases of systemic infection by the new strain of the pathogen is the characteristic white chlorosis of the leaves of affected stalks. Recent records and observations have always shown that such symptom was very rarely produced by the old strain. However, the name of «maladie blanche» given to gumming disease last century would tend to indicate that in those days the presence of the bacterium in the stalk could induce the production of white leaves.

Table 14. Reactions of commercial varieties to the new strain of the gumming disease pathogen.

Rating	*Variety*	*%Crop*
Very highly susceptible	M. 147/44	31
	B. 3337	6
	B. 34104	2
	Total	39
Highly susceptible ...	B. 37172	11
	Ebène 1/37	15
	Total	26
Moderately susceptible	M. 93/48	9
Moderately resistant ...	M. 442/51	< 1
Resistant	M. 134/32	6
	M. 31/45	3
	M. 202/46	8
	M. 253/48	2
	Ebène 50/47	5
	Total	24

Ebène 1/37 and B. 37172, rated as highly susceptible, although showing an abundance of long stripes on the leaves have so far failed to contract systemic infection.

M. 93/48 is rated as moderately susceptible, M. 442/51 as moderately resistant whereas, M. 134/32, M. 31/45, M. 202/46, M. 253/48 and Ebène 50/47 are resistant.

There is no escape from the fact that varieties covering 39% of the cultivated area will have to be replaced in the immediate future followed as soon as possible by another 26%. This, indeed, is the very arduous task which suddenly confronts the sugar industry of Mauritius.

(c) The pathogen

Xanthomonas vasculorum, the pathogen causing gumming disease of the sugar cane has, on occasion, been suspected of producing variants.

It has been proved since 1961 at the Commonwealth Mycological Institute that distinct strains isolated from different territories can be distinguished on the basis of their cultural and physiological characters and on varietal host reactions. The cultural and physiological characters which appear to differentiate the strains significantly are :

(a) colony form and degree of mucoidness on first isolation in young (3-day) cultures on 2% glucose or sucrose/peptone agar;

(b) proteolysis : reaction on media containing gelatin and casein;

(c) starch hydrolysis.

Isolates from Mauritius, Réunion, Madagascar, Natal and Southern Rhodesia were studied at the Commonwealth Mycological Institute and it was found that the Réunion and Mauritius isolates, indistinguishable in cultural and physiological characteristics, could be differentiated on host reaction only.

Following the new outbreak in Mauritius, isolates of the two strains, old and new, were obtained in pure culture. The assumption as to the existence of two strains being based on varietal reaction.

It is fortunate that co-operative research on strain differentiation in bacterial pathogens of the sugar cane had been initiated since 1958, as the information already obtained proved most invaluable in assessing at once the true nature of the new epidemic.

Attempts were made to differentiate the two strains. It was found that nearly all the cultural and physiological characteristics of the two strains were indistinguishable. Only two tests gave an indication that the two organisms were not identical : the ability to liquefy gelatin and the rate of flow down slopes of Wilbrink agar.

(a) Liquefaction of gelatin.
The old strain showed a general greater ability to liquefy gelatin than the new one, giving rise after 2 to 3 weeks at room temperature to a crateriform to stratiform type of liquefaction.

(b) Rate of flow down an agar slope.
The new strain showed a general tendency to flow more rapidly than the old one down slopes of Wilbrink agar.

Following the observation on the differential rates of flow, several isolates of the two strains were grown on various culture media. On Wilbrink agar, only fresh actively growing isolates, which had not been subcultured more than twice could be separated. The lag in the rate of flow was short, at times less than 12 hours. On other media, no better results were obtained. However, while attempting, unsuccessfully, to differentiate the two strains on a colour basis by growing them on a medium containing tri-phenyl tetrazolium chloride, it was observed that the difference in the rates of flow was considerably increased; the lag period becoming one month or more. The medium used was the following :

Peptone	1.0%
Casein hydrolysate	0.1%
Glucose	0.5%
Agar	1.7%
Tri-phenyl tetrazolium chloride ...	0.05%

pH adjusted to 7.2

As a result of the marked difference in their ability to flow down the slope, the growth habit of the two strains stood out in sharp contrast. Whereas the old strain assumed a large convex to pulvinate, circular type of growth, the new strain grew thinly on the medium and gave a filiform growth habit after only 4 to 5 days (Plate 5 *top*).

In addition, even old cultures and isolates of the two strains after sub-culturing several times can be differentiated on their rates of flow.

The results suggest that the difference in cultural character is due to a difference in the amount and viscosity of the extra-cellular polysaccharide slime produced by the old and new strains of *X. vasculorum*. This confirms the finding in the case of *X. phaseoli*, that colony variants differed in virulence for bean on inoculation.

(d) Control measures

Preliminary observations tend to indicate that systemic infection by the new strain of the organism is accompanied by a symptom which is easily detectable, namely the chlorosis of the leaves. Although the correlation between infection and symptom is under study it was thought advisable, at the very beginning of an epidemic, to recommend the rogueing of all lightly infected fields on the basis of the white-leaf symptom and the uprooting of heavily infected ones.

As widespread systemic infection has been observed in M. 147/44, B. 3337 and B. 34104, legislation has been passed prohibiting the planting of these varieties as from 1st July 1965. Furthermore their uprooting and destruction should have been completed by 31st December 1970.

It is fortunate that several commercial varieties are resistant enough to be accepted as substitutes. Consequently a replacement programme has been formulated as follows :

M. 147/44 : by M. 442/51 in sub-humid areas (particularly sub-humid areas without irrigation), M. 253/48 (irrigated areas only) and M. 202/46, M. 31/45, Ebène 50/47.

B. 3337 : by M. 93/48 and by M. 99/48, a variety, the release of which has been recommended.

B. 34104 : variety grown on a very limited scale sets no replacement problem.

Quite apart from the urgent work which involved an assessment of the spread of infection and the varietal reaction in order to apply adequate control measures, the impact of the epidemic on research, both in the breeding and pathology fields, has been considerable.

The only variety which can replace M. 147/44 in the sub-humid area where no irrigation is available is M. 442/51. As this variety is a medium to late maturer, special emphasis has been placed upon selection for adaptation in such an environment. In order to obtain, as rapidly as possible, resistant varieties adapted to dry conditions for the replacement of M. 147/44, a series of experiments will be laid down in 1965 in sub-humid coastal areas involving about 100 promising varieties at present in variety trials.

Observations made in variety trials exposed to natural infection have shown that the new strain of the organism seems to be much more virulent than the original one. Indeed, several varieties, already tested to the old strain and found to be resistant, became readily infected by the new one. Gummosis has thus become a major limiting factor in the selection work and, consequently, special emphasis has to be placed on varietal resistance to the disease.

Up to this year, varieties selected from First Selection Trials, numbering on an average about 40, were included in the gumming resistance trial, their reactions assessed and the susceptible varieties, usually 3 or 4, discarded. As the presence of a new and more virulent strain will lead to a much bigger discard, it is essential to test the reactions of varieties at an early stage of selection. Consequently resistance trials will be established at the Propagation Plot stage where the reactions of some two thousand seedlings can be assessed. The advantage to be derived from such a procedure, quite apart from sieving out resistant canes at an early stage of selection will, in a few years, be the accumulation of data which, it is hoped, would throw some light on the inheritance of resistance to the disease.

The testing to the old strain of varieties coming out of First Selection Trials will be continued, while it is being ascertained whether the difference between new and old strains is confined to their degree of virulence on host reaction.

Immediately after the discovery of the new epidemic, two resistance trials have been established in which varietal reactions to the two strains are being assessed in different localities. The trial with the new strain includes about 300 varieties and to the old one about 100, the balance having already been tested. The results, which should be available in July 1965, will allow a preliminary assessment of the reactions of a fairly large number of varieties to the two strains. In addition, inoculation experiments have been conducted in two greenhouses.

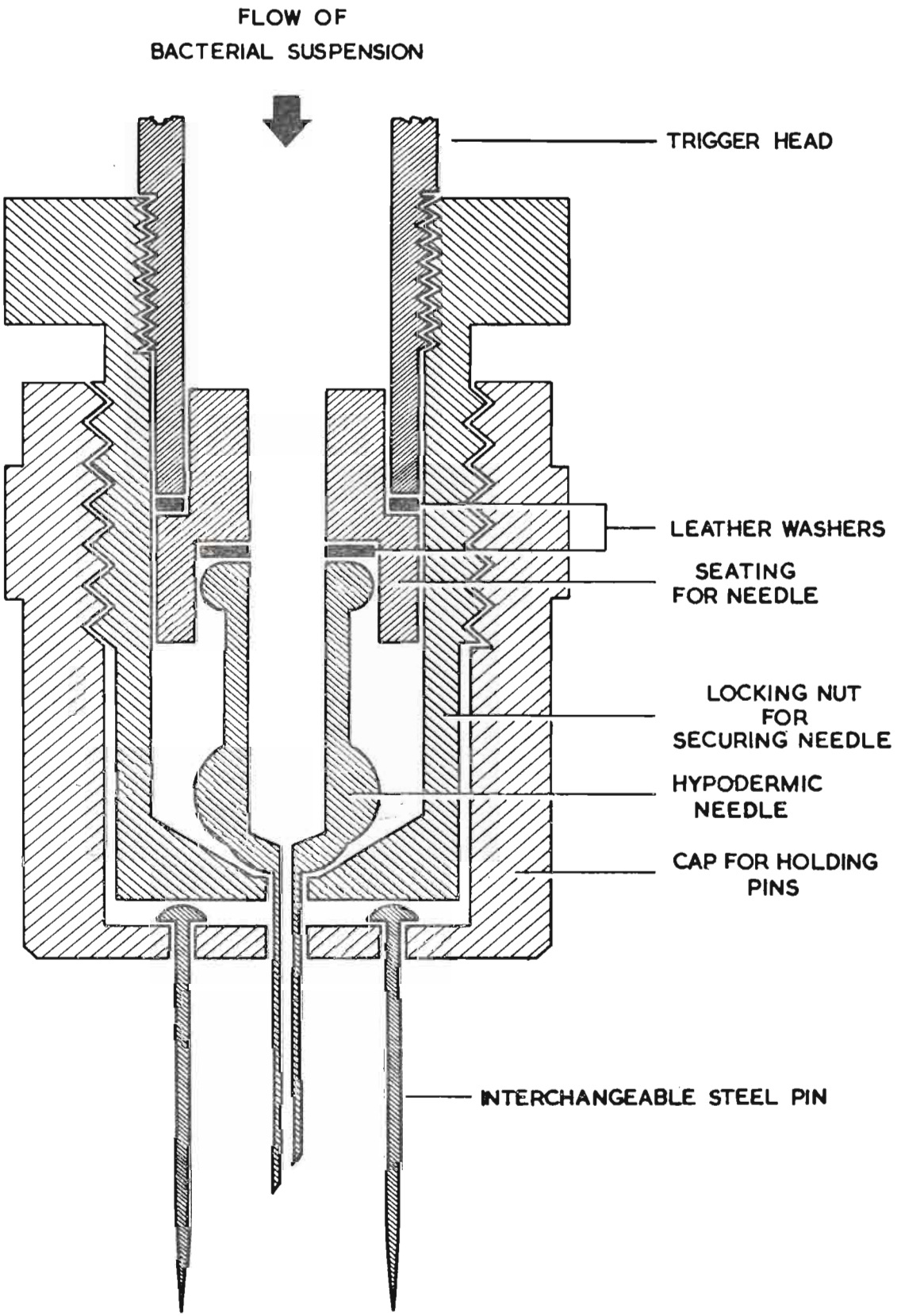

Fig. 12. Detail of injection head for inoculating the gumming disease pathogen in resistance trials. (Designed by C. Ricaud, Associate Pathologist).

The problem of inoculating rapidly the susceptible cane which will provide infection in large scale trials has been solved through the development of an apparatus consisting of an inoculation head in which a hypodermic needle surrounded by steel pins is mounted; the head being adapted to a plastic knapsack sprayer containing the suspension of the bacterium (Fig. 12 and Plate 5 *bottom*).

The campaign against gumming disease, if it is to be successful, has to be conducted on an island-wide basis. Indeed, if the effect of the pathogen on the cane results in reduced yields in the field, the presence of the gummy material in the juice extracted from diseased stalks can cause considerable trouble in the factory. The gum impedes clarification, interferes with the efficeint working of the evaporators and vacuum pans, makes the handling of molasses very difficult and affects adversely the quality of sugar produced. Fields belonging to estates and large planters are being regularly surveyed and rogueing of diseased stools or uprooting of whole plantations carried out, depending upon the extent of infection. A scheme for the control of the disease in small planters' fields has been submitted to Government and approved.

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3. LEAF SCALD

R. ANTOINE & M. PÉROMBELON

The first record of leaf scald in Mauritius dates back to 1928. A survey, carried out at the time, revealed that the disease was widespread in the island attacking chiefly the Tanna canes. No doubt leaf scald had been present for many years but had been confused with gumming disease.

At the time leaf scald was discovered, the Tanna canes (white and striped) occupied about 60% of the cultivated land, MP seedlings (55 and 131) about 10% and Demerara canes (D. 109, D. 130, R.P. 8 and R.P. 6) roughly 18%. The Tanna canes, although the disease was widespread in them, showed a fair degree of tolerance. Of the others, R.P. 8, a variety which was gaining in popularity, was affected and so were the old-standing varieties Louzier and Iscambine still occasionally encountered. R.P. 8 showed moderate susceptibility.

The epidemic was a serious one considering the large acreage devoted to Tanna canes. Vigorous attempts were made in order to establish disease-free nurseries of that variety. Although cuttings were selected from apparently healthy stools, as far away as possible from diseased plants, it was impossible to establish and maintain healthy nurseries, in spite of repeated rogueings, owing to the presence of leaf scald in a latent form in apparently disease-free plants. It was evident therefore that the Tanna canes had to be replaced by resistant varieties. Leaf scald trials were initiated but the results obtained were not found to be reliable.

In 1933, P.O.J. 2878 came into the picture. Although that variety showed only moderate susceptibility to leaf scald it never became an important commercial cane. It occupied about 5% of the cane land in 1940 and then rapidly went out of favour.

The cultivation of B.H. 10/12 began in 1930. As it showed itself resistant to leaf scald, planters were recommended in 1931 to propagate that variety and plant locally-raised seedlings for trials on estates in order to determine their reaction to the disease.

In 1939, a promising cane which was being propagated, S.C. 12/4, showed high susceptibility to leaf scald and the cultivation of that variety had to be abandoned.

It is interesting to note that in 1940, B.H. 10/12 was occupying 40% of the cane

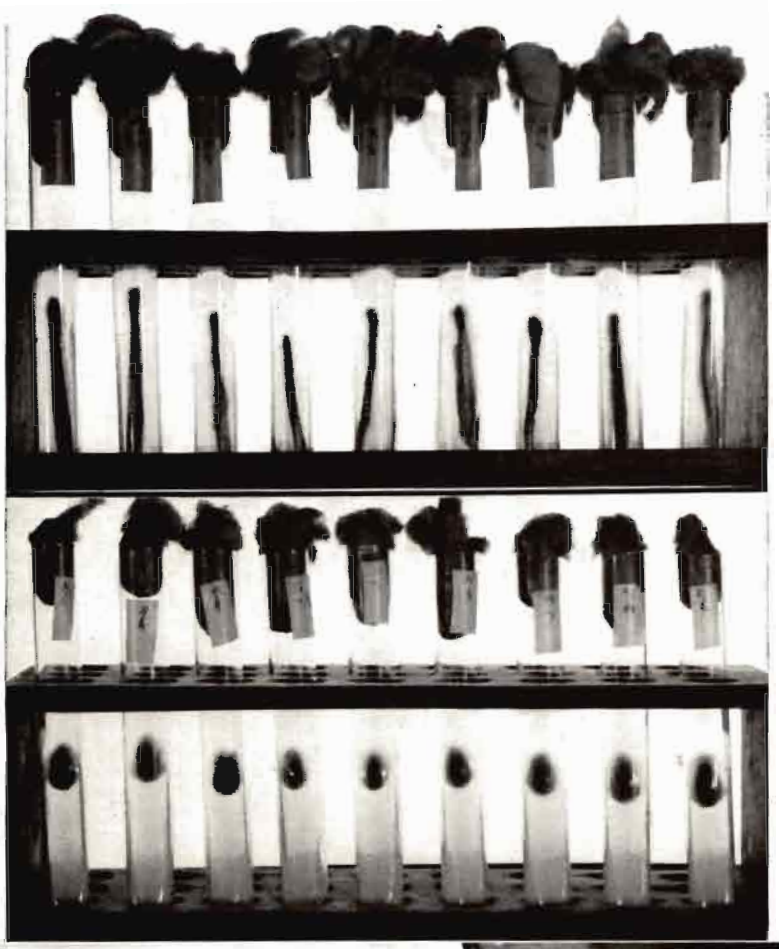

Plate 5.

Top : Growth habit of *Xanthomonas vasculorum* on a medium containing tri-phenyl tetrazolium chloride. Top : new strain of bacterium : Bottom : old strain.

Bottom : Apparatus used for inoculating *X. vasculorum* in large scale resistance trials.

land and that it always showed high resistance to leaf scald. With the advent of M. 134/32 in 1940, the acreage under B.H. 10/12 declined rapidly and the variety went out of cultivation almost completely in 1949. The same fate had befallen the Tanna canes two years earlier.

From 1949 to 1953 the highly resistant M. 134/32 was the variety almost exclusively cultivated in the island with the result that leaf scald was very rarely encountered, except in occasional small Tanna fields and in old varieties in the cane collection. Of the Mauritius seedlings cultivated along with M. 134/32 and which never rose to any real commercial importance (with the exception of M. 112/34 in specific areas), M. 213/40 and M. 423/41 showed resistance to leaf scald. M. 112/34, a variety highly susceptible in British Guiana, was rated as moderately resistant and M. 171/30 showed average resistance.

With the appearance of Ebène 1/37 in 1953 and the Barbados canes in 1954, the variety picture began to change again in the island. M. 134/32 has gradually declined to the present 6% level, with Ebène 1/37, well-suited to the super-humid uplands, rising to a peak of about 25% but later falling to the present 15% on account of its susceptibility to wind damage. The Barbados canes are now occupying 19% of the cultivated area. Recently two locally bred canes, M. 147/44 and M. 31/45, particularly the first one, have been propagated on a large scale and now occupy 31% and 3% of cane lands respectively.

More recently still, M. 202/46, M. 93/48, M. 253/48, M. 442/51 and Ebène 50/47 have been released for commercial plantings. They now represent 25% of the crop with a share of 8% and 9% to M. 202/46 and M. 93/48 respectively.

Ebène 1/37, just as M. 134/32, is highly resistant to leaf scald and the disease had never been observed until 1964 on M. 147/44, M. 31/45 nor on the more recently released varieties.

The Barbados canes cultivated in the island are B. 3337, B. 34104 and B. 37172. Although B. 34104 has showed very high susceptibility to the disease in British Guiana, that variety as well as the other Barbados canes were found to be resistant in Mauritius. There were indications however that the Mauritian strain of *X. albilineans* was different from the one present in British Guiana.

In 1963 therefore, all varieties cultivated in Mauritius were resistant to leaf scald. Evidently this did not mean that the disease had been eradicated from the island. Indeed, the chronic and acute phases are still encountered in old susceptible varieties in the cane collection and, on occasion, seedlings infected under natural conditions, show high susceptibility to the disease during selection. Recently one promising cane which was being considered for release proved susceptible and had to be discarded.

It follows from the foregoing that, although leaf scald had been responsible for severe epiphytotics in the past, the disease had ceased to be a problem in commercial plantations due to the cultivation of highly resistant varieties.

Difficulties were encountered in the resistance trials, which are conducted, as a routine procedure, under different climatic conditions, and a method of inoculation had to be devised in order to obtain a reasonable level of infection in such trials (*vide Ann. Rep. Sug. Ind. Res. Inst. Mauritius,* 1961 : 55-56). The commercial varieties at present under cultivation had evidently reacted as resistant to the disease in the resistance trials.

In October 1964 however, the disease suddenly reappeared in epidemic form and it is believed that a new strain of the organism has either developed here, through mutation, or has gained entry into the island. Varieties which have shown susceptibility so far are M. 147/44 and M. 202/46. Both varieties are susceptible to the strain of the bacterium present in Réunion and M. 202/46 contracted natural infection by the leaf scald pathogen in the Fiji disease resistance trial on the East Coast of Madagascar.

The bacterium has been isolated from M. 202/46 and comparative studies with the old strain are being conducted. Furthermore resistance trials to the presumed old and new strains will be established in different localities.

M. 147/44 is being discarded owing to its high susceptibility to gummosis. M. 202/46, a variety well adapted to the humid zone and

resistant to the new strain of the gumming disease pathogen, sets a problem. It is not contemplated, at this stage, to prohibit the cultivation of the variety. A detailed survey of sugar cane lands is being conducted and highly infected fields are being rogued and diseased stools destroyed. Heavily infected fields, if discovered, will be immediately uprooted. It is hoped that, provided the work is properly done and weather conditions are favourable, the position will not deteriorate until more varieties, resistant to gummosis, are available.

4. RATOON STUNTING

R. ANTOINE

(a) Varietal reaction

Experimental results given in Table 15, summarize the performance of varieties in the resistance trial planted in November 1957 under sub-humid conditions. As no data were collected in the cyclone year 1960, figures are averages for virgins, 1st, 3rd, 4th, 5th and 6th ratoons and give a good indication of the reactions of commercial varieties, of longer standing, to the disease. The trial is now concluded. It will be noted that M. 147/44 originally rated as moderately susceptible has shown the highest reduction in yield and M. 31/45 the lowest.

Table 15. Summary of results obtained in a ratoon stunting trial laid down at Pamplemousses in 1957.

	TONS CANE/ARPENT			TONS SUGAR/ARPENT		
	(Figures are averages for virgin, 1st, 3rd, 4th, 5th and 6th ratoons)					
Varieties	*Treated*	*Untreated*	*Reduction %*	*Treated*	*Untreated*	*Reduction %*
M. 134/32 ...	29.0	25.0	14	4.22	3.62	14
M. 112/34 ...	31.1	27.5	12	4.63	3.95	15
M. 147/44 ...	39.5	32.2	19	5.20	4.21	19
M. 31/45 ...	34.3	31.8	7	4.88	4.57	6
Ebène 1/37 ...	30.3	27.8	8	4.49	4.06	10
B. 34104 ...	32.1	28.9	10	4.52	4.05	10
B. 3337 ...	36.0	32.6	9	4.76	4.29	10
B. 37161 ...	32.2	27.9	13	4.44	3.79	15
B. 37172 ...	36.4	32.8	10	5.09	4.63	9

Table 16. Effects of ratoon stunting on yields of cane and sugar at Pamplemousses Experiment Station.

	TONS CANE/ARPENT			TONS SUGAR/ARPENT		
	(Figures are averages for 1st, 2nd, 3rd and 4th ratoons)					
Varieties	*Treated*	*Untreated*	*Reduction %*	*Treated*	*Untreated*	*Reduction %*
M. 202/46 ...	34.2	27.8	19	4.56	3.71	19
M. 93/48 ...	35.7	31.0	13	4.63	4.08	12
M. 253/48 ...	34.4	36.7	—6	4.40	4.56	—4

Table 16 gives the results for varieties released more recently. The data collected at Pamplemousses Experiment Station are averages for 1st, 2nd, 3rd and 4th ratoons. The results in virgins, in the cyclone year 1960, were not recorded

It follows that M. 202/46 and M. 93/48 are susceptible to the disease whereas M. 253/48 has consistently shown resistance.

The trials in the super-humid zone were once more badly hit by the cyclones and had to be abandoned. No results were therefore obtained in 1964 for the varieties more recently released : Ebène 50/47 and M. 442/51. The former variety however had shown an average reduction in yield of 11% in virgins and 1st ratoons.

(b) Progress in control measures

Had the unpredictable outbreak of gumming disease not occurred, the implementation of the Central Nursery Scheme, as the initial step in the production of planting material free from ratoon stunting disease, would have been a complete success in 1964 inasmuch as the requirements of estates for the establishemnt of B nurseries had been met.

The total area under cane (estates) in 1964 covered 108,110 arpents. Very nearly one-eighth of that area (13,755 arpents) was planted during the year. The supply of planting material to Estates from A Nurseries at the Central Nursery amounted to approximately 3,400 tons. It was thus possible to establish B nurseries on Estates covering about 1,200 arpents. (In 1963, the supply was 1,900 tons and the area planted 610 arpents). The potential output from the B Nurseries should provide for about 12,000 arpents in 1965, practically the total area needed.

Unfortunately the gummosis problem has completely upset the programme. The planting of the leading variety, M. 147/44, has been prohibited due to its high susceptibility to gumming disease. As that variety had been planted over nearly one-third of the area under B nurseries, 410 arpents are thus lost for the 1965 regular plantations.

The planting programme at the Central Nursery had to be completely reshuffled during the second part of the year and it was possible to establish approximately 60 arpents with resistant varieties and promising canes, the reactions of which to gumming disease has not yet been established. Details on plantations of A nurseries thus made at Pointe aux Sables, together with the percentage germination of the different varieties is given in Table 17.

Table 17. Plantations of A Nurseries made at Pointe aux Sables in 1964 with varieties resistant to gummosis.

	Variety	*Area planted (arpents)*	*% germination*
Commercial Canes	M. 134/32	2.72	100
	M. 31/45	12.06	40
	M. 202/46	13.00	92
	M. 93/48	7.38	49
	M. 253/48	4.72	58
	M. 442/51	13.73	45
	Ebène 50/47	5.50	51
New Varieties	M. 39/49	0.21	83
	M. 409/51	0.53	100
	M. 658/51	0.20	83
	M. 13/53	0.21	87

The poor quality of planting material available is responsible for the fairly low germination obtained with M. 31/45 and M. 442/51.

In addition to the 60 arpents in virgins, another 56 arpents of resistant varieties in first ratoons will be available thus bringing the total area to be supplied in 1965 to 116 arpents.

The area of B Nurseries established at Pointe aux Sables for the supply of planting material to small planters in the vicinity of the nursery amounted to 17 arpents and an additional 50 arpents of A nursery cane, all resistant to gummosis, in 2nd ratoons could also be disposed of as a B Nursery.

5. CHLOROTIC STREAK

R. ANTOINE

(a) Studies on disease transmission

Evidence having been obtained in 1957 on soil transmission of the disease, an extensive research programme was initiated in order to elucidate the factors involved in the soil.

One of the methods used was highly successful. That method consisted in growing the sugar cane plants, individually in specially designed pots containing the culture solution.

Cuttings obtained from apparently healthy plants, after receiving the short hot water treatment (52°C for 20 minutes) and surface sterilization, were used as the source of healthy plants. Cuttings obtained from plants showing pronounced leaf symptoms, after surface sterilization, provided the diseased plants. The variety used was M. 442/51.

The cuttings were germinated in sterilized chipped basalt contained in the upper compartment of the pots, the culture solution being in the lower compartment. One advantage in the method was that sett and shoot roots developed and grew directly into the culture solution, the level of which was lowered as the plants became established.

Diseased and healthy plants were kept separate. Pronounced leaf symptoms appeared readily on plants derived from diseased cuttings. All plants derived from heat-treated cuttings never showed the characteristic streaks.

At regular intervals, the top part of pots containing diseased plants were removed and replaced by the top part of pots containing healthy plants (3 replicates), the diseased plants being discarded. Healthy plants were thus subjected to infection for varying periods of time.

Water was added regularly in order to keep the culture solution in the pots at the desired level. As the infective principle had to be retained, the culture solution could not be replaced at intervals. The plants were therefore fed by the addition of salts to the solution

every month. As it was feared that a build up of salts in solution would occur, out of the 3 replicates, 2 were treated in the following way : every month, the culture solution from each pot was dialysed in running water for 24 hours; the time of treatment having been determined by conductivity tests. After washing, the solution was returned to the pot, the level adjusted with water and the salts added. With the third replicate, no washing was done; the salts were added every month and the level of the solution adjusted. At the end of the experiment no difference in disease transmission was obtained in «washed» and «unwashed» pots, nor was there any evidence of build up of salts as indicated by conductivity tests and dry matter determinations.

Symptoms appeared suddenly in the majority of plants (82%) which had been exposed to infection for periods ranging from 1 to 7 months.

The culture solutions in which plants which had contracted infection had been grown, as well as the root system of diseased plants, were examined and found to be free from plant parasitic nematodes. Furthermore, examination of the roots of diseased plants revealed the presence of a *Chytrid* fungus in large numbers.

Preliminary Conclusions

1. It is confirmed that chlorotic streak can be easily transmitted in culture solution.

2. Appearance of symptoms seems to be related more to the age of the plant or to environmental conditions than to time of exposure to infection. Symptoms may appear as early as one month after exposure.

3. There is no need to ratoon the plant to have expression of symptoms, nor is there need to damage the root system.

4. Transmission was obtained in the absence of plant parasitic nematodes.

The role of *Chytrids* in disease transmission is under investigation.

(b) Control of the disease

(i) *Inheritance of resistance*

All varieties cultivated at present in Mauritius are susceptible to chlorotic streak.

The direct approach to the production of resistant varieties was started in 1963. To that effect, trials are being conducted in order to assess the reactions of a large number of varieties to the disease and thus screen the resistant canes which could be used in breeding work, if such canes exist.

In one trial established in the super-humid zone (Belle Rive) where the best environment for disease transmission prevails, out of 33 varieties, 3 never showed the characteristic leaf streaks in virgins and first ratoons. In another trial also in the super-humid zone (Union Park), out of 124 varieties subjected to natural infection, 9 remained symptomless in virgins and first ratoons.

The 12 varieties which so far seem to be resistant to the disease are : M. 35/47, M. 209/47, M. 487/47, M. 53/48, M. 305/49, M. 336/50, M. 405/50, M. 18/51, M. 92/51, Co. 290, Uba Marot and *Saccharum spontaneum* (*Kletak*).

(ii) *Hot water treatment*

The short hot water treatment of planting material inactivates the pathogen inside the cutting. Such treatment, generally 52°C for 20 minutes and occasionally 50°C for 30 minutes, is used on a large scale in Mauritius for plantings particularly in the wet areas where the disease is commonly encountered. The area planted with treated cuttings during the year amounted to 5,460 arpents (4,760 in 1963) or 40% of the total area planted.

It is gratifying to note that the trend, which has led, through a better understanding of the nature and effects of chlorotic streak, to the installation of more efficient treatment tanks on estates, is continuing. Varieties resistant to gummosis, yet highly susceptible to chlorotic streak, such as M. 253/48 and M.442/51 will have to be grown and this can be successfully achieved provided the planting material, through a proper hot water treatment, is freed from the chlorotic streak virus.

Tests were conducted at three more treatment installations during the year.

6. YELLOW SPOT

R. ANTOINE

Yellow spot, caused by the fungus *Cercospora koepkei*, was observed for the first time in Mauritius in March on an estate in the super-humid zone in the variety B. 3337. The first record in Madagascar dates back to 1961.

A survey, which was immediately conducted on cane lands of that estate revealed the following points :

(i) The intensity of disease symptoms varies considerably in an infected field with patches showing severe symptoms amongst lightly infected cane.

(ii) Patches of heavily infected cane are associated with spots where the soil moisture is high : depressions in the field, seepage from ditches.

(iii) The disease was not observed in B.3337 growing in the best, well drained soils of the estate.

(iv) Except for very light infection in the vicinity of heavily infected B. 3337, the other varieties cultivated were showing resistance. These include M. 147/44 in which brown spot, which is common, should not be confused with yellow spot, M. 202/46, M. 93/48, M. 31/45, M. 134/32 and Ebène 1/37.

Rainfall has been exceedingly high during the first three months of the year in the three sections of the estate where the disease has been observed as given in Table 18.

This exceedingly high rainfall may have been conducive to the spectacular outbreak in places.

The only other variety which proved to be susceptible during later surveys was Ebène 50/47.

By the end of winter the symptoms had completely disappeared from all affected fields.

Table 18. Rainfall during the first three months of 1964 on three sections of an estate where the outbreak of yellow spot was observed.

Rainfall in inches

	Section A	*Section B*	*Section C*
January 1964	26.99	28.80	33.09
February ,,	14.70	12.32	26.46
March ,,	13.69	16.71	22.42
Total ...	55.38	57.83	81.97
Average for 1st quarter	25	27	39
Annual rainfall	77	89	126

Discussion

The leaf symptoms of yellow spot are dependent upon the amount of down produced on the underside of the leaf. In light infections depending upon the varietal reaction and water, the spots may remain small and yellow and stay as discrete entities, as observed in M. 93/48 and Ebène 1/37. But, if the variety is susceptible and the weather favourable then the spots coalesce to cover large areas, the yellow turning to red, giving the foliage a general rusty appearance. Although factors affecting down production are not yet understood, it has been postulated that it may be influenced by the internal humidity within a field. That has been clearly seen during surveys.

Also, in Queensland, it has been observed that the first appearance of obvious symptoms may vary widely from season to season. The disease becomes obvious during periods of wet weather, the host-parasite relationship being markedly dependent on humidity and not on temperature. This accounts for the fact that in Queensland, the amount of disease varies from one season to the next, and at times symptoms are difficult to find even in susceptible varieties.

In the light of the above, it is considered that there is no immediate cause for alarm. A close watch on the progress of the disease, which is one of wet areas, will be kept. No control measures are considered justified at the moment.

7. RUST

R. ANTOINE AND M. PÉROMBELON

Another unwanted immigrant, rust, was discovered for the first time in October. The disease had been identified on the West Coast of Madagascar in 1962 and from the experience gained on maize rust (*Puccinia polysora*), which travelled round the world in two years, an outbreak of the disease in the island had been expected for some time.

Rust of the sugar cane may be caused by two fungi : *Puccinia kuehnii* or *Puccinia erianthi*. The first rust which occurs in Australia, Burma, Ceylon, China, Egypt, Fiji, India, Indonesia, Japan, Madagascar, Mozambique, New Guinea, Philippines, South Africa, Thailand and Taiwan, is considered a minor disease of the sugar cane. As the disease occurs sporadically and never reaches epiphytotic proportion, it is of slight importance. Furthermore, most present day commercial varieties appear to be resistant to that type of rust. In the case of the second rust (*P. erianthi*), which has been recorded on cane in India and China, quite a different picture prevails. Epiphytotics of rust have occurred regularly in India (Deccan, Madras State and Uttar Pradesh) with severe infections in several Indian commercial varieties, leading even to the withdrawal from cultivation of the variety Co. 475.

It was therefore essential to identify the causal organism. Table 19, gives the measurements of the two types of spores (uredospores and teleutospores) for *P. erianthi*, *P. kuehnii* and the new rust fungus.

Table 19. Spore measurement of rust fungi (microns).

Rust fungus	*Uredospore*		*Teleutospore*	
	length	*breadth*	*length*	*breadth*
Puccinia erianthi ...	24.1 — 34.9	18.1 — 25.3	28.9 — 45.8	14.5 — 21.7
Puccinia kuehnii ...	29.0 — 57.5	18.0 — 34.5	25.0 — 40.0	10.0 — 18.0
New rust fungus ...	27.9 — 44.2	18.6 — 32.5	21.4 — 29.2	7.9 — 11.2

The measurements show that the new rust fungus cannot be *P. erianthi* and is very similar to *P. kuehnii*. Photomicrographs of both uredo- and teleutospores have been prepared.

During the studies the following points which were still to be defined in the life history of *P. kuehnii* have been established :

(i) Teleutospores are readily produced.
(ii) Teleutospores and uredospores can occur in the same sorus.
(iii) The mature teleutospores are light coloured.
(iv) Germination of the teleutospores has been observed and recorded.

Commercial varieties which have shown susceptibility so far are M. 147/44, M. 202/46 and M. 442/51.

As it has been established that rust spores can travel long distances in the air currents of the upper atmosphere and still remain viable, it can be assumed that the disease gained entry into the island by wind-blown spores.

On present knowledge, the disease is not expected to be of economic importance. A close watch on the progress of rust will be maintained. No control measures are recommended at the moment.

Table 20. Summary of varietal reaction to the four new diseases as assessed in 1964.

Variety	*Gumming (new strain)*	*Leaf scald (new strain ?)*	*Rust*	*Yellow spot*
M. 134/32	+	+	+	+
M. 147/44	—	—	—	+
M. 31/45	+	+	+	+
M. 202/46	+	—	—	+
M. 93/48	±	+	+	+
M. 253/48	+	+	+	+
M. 442/51	+	+	—	+
Ebène 1/37	—	+	+	+
Ebène 50/47	+	+	+	—
B. 3337	—	+	+	—
B. 34104	—	+	+	+
B. 37172	—	+	+	+

+ = resistant ; — = susceptible.

8. TESTING DISEASE REACTION OF SEEDLINGS

R. ANTOINE

The whole procedure used in testing the reaction of seedlings during selection to the major diseases existing in Mauritius had been streamlined in 1963 (vide *Ann. Rep. Sug. Ind. Res. Inst. Mauritius*, 1963 : 86-87). The presence of new strains of the gumming disease and leaf scald pathogens having been detected in 1964, other changes had to be brought to the testing programme.

A detailed description of the procedure adopted in testing the reaction to major diseases of sugar cane seedlings during selection has been submitted for publication elsewhere. It is therefore intended to outline the changes which had to be adopted in the light of the new outbreaks of gummosis and leaf scald.

It can be foreseen that the virulence of the new strain of *Xanthomonas vasculorum* will lead to the discard of a large number of seedlings. Consequentlty, a preliminary screening of disease reaction to the new strain will have to be conducted while the seedlings are still in the

propagation plots after selection in bunches, i.e. after the third or fourth year of selection. At this stage the number of seedlings which are planted in each of two environments is approximately 2,000.

Selected seedlings from First Selection Trials will be tested further in resistance trials as in the past but this time to the old strain of the pathogen in one environment and to the new in another unless (a) it is proved that the difference between the two strains lies in a degree of virulence of host reaction only and (b) it is not possible to keep the two strains separate. The number of varieties selected will by then have dropped to about 140.

For leaf scald trials requiring a larger number of cuttings, testing will be carried out, as usual, after propagation of selected varieties from First Selection Trials in a nursery. The varieties, which by then should number approximately 40, will be tested to the old strain of the organism in one environment and to the new in another as for gumming disease and with the same proviso.

It is thus expected to obtain results in both gumming and leaf scald trials within two years after selection from First Selection Trials.

The new procedure is summarized in Fig. 13 and detailed in Fig. 14.

9. FIJI DISEASE IN MADAGASCAR

R. ANTOINE

(a) Control in the field

During the year under review efforts of the Fiji Section of the Plant Protection Service were concentrated in the innumerable small plantations scattered in the whole province of Tamatave. A total of 3,700 old family plantations covering 340 hectares were inspected and 350,000 stools of unauthorised varieties, almost exclusively Louzier, were uprooted and destroyed. The rogueing gangs also surveyed 268 hectares of new plantations and eliminated all volunteer stools. The same operation was conducted in the commercial plantations of Brickaville where the cane is grown for the production of sugar, now entirely under resistant varieties.

It should be noted that in spite of an intensification of the survey work, not a single case of Fiji disease was detected during the year.

The new plantations authorized in 1964 numbered 1,241 and were established with 600 tons of cuttings of resistant varieties, mainly Pindar and S. 17, supplied from the 52 nurseries planted by the Fiji Section. It is worth mentioning that betsa-betsa (the fermented beverage obtained from cane juice extracted in primitive mills) made with Pindar is more in favour on account of its darker colour.

Eight resistant varieties have been added to the list of approved cane varieties, bringing the total to 13. The varieties are : CP 44/101, M. 202/46, M. 165/38, M. 63/39, M. 31/45, Q. 50, R. 331, Ragnar, Trojan, Pindar, S. 17, Q. 57 and Co. 290. M. 63/39 and Q. 50 are the most popular canes for chewing.

Regular cattle shipments from Madagascar to Mauritius are made from the port of Vohémar. The small village plantations in the district of Vohémar were visited during the year and found to be free from the major diseases attacking the sugar cane.

It is contemplated to finish the uprootings in the whole province of Tamatave by the end of February 1965. Furthermore, rogueing gangs will be expected to complete inspection and rogueings, wherever necessary, of all new plantations by 31st December 1965, date on which the official campaign against Fiji disease will come to an end.

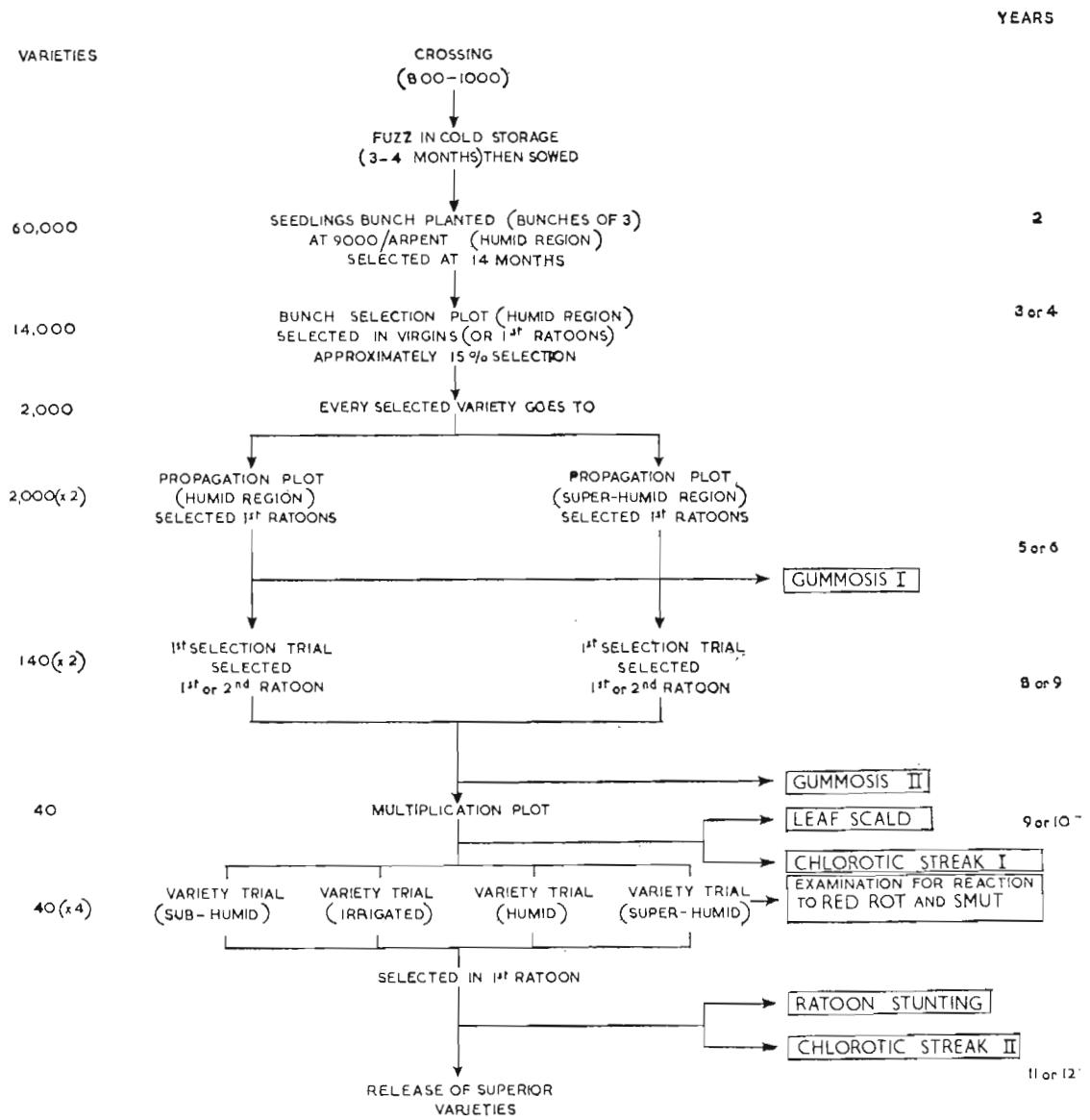

Fig. 13. Selection scheme showing the stages at which the reaction of seedlings to major diseases is assessed.

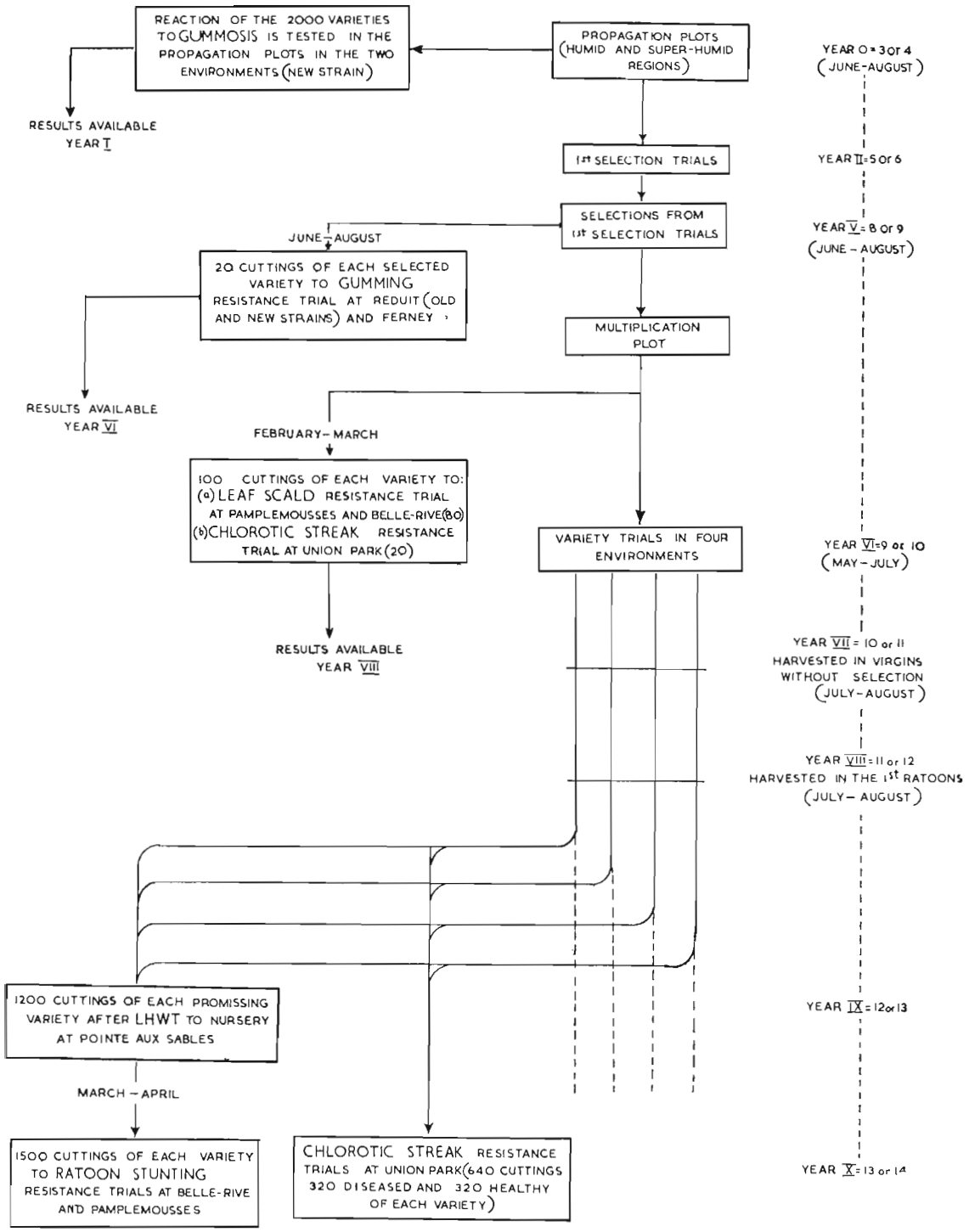

Fig. 14. Scheme illustrating the procedure adopted in testing the disease reaction of seedlings during selection.

As from the 1st January 1966, the provincial sections of the Plant Protection Service and of the Agricultural Service will take over from the Fiji Section which was established immediately after the discovery of the disease in 1954.

(b) Control in the markets

The sale of cane was once more authorized in three markets during the year, bringing the total to six since 1962, when the ban was lifted for the markets of the town of Tamatave, after adequate control measures had been enforced. Other centres will be opened in 1965. No variety other than Pindar was brought to the markets during the year.

It should ne noted that although 97 tons of cane were sold in the markets of Tamatave in 1964, this is well below the amount sold annually before the Fiji outbreak.

(c) Control in the port area

The control organization which was set up in Tamatave in order to prevent the entry of any part of the sugar cane plant into the port area continued to operate very satisfactorily during 1964. Twelve persons were stopped while taking sugar cane into the area. All the canes seized were Pindar. In two cases, 15 and 30 whole canes respectively were being taken out of Tamatave. On the whole 79 cuttings were seized during the year.

The control which is financed by the governments of Mauritius and Réunion should be maintained until the total eradication of Fiji disease is achieved on the East Coast of Madagascar.

(d) Resistance trials

All varieties tested in the 1962-1964 trial proved to be susceptible to the disease. In the 1963-1965 trial, the following varieties have contracted infection in virgins : B. 42231, B. 45151 and H. 39-3633. The 1964-1966 trial has been established and includes 14 varieties.

A summary of varietal reaction for the years 1960-1964 is given in Table 21.

The resistance trials are financed jointly by the Plant Protection Service of Madagascar, IRAT (Madagascar), IRAT (Réunion) and the Government of Mauritius. Such trials should continue until it is certain that Fiji disease has been eradicated.

Table 21. Varietal reactions in Fiji disease resistance trials on the East Coast of Madagascar (1960-1964).

Highly Susceptible	*Susceptible*	*Moderately susceptible*	*Resistant*
B. 34104	Azul	Atlas	Co. 290
B. 37172	Co. 421	**B. 3337**	C. P. 44/101
B. 4098	C. P. 29/116	**B. 37161**	M. 165/38
B. 4362	Jason	B. 41227	M. 63/39
B. 4744	Louzier	Co. 281	**M. 31/45**
Ebène 1/37	**M. 112/34**	M. 74/39	**M. 202/46**
F. 108	**M. 147/44**	R. 366	Pindar
M. 134/32	M. 213/40	R. 383	Q. 50
M. 272/52	**M. 253/48**	Uba	Q. 57
M. 93/48	Pepecuca		R. 331
N : Co. 310	Q. 47		Ragnar
P. R. 980			S. 17
P. R. 1000			Trojan
Q. 42			
Q. 49			
R. 337			

CANE PESTS

J. R. WILLIAMS

1. THE SCALE INSECT ON PLANTING MATERIAL

AN outbreak of the scale insect (*Aulacaspis tegalensis* Zehnt.) at the Sugar Planters' Rehabilitation Fund Central Cane Nursery early in the year drew attention to adverse effects which might result from the use of infested canes as planting material. An examination of the fields at the Nursery in April showed 25 out of 86 fields to be appreciably or heavily infested, at least in part, both virgin and ratoon cane of several varieties being affected. The Nursery is situated in a region where environmental factors favour this insect and as there is no known method of preventing outbreaks, its recurrence from time to time on Nursery canes is to be expected. In view of this, the possible consequences of utilizing scale-infested cane as planting material were considered and several experiments in this connection were carried out. Experimentation is, however, still incomplete though a detailed account of its progress in 1964 is available in Technical Circular No. 24 (mimeograph).

There appear to be three subjects which need to be considered in connection with the use of scale-infested canes as planting material. These are are :

(1) Dissemination of the insect (more specifically, its eggs and the active 1st larval stage) during transport of infested canes.

(2) Development of infestation in virgin cane as a result of the presence of the insect on the planted setts.

(3) Reduced germination and/or vigour of growth, and reduced yield of cane, following use of setts obtained from infested stalks irrespective of whether infestation develops during growth of the cane.

All three considerations are pertinent in the dry coastal belt (approximately the zone with an average annual rainfall of less than 75'') but in wetter regions where scale infestation never occurs only the third factor can be of consequence.

Eggs and infective 1st stage larvae («crawlers») are extremely abundant on appreciably infested canes and they are dislodged and scattered during cutting, manipulation and transport of such canes. Mortality is undoubtedly very high but some which fall near or on cane shoots will survive and during transport of infested canes this might lead to new foci of infestation. Infested canes are, of course, transported from field to factory every year without consideration of this matter which, however, assumes a different aspect when nursery canes are involved, more so if planting of such cane occurs before the crop period when scattering of infective stages is more likely to lead to new attacks. Some treatment of infested nursery canes before their transport thus seems advisable if their destination lies within the coastal belt.

To assess the persistence of scale insects on infested setts after planting and the probability of their giving rise to infestation in the resulting stand of cane, a number of infested setts were planted in June in two localities according to normal field practice. It was found that although many of the scales on the

setts died following burial in the soil, others survived and multiplied and about two months later clusters of live scales were common on the setts. Thereafter, live scales decreased gradually in number on the setts but were still quite abundant on some after five months, by which time they could also be found on the underground parts of the developing shoots. At the end of the year the basal internodes of the young stems bore scale clusters. These observations are continuing but they seem already to show conclusively that, despite the adversities of burial, scales on the setts are able to initiate foci of infestation in virgin cane. Consequently, the destruction or removal of scales on infested setts is to be advocated when such setts are to be planted in the coastal belt.

Experiments were started in May to determine if germination and early growth are affected in any way by infestation of planting material. Given that this is so, the question of reduced yield, irrespective of infestation of the cane during its growth, would arise. The experiments conducted to date have been described in detail in Technical Circular No. 24. They comprised the planting of comparable infested and uninfested setts, variously treated, in both the field and in the greenhouse, results being assessed by germination counts and measurements of shoots during their first few weeks of growth. The cane variety used was usually M. 202/46. The conclusions drawn from these first experiments are that both germination and early shoot growth are reduced if setts are heavily infested with scales when planted. Removal of the insects by washing the setts (e.g. by brushing them in water) improves their performance, often to a considerable extent (Plate 7 *top*), while hot-water treatment of the setts using an appropriate temperature/time combination destroys all stages of the scale and sometimes, but not always, virtually overcomes the depressive influence of the insect (Plate 7 *bottom*). Insecticidal dips were less effective and none used gave a satisfactory kill of the scales on the setts.

In these experiments, infested canes were selected for heaviness of scale encrustation and it should be noted that a grower would never be obliged to make use of material so heavily and uniformly attacked. In fact, manipulation of canes when cut and transported, etc., according to field practice is instrumental in dislodging many scales, a factor which is all to the good from the point of view of germination and shoot growth.

Hot-water dips for destruction of the scale insect

Cane pieces heavily infested with scales were subjected to hot-water dips using different temperature/time combinations. A thermostatically controlled laboratory tank was used and temperature variations during treatments did not exceed 0.5°C. After treatment, the cane pieces were examined repeatedly for several days to determine the presence of live scales and viable eggs. All treatments were repeated several times and the results are shown in fig. 15. The eggs proved to be more resistant than other stages so that the figure shows in effect the temperature/time combinations effective for destruction of eggs.

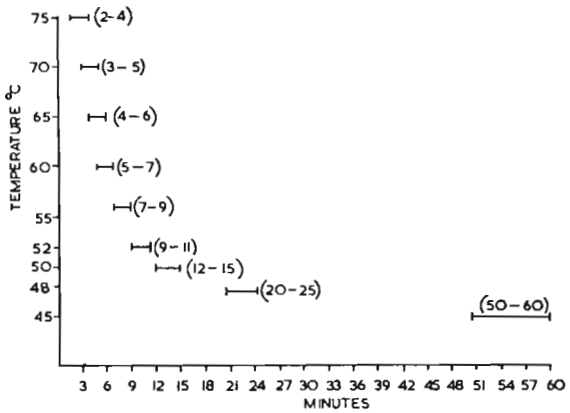

Fig 15. Temperature – Time combinations for hot-water treatments to destroy *Aulacaspis tegalensis*. The shorter time period indicated for each temperature results in a high mortality and the longer time period in a complete kill of all stages.

Insectidical dips for destruction of the scale insect.

Insecticidal dips tested for treatment of scale-infested setts comprised oil emulsions and organophosphorus compounds at various strengths, used alone and in combination and with immersion periods of from 0 to 1 minute. None of the dips was satisfactory. The OP compounds

Plate 6. The scale insect *Aulacaspis tegalensis* (Zehntner).

Top Left: Heavily infested cane of var. M.202/46. The stalks are badly encrusted while many scales are also present on the foliage.
Top Right: A close-up of attacked leaves.
Bottom Left: Scales being destroyed by adults of the Coccinellid beetle, *Lindorus lophanthae* Blaisd.
Bottom Right: A group of larvae of *Lindorus* also devouring scale insects.

Plate 7. Growth depression following the planting of setts heavily infested with the scale insect, *Aulacaspis tegalensis* Zehnt. Cane variety M.202/46.

Top: Growth at four weeks from single-bud setts which were heavily infested (left), heavily infested but washed clean immediately before planting (middle), uninfested (right).

Bottom: Growth at three weeks from three-bud setts which were heavily infested (left), heavily infested but HWT at 52°C for 10 min. (middle), uninfested (right).

with contract action (Malathion, Folithion, Gusathion) were highly efficacious against crawlers but left eggs and a high percentage of the fixed stages alive. Systemic OP compounds (Rogor, Metasystox, Phosdrin, Thimet) gave less control than the contact compounds. The refined-oil emulsion, Albolineum, was most efficacious and destroyed a good proportion of all stages, including eggs. The best of the dips used was judged to be one containing 2% Albolineum and 0.1% malathion, an immersion of ¼ min. being about as effective as one of 1 min. Control of the insect however, seldom approached 100% and, depending on the nature of the scale crusts, many insects survive the treatment. Germination tests indicated that this dip has no adverse effect on the setts.

General conclusions and practical considerations

Of the three undesirable effects which might follow the use of scale-infested canes as planting material, viz., dispersion of the insect during transport of the canes, carry-over of infestation by the scales on the setts, and growth depression, the first two are of consequence only in the coastal belt to which scale infestations are restricted while the third might occur in new plantations anywhere in the island. The degree of infestation is obviously an important factor and experimental work to date has considered only the results of heavy sett infestation.

In field practice, it is considered that, as far as possible, infested canes should not be used as planting material : when this is unavoidable, some selection of canes should be made to reject the more heavily infested. Setts prepared from infested canes should be freed from scales before planting : this applies particularly in the coastal belt where carry-over of infestation may occur but elsewhere only growth depression is involved and the use of lightly infested planting material is probably of little or no consequence.

Hot-water treatment at 50°C for 15 min., or at 52°C for 11 min., will destroy all stages of the insect. Alternatively, setts can be freed from scales by washing them and in practice this would be facilitated by the prior removal of many scales and the loosening of others which results from handling the material. A third alternative, which might perhaps be used in conjunction with the second, is use of an insecticidal dip.

With regard to dissemination of the insect in the coastal belt during transport of infested canes, the likelihood of this occurring would be reduced by spraying canes after loading on the cane carrier with the Albolineum-Malathion mixture already alluded to.

2. THE SPOTTED BORER

Another attempt to establish *Diatraeophaga striatalis* Sn., the Javanese Tachinid parasite of the spotted borer *Proceras sacchariphagus*, was made in July-August. The previous effort to establish the parasite had been in 1961. Through the co-operation of the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières, which had organized collection of *Diatraeophaga* in Java for dispatch to Madagascar and Réunion, approximately 8000 puparia of the fly were received by air. Many were unavoidably in poor state on arrival, and the flies emerged and died in transit from others, so that the total number of flies eventually obtained for release was about 1500 (as opposed to 850 released in 1961). To increase chances of establishment, two liberation sites were selected, one in the dry coastal region and the other in the uplands. The outcome of these liberations is awaited. Close cooperation with Madagascar and Réunion, where *Proceras* is also an important pest, is proving of mutual advantage in connection with work on *Diatraeophaga* : apart from exchange of technical data, the establishment of the parasite in any one of the three countries will mean a ready source of material for further work in the other two. This aspect is of particular importance in view of the difficulty of obtaining material from Java and of culturing the insect in the laboratory.

Other parasites released against *Proceras*

were *Trichospilus diatraeae* C. & M., *Trichogramma japonicum* Ashm. and *T. australicum* Gir., all obtained from India through the Commonwealth Institute of Biological Control.

The depredations of *Proceras* are familiar to all cane growers, but qualitatively rather than quantitatively for the incidence of the insect and particularly the crop loss it causes are not easy to assess. Difficulties are multiplied with respect to data for the island as a whole because sampling procedure and the derivation of reliable figures are complicated by seasonal, climatic, cane varietal and other factors. During the 1964 harvest, however, data on incidence of attack were acquired from as many fields as possible on six estate areas representing different climatic zones. The fields examined were usually those being harvested and with a sample 50 canes taken at random from each field, the number bored as well as the number of internodes bored were counted. A total of 205 fields were sampled in this manner and the overall results are given below :

Estate	*No. fields sampled*	*Average % canes bored/field*	*Average % internodes bored/field*
St. Antoine	29	49.0	6.7
Médine	36	44.3	5.9
Mon Désert-Alma ...	30	42.3	5.4
Rose-Belle	38	38.7	4.4
Mon Désert-Mon Trésor ...	39	29.4	3.5
The Mount	33	26.4	2.6
Island	205	37.9	4.7

Thirteen varieties were involved with M.147/44 predominant and occupying 60 of the fields sampled. Breakdown of the figures according to variety, but only including varieties which occupied more than 15 of the fields sampled, gave the following results :

Variety	*No. fields sampled*	*Average % canes bored/field*	*Average % internodes bored/field*
M. 93/48	16	49.3	6.4
E. 1/37	38	42.3	5.1
M. 147/44	60	40.1	5.5
B. 37172	25	34.6	3.8
M. 202/46	16	32.5	4.2

Also of interest is that borer damage, as assessed on the sample canes, was completely absent in only three out of the 205 fields visited and the heaviest damage was in a field of M.147/44 at St. Antoine where 98% of the canes and 33% of the internodes were bored.

It will undoubtedly be useful to obtain further data of this nature each season and to attempt derive from it an appreciation of crop loss and of the influence of environmental factors such as variety and weather on the insect's abundance.

3. VARIOUS PESTS

Locusts

Renewed outbreaks of the red locust, *Nomadacris septemfasciata*, which had been feared during December 1963 February 1964, did not materialize on any scale despite the great abundance of adults observed in many areas during the cool months of 1963. This is attributed to the very dry conditions prevailing in November of 1963 which probably caused a high mortality of the eggs in the soil. A few localized attacks, some necessitating application of insecticide, did occur however. One of these, in a field of 10 arpents of M. 31/45, illustrated the considerable influence of cane variety on the insect for despite nearly complete defoliation of the field in question and the presence of a nymphal population estimated at between ½ - 1 million, the surrounding fields of E. 1/37 were almost untouched, even along their borders where they adjoined the attacked field. Another observation of interest in connection with this particular attack was that cyclone *Danielle* (Jan. 19-20), with gusts of 100 m.p.h., had no discernable effect of any kind on the locust population in the field, there being no sign of dispersal, movement, or death.

It is now considered that locust activity has subsided and no outbreaks of any magnitude are expected in the near future.

Nematodes

Study of the nematode soil fauna of cane fields was continued as time allowed and two papers were prepared for publication. The collection of *Xiphinema* spp. and *Longidorus* spp., to identify the forms which occur and to assess their distribution, was also started.

Armyworms

The defoliation experiments described in the report for 1963 were carried over to 1964 and yield of cane assessed. There were, however, no signficant differences of yield between treatments in 1964 and it is concluded that reduced yield following defoliation such as that caused by armyworms is limited to the growing season in which it occurs.

WEED CONTROL

E. ROCHECOUSTE

1. INVESTIGATIONS ON THE USE OF THE SUBSTITUTED URACILS

EXPERIMENTAL work on the two substituted Uracils, Bromacil, 5-bro-3-*sec*-butyl-6-methyl urea and Isocil, 6-bromo-3-isopropyl-6-methyl urea was continued in 1964. In pre-emergence application in plant canes results obtained showed that both Uracils might have a deleterious effect on germination and early growth when excessive rainfall occurred in the first fortnight following herbicide application or when a drought lasting several weeks followed the herbicidal spray. In conclusion it may be said that these two herbicides are too phytotoxic to be used in pre-emergence treatment of plant canes. Investigations on the comparative effectiveness of mixtures consisting of DCMU, Bromacil, Isocil, Sodium Chlorate and an ester of 2, 4-D were carried out in ratoon crops both in humid and super humid areas. Those experiments were conducted in two series. In the first the herbicidal spray was applied one week after lining up of trash when only a few weeds had emerged and in the second it was applied four to six weeks after that operation when weed growth was 4-6 in. high. Of the different formulations tested those consisting of DCMU (2.4 lb a.i.) plus Bromacil (0.6-0.8 lb a.i.) per arpent gave the best results.

The response of the major weeds to the substituted Uracils used alone and in combination with DCMU may be briefly summarized thus :-

(i) Bromacil used alone proved more effective than Isocil on the following weed species : *Ageratum conyzoides*, *Digitaria timorensis*, and *Paspalum paniculatum* but it was as effective as Isocil on *Oxalis debilis*, *Oxalis repens*, *Bothriospermum tenellum*, *Youngia japonica* and *Solanum nigrum*.

(ii) Combinations of the substituted Uracils with DCMU were more effective over a wider spectrum than either of the herbicides used alone. In fact weed species tolerant to DCMU such as *Paspalum paniculatum* and *Plantago lanceolata* and those fairly tolerant to the substituted uracils such as *Ageratum conyzoides* and *Bothriosperum tenellum* were more effectively controlled by combinations of the two herbicides.

Yield trials

Experiments laid down in 1963 to determine the effect of Bromacil and Isocil on yield of cane and sugar were harvested this year. Owing to the susceptibility of plant canes to those herbicides investigations were carried out only in first ratoon crops. The trials were distributed in humid and super humid areas and the herbicides were applied a fortnight after harvest. The statistical lay out consisted of a 5×5 latin square and each experimental plot was 1/80th of an arpent. The Uracils were applied at dosages of 0, $\frac{1}{2}$, 1, 2 and 3 lb active material per arpent.

Results

From the results obtained presented in Table 22, it will be observed that, with the exception of the Belle Rive (Beau Champ) trial, the Uracils had no effect on cane yield at rates of applications up to 1 lb a.i. per arpent. However, in all but one of the treatments (Ebène 1/37 at the 3 lb rate) where significance level was reached, M. 93/48 was the variety under test. This indicates a varietal susceptibility to the Uracils at the higher dosage rates. No adverse effect on sugar yield was observed with both Uracils at all rates of application experimented. Results obtained therefore indicate that both Uracils may be applied in ratoon canes up to 1 lb a.i. per arpent.

It must be pointed out however that in large scale field trials conducted on sugar estates in 1964 on about 500 arpents of ratoon crop the application of the mixture DCMU (2.4 lb a.i.) and Bromacil (0.8 lb a.i.) per arpent had affected cane growth under conditions of water stress, in fields where subsoil had been brought to the surface, and in all cases where application had not been properly made. In conclusion we may say that with the present stage of our knowledge, mixtures consisting of DCMU-Bromacil may be used only on an experimental basis and on a limited acreage of ratoon crop and that great care should be exercised in regard to its application. Its use, however, in M. 93/48 should be avoided.

Table 22. Effect of Bromacil and Isocil on cane yield (Tons/arpent).

BROMACIL

TREATMENTS	*M. 93/48*					*M. 202/46*		*E. 1/37*	*M.147/44*
lb. a.i. per arpent	*Belle Rive (Beau Champ)*	*Henrietta*	*Riche en Eau*	*Bonne Veine*	*Alma*	*Gros Bois*	*New Grove*	*Mon Desert St. Pierre*	*St. Aubin*
CONTROL	30.0	26.2	20.8	40.4	27.1	27.7	22.1	16.8	44.6
1/2 lb ...	28.1	28.3	22.2	40.0	27.0	27.0	24.9	17.7	44.8
1 lb ...	26.5*	26.5	22.3	38.8	27.8	27.4	27.5	19.2	44.7
2 lb ...	20.5*	22.2	20.7	37.3	23.8*	28.1	25.7	16.6	43.3
3 lb ...	20.0*	25.2	18.6	30.0*	16.4*	24.7	24.6	11.7*	42.9

ISOCIL

TREATMENTS	*M. 93/48*					*M. 202/46*		*E. 1/37*	*M.147/44*
lb. a.i. par arpent	*Belle Rive (Beau Champ)*	*Henrietta*	*Riche en Eau*	*Bonne Veine*	*Alma*	*Gros Bois*	*New Grove*	*Mon Desert St. Pierre*	*St. Aubin*
CONTROL ...	21.6	24.3	21.2	37.5	30.7	27.5	22.6	15.2	40.1
1/2 lb ...	22.8	27.5	22.5	37.8	31.4	30.5	24.7	17.3	39.7
1 lb ...	22.1	30.4	23.6	35.7	29.7	25.5	26.4	17.0	42.0
2 lb ...	15.2*	27.8	23.9	32.1*	25.3*	26.6	28.3	16.2	41.7
3 lb ...	12.8*	21.8	20.4	27.9*	21.3*	27.3	26.4	14.2	43.6

* Significant at 5% level.

2. EXPERIMENTAL WORK WITH MIXED HERBICIDE FORMULATIONS

Experiments were carried out with a view to determining whether the addition of oil or of a surfactant to DCMU or Atrazine would give better weed control than mixtures of these herbicides with sodium chlorate. The trials were laid down in plant and ratoon canes in the different localities of the humid and super-humid zones. In plant canes the herbicidal spray was applied one week after planting and in ratoons 4 weeks after lining up of trash when weed growth was about 4 to 6 inches high. Observations were made at monthly intervals and a weed assessment was carried out about 10 weeks after herbicide application.

Results and conclusions

From the data obtained presented in Table 23 it will be observed that in plant canes, mixtures consisting of DCMU or Atrazine with Bromus B oil (specially blended soluble oil containing mineral sulphonates) or surfactant W.K. (dodecyl ether of polyethylene glycol) gave very comparable results to those in which sodium chlorate had been added. Since DCMU or Atrazine applied at equivalent dosages with oil or surfactant instead of sodium chlorate is a more expensive formulation without being more effective, the substitution would not prove an economic proposition. It must be pointed out, however, that rainfall was deficient during the period these experiments were run and consequently this may have to some extent affected the results obtained.

Considering the data obtained in ratoons (Table 24) it will be observed that again the addition of oil or surfactant instead of sodium chlorate did not improve the effectiveness of those mixtures. It must be noted, however, that formulations in which the rate of application of DCMU or Atrazine are decreased from 4.8 to 4.0 lb. a.i. would be slightly less expensive to those consisting of these herbicides at 4.8 lb a.i. plus sodium chlorate.

Table 23. Comparative effectiveness of different herbicide mixtures in plant canes. Weed infestation % at 10 wk.

TREATMENT (*lb. a.i. per arpent*)	*Valetta*	*Alma*	*Union Park No. 1*	*Union Park No. 2*	*St. Aubin (Beau-Bois)*	*Ferney*
DCMU 4.0 lb + sodium chlorate 10 lb ...	46.9	46.1	49.2	61.8	43.3	40.0
„ 4.0 lb + Dromus oil 2 gallons ...	55.2	38.0	49.8	53.2	38.8	55.5
„ 4.0 lb + Surfactant WK 1.0% ...	49.4	32.4	64.3	64.4	29.9	33.5
Atrazine 4.0 lb + sodium chlorate 10 lb ...	65.6	41.9	54.8	55.4	39.2	49.0
„ 4.0 lb + Dromus oil 2 gallons ...	41.9	36.6	49.2	55.2	34.3	49.7
„ 4.0 lb + surfactant WK 1.0 % ...	54.4	40.8	56.7	59.6	—	37.4
Duration (days) ...	138	136	150	133	104	153
Total rainfall (in) ...	26.83	28.08	35.31	31.81	25.36	23.45
No. of rainy days ...	111	112	101	89	67	55

Table 24. Comparative effectiveness of different herbicide mixtures in ratoon canes. Weed infestation % control

TREATMENT (*lb a.i. per arpent*)	*Rose Belle*	*Union Park*	*St. Aubin Bri-tannia*	*Beau-Bois*	*Bel Etang*	*Valetta*	*Union Ducray*
Atrazine 4.8 lb + Sodium chlorate 6 lb	24.9	33.7	27.7	23.8	17.2	23.6	16.9
,, 4.0 lb + Dromus oil 2 gallons	20.8	28.3	27.3	22.3	22.8	26.7	19.8
,, 4.0 lb + surfactant 0.5% ...	24.2	32.4	38.2	25.7	19.3	16.5	20.3
DCMU 4.8 lb + sodium chlorate 6 lb	21.8	26.2	32.4	19.3	19.6	19.3	14.6
,, 4.0 lb + Dromus oil 2 gallons	24.2	27.0	16.9	16.2	18.2	21.9	21.7
,, 4.0 lb + surfactant 0.5% ...	30.1	32.0	21.2	25.7	19.6	21.3	18.4
Cotoran 4.0 lb + sodium chlorate 6 lb	31.5	33.0	33.5	16.6	27.1	21.3	19.3
,, 4.0 lb + Dromus oil 2 gallons	37.4	41.0	33.8	20.7	29.5	19.3	19.3
Duration (days) ...	77	65	61	68	72	62	79
Total rainfall (in) ...	14.39	3.46	10.85	10.45	9.01	11.88	11.48
No. of rainy days ...	37	20	27	26	27	31	27

3. FURTHER INVESTIGATIONS ON THE CONTROL OF PERENNIAL WEEDS

(i) Chiendent (*Cynodon dactylon*)

During the years 1963-1964 investigations were carried out on the eradication of chiendent (Constance biotype) with the substituted uracils Bromacil and Isocil in comparison to TCA and Dalapon and other herbicide-mixtures. The trials were laid down at Constance Sugar Estate. Plot size was 400 sq ft and each treatment was repeated twice. The first spraying was made in June 1963 and the plots were resprayed with the same chemicals at the same dosages in June 1964.

Results obtained presented in Table 25 show that the combination DCMU plus Isocil was the best treatment. However both Uracils used alone at 6.4 lb a.i. per arpent gave results very comparable to that treatment.

Table 25. Comparative effectiveness of substituted Uracils and other herbicides on chiendent. Infestation expressed in % regrowth.

TREATMENTS (*lb a.i. per arp.*)	*Sprayed 19.6.63 Date of observation after spraying*			*Resprayed 6.6.64 Date of observation after respraying*		
	3.8.63	*5.2.64*	*7.5.64*	*5.8.64*	*9.11.64*	*15.3.65*
Isocil 6.4 lb	10	25	30	0	5	5
Bromacil 6.4 lb	0	10	20	0	5	5
DCMU 8 lb + isocil 6.4 lb ...	0	2	15	0	2	2
DCMU 8 lb + Sodium chlorate 200 lb ...	5	40	50	0	30	95
DCMU 8 lb + paraquat 2 lb	50	100	100	45	90	100
Simazine 8 lb + sodium chlorate 200 lb ...	2	60	90	5	50	90
Simazine 8 lb + paraquat 2 lb	40	100	100	35	90	100
TCA 200 lb	15	100	100	0	100	100
DALAPON 20 lb	90	100	100	80	100	100
,, 40 lb	90	100	100	75	100	100

(ii) Liane lingue (*Paederia foetida*)

Eradication of «liane lingue» growing in stone walls is a difficult problem owing to the peculiar habit of growth of that vine in such an environment. In fact a study of its growth behaviour under such conditions has shown that it consists of a shallow rhizomatous system from which spring a large number of sturdy shoots which grow rapidly between the stones of the walls. These shoots branch at frequent intervals and form a complex system between the interstices in the walls. All herbicides so far tested to eradicate this plant have failed probably because those herbicides could not be translocated right down to the rhizomes situated in the soil below the stone wall. It must be observed, however, that satisfactory control of the plant growing in arable land may be easily achieved by esters of 2, 4-D and 2, 4, 5-T. Owing to the fact that this pest is becoming more and more a problem in stone walls on some estates further investigations were carried out on its control this year with the collaboration of Savannah Sugar Estate. The problem was approached in two ways: fumigation with methyl bromide and spraying with some selected herbicides. Briefly, the experiments were conducted as follows :

(a) Methyl bromide trial. In order to determine the susceptibility of liane lingue to methyl bromide, 20 ft of wall was destonned carefully to expose the intricate branching system. Methyl bromide was then fumigated at the rate of 1 lb per 90 sq ft and the fumigated area was left covered with a plastic sheet for 48 hours. Subsequent observations made at monthly intervals showed that the plant had been completely killed by the fumigant.

(b) Trial with selected herbicides. The following chemicals Tordon, Trysben, Pesco 18/15 and Weedazol TL applied at dosages of 2 and 4 lb a. i. in 100 gallons of water per arpent of surface covered were compared to an iso-octyl ester formulation containing 2, 4-D, and 2, 4, 5-T. The herbicides were applied in June 1964 and results obtained 8 months after treatment are shown in Table 26

Table 26. Effect of certain herbicides on liane lingue

	Treatments *lb a.i. per arpent*	*Infestation expressed in % regrowth*
Iso-octyl Ester ...	3 lb	60
Tordon ...	2 lb	0
Tordon ...	4 lb	0
Trysben ...	2 lb	80
Trysben ...	4 lb	80
Weedazol T.L. ...	2 lb	25
Weedazol T.L. ...	4 lb	15
Pesco 18/15 ...	2 lb	100
Pesco 18/15 ...	4 lb	95

From those results it will be observed that Tordon was the only chemical which gave a complete control of the vine. Weedazol T.L. was the second best treatment. It must be observed, however, that Tordon is very toxic to sugar cane, consequently its use to eradicate that plant should be confined strictly to stone walls. However, before recommending its use it is essential, as a measure of safety, to determine whether at lower dosages it would not prove as effective as at the higher rates.

It is interesting to note that Tordon was also effective on *Passiflora suberosa*, a common vine of stone walls which has shown so far great tolerance to 2, 4-D weed killers.

CLIMATE AND CULTIVATION

1. CLIMATIC CONDITIONS DURING 1964 CAMPAIGN

PIERRE HALAIS

AFTER 1960 and 1962, Mauritius was once more hit by two cyclones in 1964, a violent one *Danielle* in January and one of small intensity *Gisele* in February.

The average amount of tons of cane per arpent reaped, the sugar made % cane, and the tons of sugar made per arpent are given for the last three crops 1962, 1963 and 1964 in Table 27.

Table 27. Cane and sugar output of Mauritius per arpent reaped.

	Tons cane/ arpt.	*Sugar made %cane*	*Tons sugar made per arpt.*
1962 cyclone year	23.9	11.52	2.75
1963 normal year	29.6	11.93	3.53
1964 cyclone year	22.5	11.86	2.66

It will be noted that apart from the disastrous year 1960, the tons of sugar per arpent in 1964 are the second lowest of the decade 1955-64 whilst the sugar made % cane is about average.

Observations carried out for the four selected climatic data, rainfall, wind, air temperature and sunshine for the *vegetative period* from November to June of the 1963-1964 sugar campaign call for the following general comments :

1. **Rainfall** : After a good start in November, the rainfall was under normal up to the second decade of January when cyclone *Danielle* visited the island with heavy accompanying rains. The rainfall recorded for January 1964 was 22.1 inches, that is twice the normal figure of 11.0 inches. Another cyclone *Gisele* only brought a small surplus of rain at the end of February.

2. **Maximum wind speed** for one hour's run reached the high figure of 60 m.p.h. totalized over the island during the passage of *Danielle* in January and 34 m.p.h. in February when *Gisele* came near to the island.

3. **Average air temperature** was below for six out of the eight months' vegetative period.

4. **Relative insolation** was below normal in November which received more rain than usual.

For the *maturation period* starting in July and ending in October, the following departures from normals were observed :

1. **Rainfall** : two inches of rain above the normal rainfall of 0.8 inch for the first ten days of October is quite an unusual excess.

2. **Maximum wind speed** did not depart much from normal values.

3. **Average minimum temperatures** were well below normal for the four consecutive months of the maturation period.

4. **Relative insolation** was above normal for the months of July and August and normal for the other two months.

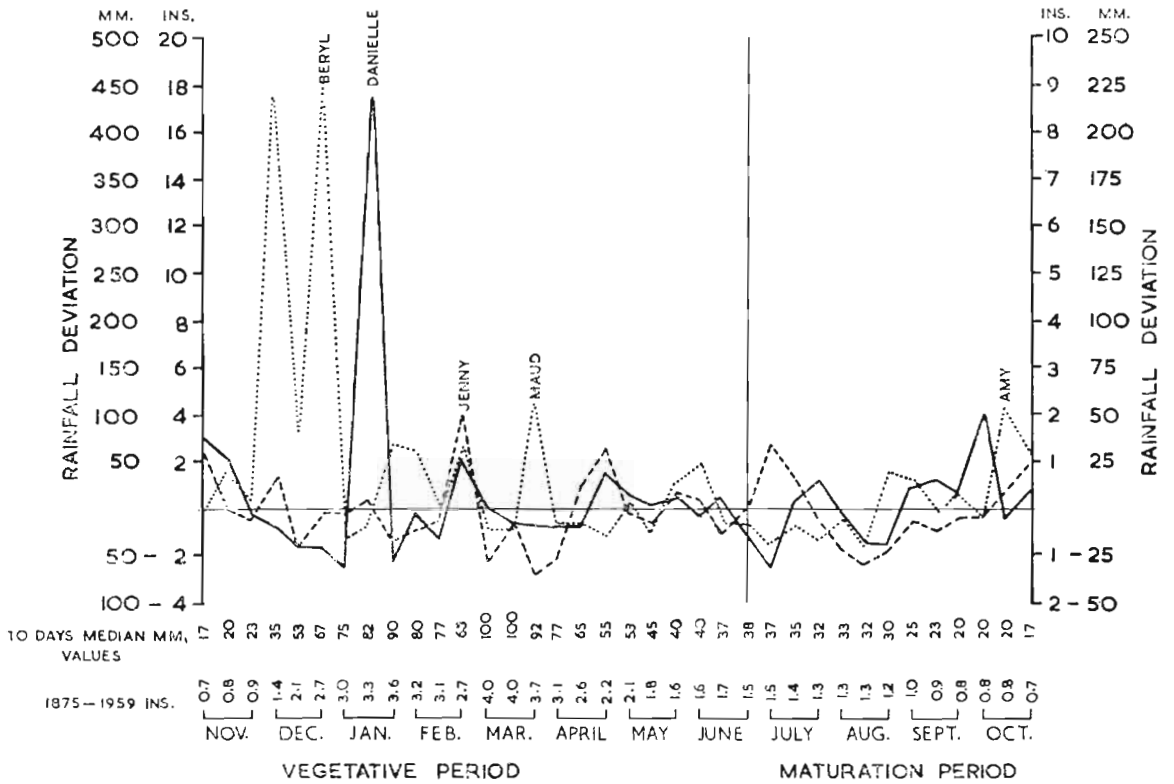

Fig. 16. Rainfall deviation from 10 days median values.
Dotted line : 1961-62. Broken line : 1962-63. Plain line : 1963-64.
Scale used for maturation period is double that of vegetative period.

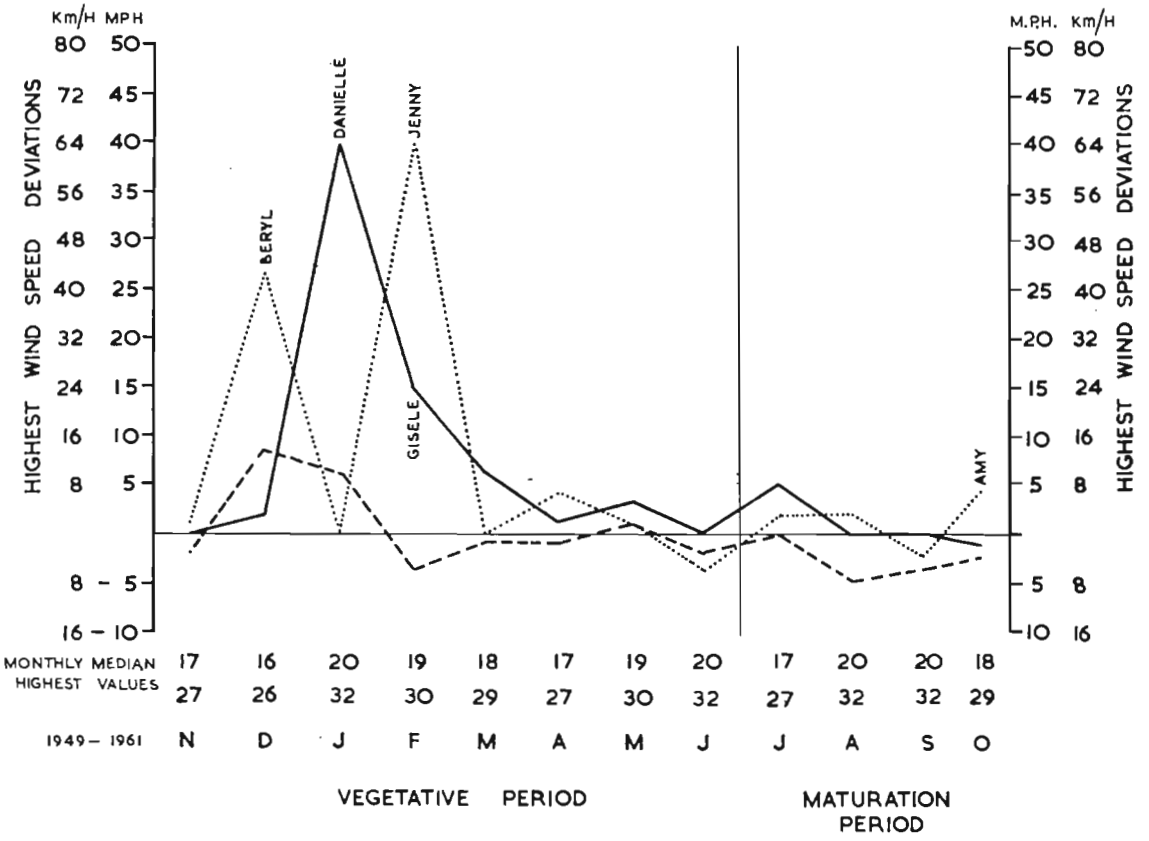

Fig. 17. Deviations of highest wind speed during one hour from corresponding median values. Dotted line : 1961-62. Broken line : 1962-63. Plain line : 1963-64.

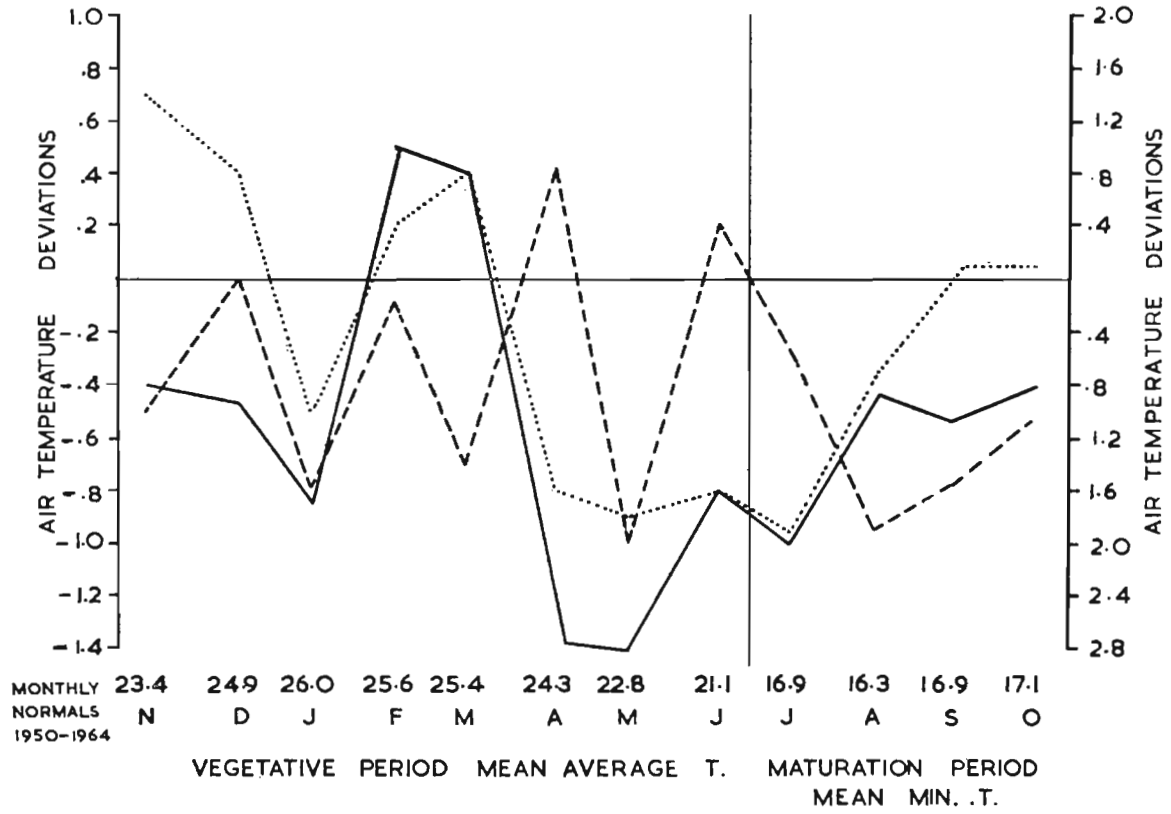

Fig. 18. Air temperature deviations from monthly normals, average mean T for vegetative periods, and average min. T for maturation period. Dotted line : 1961-62. Broken line : 1962-63. Plain line : 1963-64.

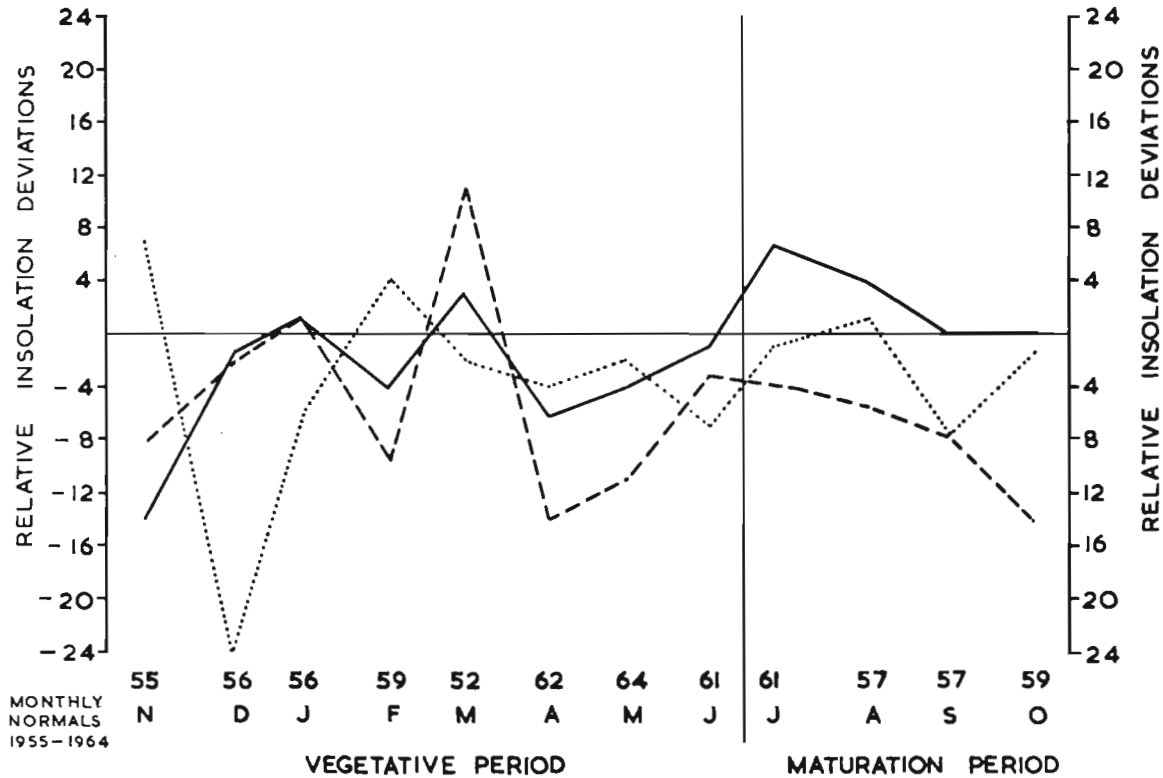

Fig. 19. Relative insolation deviations from monthly normals.
Dotted line : 1961-62. Broken line : 1962-63.
Plain line : 1963-64.

As done every year in the Annual Report four graphical representations (figs. 16–19) give the deviations from normals for the last three sugar campaigns.

The general conclusion is that cane production was severely hindered first by the violent winds that accompanied cyclone *Danielle* and to a lesser extent by cyclone *Gisele*. The lower temperatures recorded from April onwards have certainly prevented the recovery of the cyclone-striken canes, specially on high grounds. No explanation can be given to account for the fact that the very low minimum temperatures recorded from July to October have not resulted in better cane quality as could be normally expected.

2. INFLUENCE OF METEOROLOGICAL FLUCTUATIONS ON SUGAR PRODUCTION 1955 - 1964

PIERRE HALAIS

Mauritius has met with considerable weather hazards during the last decade 1955-1964 as a result of which the sugar output of the island has shown very wide variations ranging from 236,000 tons of sugar manufactured in 1960 to 685,000 tons in 1963.

From the purely meteorological angle, though the actual variations of atmospheric conditions in absolute terms are large between the five sugar sectors, West (W), North (N), East (E), South (S) and Centre (C), of the small and moderately elevated island of Mauritius (M), these variations are very highly correlated. Consequently, averages worked out for the island as a whole constitute a reliable measure of the weather conditions when broad conclusions are aimed at.

Furthermore, out of the extensive weather data assembled by the Meteorological Services and made available to the Institute, three have proved dominant under local conditions as far as sugar production is concerned. They are :

(1) The maximum wind speed (V) for one hour's run recorded during the passage of a cyclone over Mauritius or in its vicinity. A speed (v) of 30 miles per hour is a recognised threshold and speeds as high as 74 m.p.h. may be reached during exceptionally violent cyclones such as *Carol* in February 1960.

(2) The sum of monthly rainfall deficits for the period from November to June (expressed in inches) (D), is critical for the growth of sugar cane (cane tonnage). For the 90 years 1875 to 1964, this deficit D (averaged for the island) has been worked out to be 14.5 inches. Such a deficit (D) is considered «normal». During the 1955-64 decade the deficits have varied between 28.7 in 1961, representing a dry growth period and 5.7 in 1962, a wet growth period.

(3) The sum of monthly rainfall excesses (E) (expressed in inches) for the period from July to October is critical for the maturation of sugar cane (cane quality). For the 90 years 1875 to 1964 this excess E (averaged for the island) has been worked out to be 2.6 inches. Such an excess (E) is considered «normal». During the 1955-64 decade, the excesses have varied between 0.0 in 1956, representing a dry maturation period and 5.9 in 1961, a wet maturation period.

Table 28 summarizes the three dominant weather factors V, D & E observed during the decade 1955-64 and worked out as averages for the island as a whole.

Table 28. Average weather data during the 1955-64 decade.

	Max. Wind Speed	*N-J Rainfall Deficits*	*J-O Rainfall Excesses*
Normals	*26 m.p.h.*	*14.5 inches*	*2.6 inches*
1955	34	8.4	0.8
1956	20	8.6	0.0
1957	20	14.2 (normal)	0.4 (normal)
1958	33	6.4	4.0 (normal)
1959	18	19.9	5.6
1960	74 (*Carol*)	12.0	5.2
1961	19	28.7	4.8
1962	59 (*Jenny*)	5.7	3.4
1963	26	13.9 (normal)	2.2 (normal)
1964	60 (*Danielle*)	10.3	2.9

Table 29 allows for the grouping of the decade into six series of years showing contrasted meteorological conditions bearing a relationship to variations in cane tonnage and cane quality.

The «normal» years, used as reference throughout this study, are those showing maximum wind speed (V) close to 30 m.p.h., sum of monthly rainfall deficits (D) from November to June close to 14.5 inches, and sum of monthly rainfall excesses (E) from July to October close to 2.6 inches.

Table 29. Grouping of the decade into contrasted series.

Groups	*Critical for*	*Years selected*	*Average value of weather data for years selected*		
			V Max. Wind speed	*D N-J Rainfall Deficits*	*E J-O Rainfall Excesses*
	Normal cane tonnage	1957 & 1963	23 m.p.h.	14.1 in.	—
I	*Cyclone* ,,	1960, 62 & 64	64 ,,	(9.3)	—
II	*Wet* ,,	1955, 56 & 58	(29) ,,	7.8	—
III	*Dry* ,,	1959 & 61	(19) ,,	24.3	—
	Normal cane quality	1957/58, & 63	(26) ,,	—	2.2 in.
IV	*Cyclone* ,,	1960, 62 & 64	64	—	(3.8)
V	*Wet* ,,	1958, 59, 61, (62) & (64)	—	—	4.8
VI	*Dry* ,,	1955, 56 & 57	—	—	0.4

Basic information for the various years of the decade pertaining to sugar production for the island (M) and for the five sugar sectors (W, N, E, S, & C) refer to cane tonnage, tons of cane per arpent reaped (TCA) averaged for the planters in general, as well as to cane quality, sugar manufactured % cane (SMC) for the corresponding sugar factories.

The figures for TCA and SMC normally published in the M.S.I.R.I. Annual Reports need adjustment for studies such as the one presently undertaken in order to compensate for the general trends which have been operating throughout the whole decade : an upward one having been observed for cane tonnage (TCA) and a downward one for cane quality (SMC), when comparisons are made between the two normal years 1957 and 1963 for cane tonnage (6 years interval) and between 1957/58 and 1963 for cane quality (5.5 years interval).

The annual corrections used for the adjustment of the data to the centre of the decade 1955-64 (have been worked out) and are presented in Tables 30-32.

Table 30. Annual trend corrections for adjustment purposes.

	M	*W*	*N*	*E*	*S*	*C*
Cane Tonnage (TCA) ...	0.67	+ 0.22	+ 1.11	+ 1.00	+ 0.23	+ 0.33
Cane Quality (SMC) ...	— 0.11	— 0.01	— 0.19	— 0.16	— 0.08	— 0.02

Table 31. Adjusted Tons of cane per arpent (TCA).

	M	*W*	*N*	*E*	*S*	*C*
1955	27.8	28.7	28.4	27.0	28.1	28.3
1956	28.3	27.7	29.3	27.4	29.0	28.0
1957 (normal) ...	27.0	31.2	23.8	25.4	29.8	29.3
1958 (normal) ...	25.2	28.2	23.2	23.9	27.6	26.4
1959	26.2	29.4	22.0	25.3	28.7	29.2
1960	12.4	16.1	13.6	11.7	12.8	8.7
1961	25.7	27.6	21.9	22.9	28.1	30.3
1962	22.5	25.8	22.0	20.0	25.0	18.6
1963 (normal) ...	27.6	31.4	24.0	25.4	30.0	29.7
1964	19.8	27.6	17.7	17.1	21.8	19.3
Normals	*27.3*	*31.3*	*23.9*	*25.4*	*29.9*	*29.5*
Averages	*24.3*	*27.4*	*22.6*	*22.6*	*26.1*	*24.8*

Table 32. Adjusted sugar manufactured % cane (SMC).

	M	*W*	*N*	*E*	*S*	*C*
1955	12.11	12.81	12.37	11.71	11.73	12.74
1956	12.57	13.14	12.93	12.28	12.19	12.82
1957 (normal) ...	12.67	13.05	13.39	12.24	12.29	12.83
1958 (normal) ...	11.98	12.35	12.67	11.98	11.41	12.09
1959	12.19	12.48	12.99	12.14	11.60	12.26
1960	9.89	10.94	10.43	9.81	9.33	9.57
1961	11.35	11.41	12.04	11.18	10.90	11.50
1962	11.79	12.09	12.37	11.78	11.32	11.81
1963 (normal) ...	12.31	12.69	13.02	12.00	11.82	12.47
1964	12.36	12.26	13.41	12.43	11.78	11.59
Normals	*12.32*	*12.69*	*13.03*	*12.07*	*11.84*	*12.46*
Averages	*11.92*	*12.32*	*12.56*	*11.76*	*11.44*	*11.96*

The % annual deviations (+ or —) from normals for cane tonnage (TCA) and for cane quality (SMC) are given in Table 33 for each of the six groups selected deviating from normal as far as dominant atmospheric conditions are concerned.

Table 33. % Annual deviations (+ or —) from normals for cane tonnage & cane quality.

Groups	*Critical for*	*No. of yrs. in group*	*M*	*W*	*N*	*E*	*S*	*C*
I Cyclone	Cane tonnage	3	— 33.3	— 24.9	— 25.5	— 35.8	— 33.4	— 47.5
II Wet	,,	3	— 0.7	— 10.0	+ 13.0	2.8	— 5.7	— 6.4
III Dry	,,	2	— 4.8	— 9.0	— 8.4	— 5.1	— 5.0	+ 1.0
IV Cyclone	Cane quality	3	— 4.0	— 2.5	— 3.8	— 3.6	— 4.1	— 7.3
V Wet	,,	3+3	— 3.9	— 4.8	— 3.5	— 2.5	— 4.6	— 4.1
VI Dry	,,	3	+ 1.1	+ 2.4	— 1.0	0.0	+ 1.9	+ 2.7

For group V dealing with deviations ascribed to cyclonic disturbances occurring in summer on cane quality observed later on at reaping time, the three cyclone years 1960, 62 and 64 have incidentally shown high excesses of rain during the maturation period. Adequate corrections had to be calculated in order that the damages ascribed to the cyclones on cane quality should not be over estimated.

The annual deviations given in above table for each of the six contrasted groups of years can be converted to deviations for the decade as a whole by multiplying the figures given for Groups I, II, III, IV, V, & VI by 0.3, 0.3, 0.2, 0.3, 0.6 and 0.3 respectively.

Table 34. % deviations (+ or —) from normals for cane tonnage and cane quality for the decade 1955-1964 taken as a whole.

Groups	*Critical for*	*M*	*W*	*N*	*E*	*S*	*C*
I *Cyclone*	Cane tonnage	— 10.0	— 7.5	— 7.7	— 10.7	— 10.0	— 14.2
II *Wet*	,, ...	— 0.2	— 3.0	— 3.9	0.8	— 1.7	— 1.9
III *Dry*	,, ...	— 1.0	— 1.8	— 1.7	— 1.0	— 1.0	+ 0.2
IV *Cyclone*	Cane quality ...	— 1.2	— 0.8	— 1.1	— 1.1	— 1.2	— 2.2
V *Wet*	,, ...	— 2.3	— 2.8	— 2.1	— 1.5	— 2.8	— 2.5
VI *Dry*	,, ...	+ 0.3	+ 0.7	— 0.3	0.0	+ 0.6	+ 0.8
	Totals for cane tonnage ...	— 11.2	— 12.3	— 4.5	— 10.9	— 12.7	— 15.9
	Totals for cane quality ...	— 3.2	— 2.9	— 3.5	— 2.6	— 3.4	— 3.9
	Totals for sugar production	— 14.4	— 15.2	— 8.0	— 13.5	— 16.1	— 19.8
	Coefficient for sugar production ...	0.856	0.848	0.920	0.865	0.839	0.802

The individual part played by the six different components of the total variation for the decade under study can be evaluated from Table 34 above. Three components are always negative : cyclone on cane tonnage, cyclone on cane quality, and wet conditions from July to October on cane quality. The three other components are either positive or negative in their action according to the sugar sector concerned. Wet conditions from November to June exercise a favourable positive influence on cane tonnage in the North and East sectors, and a negative one in the other four sectors; for Mauritius as a whole, the influence is only slightly negative. Dry conditions from November to June exercise an unfavourable negative influence on cane tonnage everywhere except in the Centre where the influence is slightly positive. Dry conditions from July to October cause a favourable positive influence on cane quality in general, except in the North sector, where the influence is slightly negative.

As could be expected the overall influence of weather hazards is more notable on cane tonnage than on cane quality. This is specially true for cyclones which exercise 8 times more influence on cane tonnage than on cane quality.

However, cyclones cause overall damages that vary considerably from sector to sector. If Mauritius is taken as 1.00, the five sugar sectors give the following coefficients of damage to sugar production on an average for the three violent cyclones of 1960, 1962 and 1964.

M	W	N	E	S	C
1.00	0.74	0.79	1.05	1.00	1.46

The high overall loss over normal sugar production arising from weather hazards that occurred during the decade works out to 14.4% for the island as a whole. Such a loss considerably exceeds normal agricultural risks calculated over longer periods of years. It follows that the sugar industry, the mainstay of the island, has been under exceptional strain due to weather hazards specially during the second half of the decade when two droughts occurred in 1959 and 1961 and three violent cyclones in 1960, 1962 and 1964.

The occasion is offered as a result of the information now available to present three Tables 35 - 37 giving the expected deviations (+ or —) from normal production for the range of weather hazards usually encountered over Mauritius taken as a whole.

Maximum wind speed (V) ranging between 20 and 80 m.p.h. and corresponding damage on sugar production (tonnage & quality together). Sum of monthly rainfall deficits (D) from November to June ranging from 5.0 to 25.0 inches and the corresponding deviations (+ or —) on cane tonnage. Sum of monthly rainfall excesses (E) from July to October ranging from 0.0 to 6.25 inches and corresponding deviations (+ or —) on cane quality.

For the evaluation of expected damage on sugar production (tonnage plus quality) arising from cyclones, the following empirical equation has been worked out from the data of the last decade :

$$D = 0.027\ (V-30)^2 \times S \times M$$

where D = % Damage over normal sugar production

V = Max. wind speed during one hour averaged over Mauritius

S = Cyclone damage coefficient for each sector already worked out : Mauritius 1.00 West 0.74 North 0.79 East 1.05 South 1.00 and Centre 1.46

M = cyclones damage cœfficient for the month when the cyclone occurs. The three violent cyclones which affected the island during the decade 1955-64 have occurred in January (*Danielle*) or in February (*Carol* & *Jenny*) which are months highest cyclone frequencies. The cœfficient M for these two months is taken as 1.00; M values for the other months of December, March and April have not yet been worked out. Of course the cœfficient M for December should be lower than unity and for March and April higher than unity.

When the above mentioned equation is used to calculate cyclone damages accruing to *Carol, Jenny & Danielle* for Mauritius and for the five sugar sectors separately the damages calculated agree within ± 5% of damages observed which have ranged from 9 to 75%. This confrontation is most encouraging so that the equations have been used to construct Table 35, giving the % damage for each successive rise of ten miles in the max. wind speed (V) observed for one hour from 20 m.p.h. upwards as averaged over Mauritius when the cyclones occur in January or February.

Table 35. Max. wind speed for one hour rises of 10 m.p.h. and corresponding % damage to sugar production (January or February cyclones).

Rise in max. wind speed (V)		*M*	*W*	*N*	*E*	*S*	*C*
Normal ...	20 to 30 m.p.h.	0	0	0	0	0	0
Windy ...	30 to 40	— 3	— 2	— 2	— 3	— 3	— 4
	40 to 50	— 8	— 6	— 6	— 8	— 8	— 12
	50 to 60	— 13	— 10	— 10	— 14	— 13	— 19
	60 to 70	— 19	— 14	— 15	— 20	— 19	— 28
	70 to 80	— 24	— 18	— 19	— 25	— 24	— 35

Table 36. Sum of monthly rainfall deficits (D) from November to June and corresponding % deviations in cane tonnage from normals.

	Sum of N-J Deficits	*M*	*W*	*N*	*E*	*S*	*C*
	D. in inches						
Dry ...	25.0	— 4.8	— 9.0	— 8.4	— 5.1	— 5.0	+ 1.0
	20.0	— 2.4	— 4.5	— 4.2	— 2.6	— 2.5	+ 0.5
Normal ...	15.0	0	0	0	0	0	0
	10.0	— 0.6	— 8.0	— 10.3	+ 2.2	— 4.5	— 5.1
Wet ...	5.0	— 1.1	— 15.9	+ 20.6	+ 4.4	— 9.0	— 10.2

Table 37. Sum of monthly rainfall excesses (E) from July to October and corresponding % deviations in cane quality from normals.

	Sum of J-O Excesses	*M*	*W*	*N*	*E*	*S*	*C*
	E. in inches						
Wet ...	6.25	— 5.3	— 6.6	— 4.8	— 3.4	— 6.3	— 5.6
	5.00	— 3.5	— 4.4	— 3.2	— 2.2	— 4.2	— 3.7
	3.75	— 1.7	— 2.2	— 1.6	— 1.1	— 2.1	— 1.8
Normal ...	2.50	0	0	0	0	0	0
	1.25	+ 1.0	+ 1.7	— 0.7	0	+ 1.4	+ 1.9
Dry ...	0.00	+ 2.0	+ 3.4	— 1.4	0	+ 2.7	+ 3.8

Tables 35, 36 and 37 can be brought together for arriving at the generalized Table 38 showing the deviations (+ or —) arising from numerous combinations of weather hazards on sugar production (tonnage plus quality). For rainfall, nine major combinations can occur. Three dry, normal and wet weather conditions from November to June corresponding to deficits (D) of 25.0, 15.0 and 5.0 inches respectively and three dry, normal and wet weather conditions from July to October corresponding to excesses (E) of 0.00, 2.50 and 6.25 inches. Five categories of cyclones of varying intensities have been chosen none, small, moderate, high and very high corresponding to maximum wind speeds (V) of 30, 40, 50, 60 and 70 m.p.h. observed in January or February.

Table 38. Fourteen combinations of weather conditions over Mauritius and their corresponding % deviations (+ or —) from normal sugar production for the island and for the five sugar sectors.

Rainfall deficits *Nov.-June*	*D in.*	*Rainfall excesses* *July-October*	*E in.*	*M*	*W*	*N*	*E*	*S*	*C*
					(*irrigated*)				
Dry ...	25.0	Dry	0.00	— 2.8	— 5.6	— 9.8	— 5.1	— 2.3	+ 4.8
Dry ...	25.0	Normal	2.50	— 4.8	— 9.0	— 8.4	— 5.1	— 5.0	+ 1.0
Dry ...	25.0	Wet	6.25	— 10.1	— 15.6	— 13.2	— 8.5	— 11.3	— 4.6
Normal	15.0	Dry	0.00	+ 2.0	+ 3.4	— 1.4	0.0	+ 2.7	+ 3.8
Normal	15.0	Normal	2.50	0.0	0.0	0.0	0.0	0.0	0.0
Normal	15.0	Wet	6.25	— 5.3	— 6.6	— 4.8	— 3.4	— 6.3	— 5.6
Wet ...	5.0	Dry	0.00	+ 0.9	— 12.5	+ 19.2	+ 4.4	— 6.3	— 6.4
Wet ...	5.0	Normal	2.50	— 1.1	— 15.9	+ 20.6	+ 4.4	— 9.0	— 10.2
Wet ...	5.0	Wet	6.25	— 6.4	— 22.5	+ 15.8	+ 1.0	— 15.3	— 15.8

Cyclone intensity	*Max. wind speed V m.p.h.*	*M*	*W*	*N*	*E*	*S*	*C*
None ...	30	0	0	0	0	0	0
Small ...	40	— 3.0	— 2.0	— 2.0	— 3.0	— 3.0	— 4.0
Moderate ...	50	— 11.0	— 8.0	— 8.0	— 11.0	— 11.0	— 16.0
Violent ...	60	— 24.0	— 18.0	— 25.0	— 25.0	— 24.0	— 35.0
Very violent ...	70	— 43.0	— 32.0	— 33.0	— 45.0	— 43.0	— 63.0

It should be stressed, however, that all the above tables for assessing sugar production deviations out of weather hazards only refer to the cane varieties which are presently cultivated. Others may be found in the future which will react with different intensities to cyclones, drought or excess rainfall.

Excluding cyclones, which are always damaging, the best or worst weather combinations for the sugar production of Mauritius as a whole may conflict with those, for each sugar sector taken individually and this inevitably brings confusion in the mind of the layman concerning the whole problem of weather and sugar production relationships.

	Highest sugar production		*Lowest sugar production*	
	N-J Def.	*J-O Exc.*	*N-J Def.*	*J-O Exc.*
Mauritius	Normal	Dry	Dry	Wet
West (irrigated) ...	Normal	Dry	Wet	Wet
North	Wet	Normal	Dry	Wet
East	Wet	Normal/Dry	Dry	Wet
South	Normal	Dry	Wet	Wet
Centre	Dry	Dry	Wet	Wet

An interesting fact to note is that the highest losses in sugar production for Mauritius as a whole arising from the worst rainfall combination (— 10%) are approximately the same as the losses (— 11%) following a cyclone occurring in January or February with maximum wind speed of 50 m.p.h. for one hour's run that is one of moderate intensity; hence the predominance of cyclone over rainfall as a weather hazard for the island as far as sugar production is concerned.

As a conclusion to this study it seems useful to evaluate the trends that have been operating during the last five years in using the normal values for tons of cane per arpent reaped and sugar manufactured % cane for 1960 and 1965, respectively as shown in Tables 39 & 40.

Table 39. Normals for 1960.

	M	*W*	*N*	*E*	*S*	*C*
Area reaped Th arpents ...	188.4	10.2	51.5	42.1	60.3	24.1
Tons cane/arpent	27.6	31.4	23.4	25.9	30.0	29.7
Sugar made % cane ...	12.27	12.69	12.93	11.99	11.80	12.45
TSM/arpent	3.39	3.98	3.03	3.11	3.54	3.70
Th tons sugar production ...	638.7	40.6	156.0	130.9	213.5	89.2

Table 40. Normals for 1965.

	M	*W*	*N*	*C*	*S*	*C*
Area reaped Th arpents ...	196.5	11.9	52.6	43.3	63.0	25.5
Tons cane/arpent	30.9	32.5	28.9	30.9	31.1	31.3
Sugar made % cane ...	11.72	12.69	11.97	11.19	11.76	12.44
TSM/arpent	3.62	4.12	3.46	3.46	3.66	3.89
Th tons sugar production ...	711.3	49.0	182.0	149.8	230.6	9.92

Table 41 gives the annual deviations (+ or —) for the three main factors contributing to total sugar production : area reaped, cane tonnage per arpent, sugar made % cane milled. Sugar production per arpent is the yardstick of agricultural progress from the technical point of view.

Table 41. Percentage annual deviations (+ or —) from 1960 to 1965.

	M	*W*	*N*	*E*	*S*	*C*
Area reaped	0.8	+ 3.4	+ 0.4	+ 0.5	+ 0.9	+ 1.2
Cane per arpent	+ 2.4	0.7	+ 4.7	+ 3.9	+ 0.7	+ 1.1
Cane Quality	— 0.9	0.0	— 1.5	— 1.3	— 0.1	0.0
Sugar per arpent	+ 1.4	+ 0.7	+ 2.8	+ 2.2	+ 0.7	+ 1.0
Total sugar production ...	2.2	4.1	+ 3.3	2.9	+ 1.6	+ 2.2

Thus the present annual rate of increase in the sugar production of Mauritius can be evaluated at +2.2%. The sugar production per unit area reaped which constitutes the agricultural progress rises by +1.4% and the area reaped which corresponds to extensions rises by +0.8% annually.

It should be noted that the two sugar sectors, North & East, which show the highest annual rise in cane tonnage per unit area reaped, namely +4.7 and +3.9%, show the highest annual fall in cane quality —1.5 and —1.3% respectively.

3. HIGHLIGHTS OF FINAL VARIETY TRIALS, 1960 SERIES

P. HALAIS & G. ROUILLARD

Out of the ten highly replicated final variety-fertilizer trials initiated in 1960, all were reaped experimentally at three dates in the season early, medium and late as virgin canes in 1961 (a drought year), as 1st ratoons in 1962 (a cyclone year) and as 2nd ratoons in 1963 (a normal year). Only nine of them (trial located at Trianon excepted) were also reaped as 3rd ratoons in 1964 (another cyclone year).

This series of trials, as well as the regular plantations on the island, has suffered from less favourable weather conditions than those usually anticipated.

Furthermore, out of two standard varieties — M. 147/44 and Ebène 1/37 — used as the essential yardsticks of these trials which group another four new varieties, M. 147/44 has been unexpectedly removed from the list of approved varieties on account of its high susceptibility to a recent outbreak of gumming disease.

Nevertheless, the series has fulfilled its main objective as an extensive mass of information has been collected on the relative performance of the four new varieties, namely M. 202/46, Ebène 50/47, M. 93/48 and M. 253/48 under a wide range of ecological conditions. As is usually the rule at this Institute, only the results observed in ratoons will be discussed in the annual report.

Table 42 allows for the comparative evaluation of the chief characteristics of the six varieties tested expressed as deviations from general means for the ten trials. The response to High Nitrogen fertilization is expressed directly in terms of tons of profitable sucrose per arpent, 0.01 TCA (IRSC-4).

Table 42. Assessment of the varietal characteristics from the mean results of ten variety fertilizer trials Series Agro. 60 reaped in 1st, 2nd and 3rd. ratoons — Deviations from means. Response to N in profitable sucrose per arpent Tons.

	IRSC	*Fibre % cane*	*0.01 TCA (IRSC-4)*		*Response to N fertilization*	*Best time for harvesting*
			1 & 3 R (cyclone years)	*2R Normal year*	*60 Kg N over 30 Kg 0.01 TCA (IRSC-4)*	*12 m. ratoons*
			1962-64	*1963*		
Ebène 1/37 ...	+ 0.6	— 0.9	— 0.14	— 0.07	+ 0.03	E & M
M. 147/44 ...	— 0.6	+ 1.7	+ 0.12	— 0.01	+ 0.04	E & M
M. 202/46 ...	+ 0.1	— 0.5	+ 0.07	+ 0.11	+ 0.21	M & L
Ebène 50/47 ...	+ 0.7	— 0.2	— 0.10	+ 0.05	+ 0.10	E & M
M. 93/48 ...	— 0.2	+ 1.3	— 0.04	— 0.08	— 0.03	M & L
M 253/48 ...	— 0.7	— 1 7	0.00	— 0.03	— 0.16	M

The six varieties comparatively tested may be grouped as follows :

very rich canes : Ebène 50/47 and Ebène 1/37;
medium rich canes : M. 202/46 and M. 93/48;
poor sucrose varieties : M. 147/44 and M. 253/48

The varieties also show very wide differences in fibre content :

very high fibre : M. 147/44 and M. 93/48;
medium fibre : Ebène 50/47 and M. 202/46;
low to very low fibre : Ebène 1/37 and M. 253/48.

Concerning comparative resistance to cyclones the varieties studied may be classified in the following decreasing order of resistance : M. 147/44, M. 93/48, M. 253/48, M.202/46, Ebène 1/37 and Ebène 50/47.

High response to additional nitrogen fertilization in terms of profitable sucrose per arpent ranks as follows : M. 202/46, Ebène 50/47, M. 147/44, Ebène 1/37, M. 93/48 and M. 253/48.

The optimal season for harvesting 12 months ratoons starting from early in the season onwards (provided that the specific nitrogen needs are fulfilled) the varieties rank as follows : Ebène 50/47, Ebène 1/37, M. 147/44, M. 253/48, M. 93/48 and M. 202/46.

From general experience acquired in the running of this series of trials, it appears that the extent of adaptability grading of the varieties should be in the descending order : M. 202/46, M. 147/44, Ebène 1/37, M. 93/48, Ebène 50/47 and M. 253/48.

As far as resistance to cooler and more cloudy conditions, the descending order appears to be : Ebène 1/37, M. 93/48, M. 202/46, Ebène 50/47, M. 147/44 and M. 253/48.

In climates associated with moderate rainfall, M. 147/44 does better on gravelly, low moisture retentive soils than Ebène 1/37, which prefers the deeper soils.

The general interpretation of this series of variety trials is being made presently on the same

lines as was done in last year's M.S.I.R.I. annual report, (Halais, 1963) the ten trials being grouped into three categories according to the differential behaviour of the two standard varieties M. 147/44 and Ebène 1/37 which were included in each of the trials widely located over the sugar area of the island. The use of only one standard in variety trials may lead to erroneous conclusions if the performance of a second standard is not tested simultaneously because the most reliable method of evaluating ecological conditions should preferably rest on the plant itself.

Table 43 gives the deviations (+ or —) of profitable sucrose per arpent, 0.01 TCA (IRSC-4), from the best suited standard varieties for three ecological groups I, II and III of the Series Agro. 60 reaped as 1st ratoons (1962), 2nd ratoons (1963) and 3rd ratoons (1964) at the normal age of 12 months.

Table 43. Mean Results of three years harvesting of Variety Trials Series Agro. 60. Deviations from Standard varieties in tons of profitable sucrose per arpent.

	Group I			*Group II*			*Group III*		
Best suited Standard	*M. 147/44*			*both M. 147/44 & Ebène 1/37*			*Ebène 1/37*		
Location of trials	*Medine St. Antoine (2) R. des Creoles Sauveterre*			*Benares Unité Trianon*			*Beau Bois (St. Aubin) Valetta*		
Harvesting dates	*E*	*M*	*L*	*E*	*M*	*L*	*E*	*M*	*L*
M 147/44 ...	*2.17*	*2.43*	*2.17*	*1.95*	*2.46*	*2.03*	—0.13	—0.38	—0.45
Ebène 1/37 ...	—0.48	—0.43	—0.70	*1.92*	*2.38*	*1.94*	*1.38*	*1.81*	*1.50*
M 202/46 ...	—0.18	—0.39	—0.12	+ 0.07	+ 0.21	+ 0.38	—0.12	—0.27	+ 0.15
Ebène 50/47	—0.24	—0.54	—0.30	+ 0.19	—0.01	+0.03	—0.22	—0.33	—0.07
M 93/48 ...	—0.43	—0.25	—0.42	+ 0.13	+ 0.28	+ 0.27	—0.16	—0.11	—0.07
M 253/48 ...	—0.33	+ 0.04	—0.21	—0.03	+ 0.05	+ 0.21	—0.46	—0.58	—0.42

NOTE : Each figure is the mean of 90, 54 or 36 plots cane weighing & analysis for groups I, II or III respectively.

The results for the four new varieties are given separately for Group I where M. 147/44 outyields the other standard Ebène 1/37, for Group II where the two standards are at par and for Group III where Ebène 1/37 outyields the other standard M. 147/44 by a large margin. These results are essentially the same as those published in last year's M.S.I.R.I. annual report. Consequently no new comments are needed.

Additional information collected in this series of trials from plots differently fertilized with nitrogen tends to confirm the view that the results derived from simple variety trials may not reach the final objective if the specific nitrogen requirement of the varieties are not simultaneously studied. This means that the final selection of sugar cane varieties is essentially a general agronomic problem for which there is no substitute to complex and long term experimentation.

REFERENCE

HALAIS, P. (1963). Highlights of final variety trials, 1960 series. *Ann. Rep. Sug. Ind. Res. Inst. Mauritius*, 1963 : 111-114.

4. NEW DEVICE FOR THE SHORT HOT WATER TREATMENT OF CANE SETTS

G. MAZERY

A new method for the hot water treatment of sugar cane cuttings has been tried on two different estates during the year. This method differs from those usually adopted in both dipping and heating systems, but, however, only this latter aspect will be discussed here because, due to a failure in some of the controlling instruments, it has not been possible to obtain complete data on the efficiency of the immersion method.

Description

The apparatus may be described briefly as follows with reference to Fig. 20.

The lower part of an immersion tank I is connected to the bottom of a water heater H by means of pipe C and to a mixer M by means of pipe S. Mixer M is also connected to the top of heater H by means of pipe L and to the inlet of circulation pump P. Pump P extracts the water from mixer M and forces it back into tank I through two perforated ramps R fixed on either side of the tank at about 8 inches from the top.

Connecting pipes S and L are provided with control valves V_1 and V_2 respectively while a non return valve N mounted on pipe C allows the water in the pipe to flow only from the tank I to the heater H. Pipe S extends horizontally inside tank I and along a centre line about 5 inches from the bottom. A series of holes extending along the upper side of pipe S, inside the tank, ensures a uniform suction of water throughout the length of the tank when pump P is in action.

Heater H is provided with a vent A which prevents pressure from building up in the system when the water is heated to boiling point. Connecting pipe C maintains the water at the same level in heater H and tank I. These latter units are so installed, with respect to each other, that when the apparatus is full of water, and ready for use, the level of the liquid lies about 1 foot below ramps R and rises about 1 foot in vent A.

Thermometers or thermographs T_1, T_2 and T_3 give an indication of the temperature of the water flowing through pipes S, L and K respectively. If desired valve V_2 may be controlled automatically by a thermostat placed on pipe K.

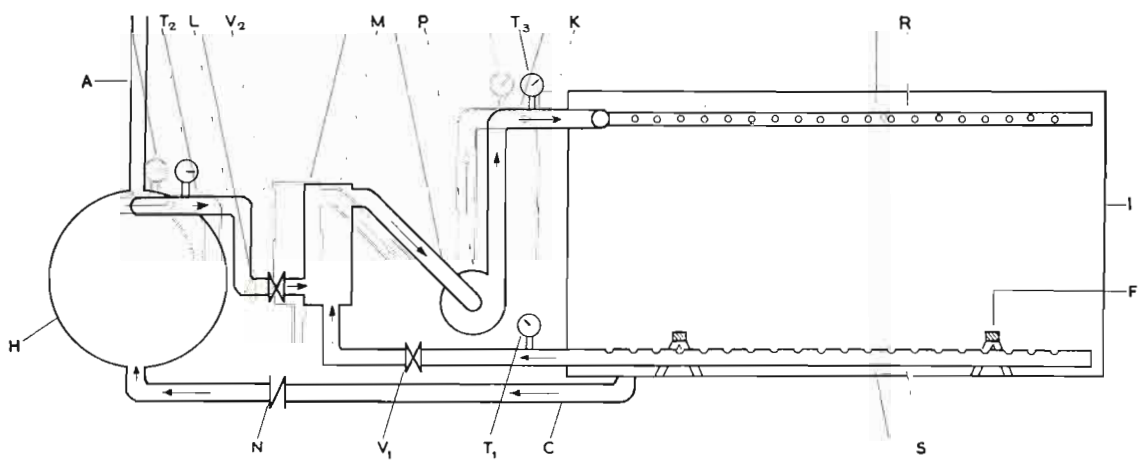

Fig. 20. Heating system for hot water treatment of sugar cane cuttings.

The source of energy for operating the heater H may be bagasse, fuel oil, electricity or steam.

When an abundant supply of steam is available, pipe L may be communicated directly to the source of steam and, in this case, heater H may be done away with.

Strainers, drain cocks and drain plugs fitted at appropriate points enable an easy cleaning of the whole system.

Supports F fixed inside the tank maintain the crates containing the cane cuttings at a few inches above suction tube S.

Operation

The apparatus works as follows : Valves V_1 and V_2 are opened and the whole system filled with water to the required level. Then valve V_1 is shut and heat is applied to heater H while pump P is put in action. All the water will thus be circulated from heater to tank through mixer H and pipe K and then back from bottom of tank to heater by pipe C. As soon as the temperature of the circulating water has reached the level required for treatment i.e. 50°C or 52°C, as the case may be, valve V_1 is opened and valve V_2 is closed gradually and adjusted so that the temperature of the mixture of water from tank and heater, churned by the pump, is maintained at constant temperature as indicated by T_3. The temperature of the water in the heater is then allowed to rise almost to boiling point.

When the material to be treated is immersed in tank I, the temperature of the water being withdrawn through pipe S starts dropping immediately while the temperature of the water being pumped back to the tank, as indicated by T_3 is raised instantly to the required level, i.e. 50°C or 52°C, by adjusting valve V_2 which controls the inflow of very hot water from the heater into mixer M.

Advantages

Although the heater is more bulky than a steam boiler of equivalent heat storage capacity, yet it can be constructed with lighter material and is more easily adaptable for the utilization of bagasse and the various sources of energy. Its advantage is especially valuable when electricity is used because it avoids peak loads thus reducing considerably the initial cost of electrical equipment as well as running expenses. An important feature of the system is the fact that there is no heating element inside the immersion tank eliminating thereby the chances of overheating at any point in the bath.

The system of control valves on the supply of steam or very hot water enables an instant adjustment of the temperature of the circulating water. Practice has proved that a sufficient degree of accuracy may easily be obtained even without the use of a thermostatic temperature control. More stability and better accuracy of control are obtained with the water heater than when live steam is used.

One of the plants actually in operation for the short hot water treatment, i.e. 52°C for 20 minutes, works with a personnel of four men — one supervisor and three attendants — and handles about 50 tons of canes per 8 hour day, using for the purpose about 2 tons of baled bagasse.

SUGAR MANUFACTURE

1. THE PERFORMANCE OF SUGAR FACTORIES IN 1964

J. D. de R. de SAINT ANTOINE

A SYNOPSIS of the chemical control figures of the twenty three factories of the island is given in Appendix XVII (i) - (v).

Cane and Sugar Production

Climatic conditions in 1964 were detrimental both to growth and to quality of cane. In January winds of 135 m.p.h. were recorded in the South of the island when cyclone *Danielle* passed near the west coast. Had conditions been normal from then onwards, a large crop would have been harvested since the cane had plenty of time to recover. It had indeed recovered to a fair extent when, about a month later, cyclone *Gisèle* struck. Further, temperatures were below normal and rainfall was deficient from February to June, with the result that cane yield per acre was 24 per cent below that of 1963.

During the maturity period conditions were also abnormal with heavy rains in September and October. Cane quality was thus adversely affected, and total sugar production amounted to only 519, 900 metric tons as against 685,500 tons in 1963. Table 44 gives the area harvested, cane crushed and sugar produced during the period 1959-64, the abnormal year 1960 having been excluded from this and from the following tables.

Table 44. Area harvested (thousand arpents), cane crushed and sugar produced (thousand metric tons), 1959—64.

	1959	*1961*	*1962*	*1963*	*1964*
Area harvested	195	201	205	204	205
Cane crushed	4,743	4,943	4,624	5,547	4,380
Sugar produced	580.4	553.3	532.8	685.5	519.9

Cane Quality

In spite of the heavy rain that fell in September and October, sucrose per cent cane averaged 13.45 in 1964 as against the disappointing figure of 13.47 registered the previous year. The main reason for this slight difference is the short crushing season, namely 100 days as against 123 days in 1963.

Sucrose content figures for the various sectors of the island are given in Table 45 for the period 1959-64. It will be observed that the cane quality of the central plateau was

more greatly affected than that of the other sectors. This same region also received the heaviest blow from the cyclones; hence its sugar production amounted to only 59,390 metric tons as against 95,350 in 1963, a reduction of 38 per cent.

Table 45. Sucrose per cent cane, 1959—64.

	Island	*West*	*North*	*East*	*South*	*Centre*
1959 ...	13.76	14.09	14.67	13.66	13.23	13.66
1961 ...	12.81	13.06	13.46	12.53	12.42	12.91
1962 ...	13.19	13.61	13.73	12.85	12.85	13.26
1963 ...	13.47	14.26	13.97	12.91	13.18	13.79
1964 ...	13.45	12.75	14.35	13.14	13.02	12.97

Fibre per cent cane and mixed juice Gravity Purity figures for the period 1959-64 are given in the following table.

Table 46. Fibre % cane and mixed juice Gravity Purity 1959—64

	Fibre % cane	*Mixed juice Gravity Purity*
1959	11.96	87.3
1961	12.61	85.2
1962	13.85	85.9
1963	13.11	86.3
1964	13.85	86.4

It will be observed that fibre per cent cane was high in 1964, as would be expected for a cyclonic year. The figure recorded was 13.85 which is exactly the same as that obtained in 1962 following the visit of cyclone *Jenny*. It was exceeded only in 1960, when a fibre content of 14.38 was obtained after the disastrous effects of cyclones *Alix* and *Carol*.

Milling

A synopsis of crushing data and milling figures is given in Table 47.

Table 47. Milling Results, 1959—64.

	1959	*1961*	*1962*	*1963*	*1964*
No. of factories	24	23	23	23	23
No. of crushing days	110	123	116	123	100
No. of net crushing hours/day ...	20.32	18.86	19.08	20.82	19.96
Hours of stoppages/day *	0.82	0.80	1.03	0.88	0.83
Time efficiency	96.1	95.8	94.9	95.9	96.0
Tons cane/hour	87.7	92.8	91.0	97.8	95.4
Tons fibre/hour	10.49	11.70	12.60	12.82	13.21
Imbibition % fibre	230	222	222	221	228
Pol % bagasse	2.32	2.09	2.18	2.08	2.03
Moisture % bagasse	48.3	48.6	47.1	48.4	48.5
Reduced mill extraction	95.7	95.8	95.8	96.0	96.2
Extraction ratio	34.1	33.3	33.9	31.7	31.0

* Exclusive of stoppages due to shortage of cane.

Table 48. Comparative milling results, 1964 crop.

Factory	*Sets of knives*	*Shredder*	*No. of rolls*	*Specific Feed Rate*	*Imbibition % Fibre*	*Dilution ratio*	*Extraction Ratio*	*Reduced Mill Extraction*
Médine ...	2 of 36	1	15	78.0	211	69	33.3	95.9
Belle Vue ...	1 „ 34	—	12	72.1	269	78	28.3	96.5
	1 „ 72							
Mon Loisir ...	2 „ 35	1	15	69.0	214	77	27.7	96.6
St. Antoine ...	1 „ 36	—	15	67.0	185	80	31.3	96.2
	1 „ 44							
Savannah ...	1 „ 28	—	12	63.4	256	68	34.7	95.7
	1 „ 48							
	1 „ 92							
St. Félix ...	1 „ 32	1	12	61.8	217	70	38.1	95.4
Union Flacq	1 „ 60	—	21	60.7	182	78	28.9	96.4
	1 „ 80							
Solitude ...	2 „ 36	—	14	59.6	218	69	34.3	95.8
R. Belle ...	1 „ 24	—	12	59.1	248	68	38.7	95.2
	1 „ 42							
Riche en Eau	1 „ 54	—	15	58.0	242	82	25.0	97.0
	1 „ 100							
Constance ...	1 „ 24	1	15	56.0	203	68	29.1	96.5
	1 „ 32							
Mon Désert	1 „ 48	—	15	55.8	250	75	29.7	96.3
	1 „ 36							
Réunion ...	1 „ 36	1	15	54.2	232	60	34.4	95.7
Bel Ombre ...	1 „ 16	1	12	52.9	277	70	34.6	95.8
Ferney ...	1 „ 60	—	12	52.6	236	71	33.9	95.9
	1 „ 80							
Beau Champ	1 „ 42	—	15	52.4	250	73	25.8	96.8
	1 „ 72							
Mon Trésor	1 „ 40	—	12	48.2	209	69	34.6	95.7
	1 „ 80							
Bénarès ...	1 „ 44	—	14	47.0	237	65	35.5	95.7
	1 „ 62							
Britannia ...	1 „ 32	—	14	45.0	297	67	31.5	96.1
	1 „ 36							
Beau Plan ...	2 „ 36	—	14	43.7	225	74	28.8	96.5
The Mount ...	1 „ 34	—	15	39.6	215	73	26.2	96.8
	1 „ 88							
Highlands	1 „ 32	—	14	38.3	257	73	33.6	95.7
	1 „ 64							
Union-St Aubin	1 „ 28	—	15	35.4	257	73	30.0	96.2
	1 „ 32							

Milling efficiency has improved further in 1964, an average reduced mill extraction of 96.2 being recorded, as compared to 96.0 in 1963, in spite of the fact that tonnage of fibre ground per hour increased from 12.82 to 13.21. Best results, viz. 97.0, were obtained at Riche en Eau, following better cane preparation and the use of more imbibition water as compared to 1963. Marked improvement was also achieved at Constance where, following the addition of a fifth mill, reduced mill extraction jumped from 95.8 in 1963 to 96.5 this crop. Excellent results were also obtained at Médine and at Belle Vue where the increase in reduced mill extraction from 1963 to 1964 amounted to 0.5 and 0.6 respectively. At Belle Vue these results were obtained mainly as a consequence of better cane preparation and of the installation of 7-ft tall vertical chutes on two of the units of the four-mill tandem.

However, it is very difficult to compare the milling performances of different factories because the equipment may vary considerably from one factory to the next. Further, for a given milling plant, the less fibre ground per hour, the better the performance. Hence any comparison should take into account the working capacity as compared to the rated capacity. One way of doing this is to compare feed rates per cubic foot of total roller volume. It is not an ideal method, as it cannot for instance take into consideration differences in maximum hydraulic loads resulting from journals of different dimensions in rolls of the same volume. Nor will it take into account differences in cane preparation, number of driving units, mill speed and setting etc. However it is a clear and simple indication of the feed rate.

In addition to feed rate, the other major factors which have a profound influence on mill performance should be laid side by side when comparing the milling work of different plants. Perk, of the Sugar Milling Institute, Natal, achieves partly this aim with the additional help of the following figures : imbibition per cent fibre, number of imbibition steps and dilution ratio.

Dilution ratio was first proposed by Douwes-Dekker (1961) for gauging the efficiency of the imbibition process. It expresses the actual drop in Brix of juice from cane to bagasse as a percentage ratio of a target drop arbitrarily chosen as 85 per cent of the original Brix in cane. As pointed out by Douwes Dekker the dilution ratio depends on :

(a) the percentage of juice expressed by the first unit of the tandem,

(b) the amount of imbibition water applied,

(c) the number of imbibition steps,

(d) the extent to which imbibition liquid and residual juice mix at the various mills.

The following table has been calculated in an attempt to take into consideration the major factors which influence the milling efficiency of different milling tandems. Factories are listed in the order of their specific feed rates, expressed in lbs of fibre ground per hour per cubic foot of total roller volume.

An analysis of the figures contained in Table 48 reveals a number of interesting features, but it is not possible to go into lengthy comparisons here. However mention should be made of Belle Vue factory where, with only four mills, 96.5 reduced mill extraction is achieved at a specific feed rate of 72.1 cu. ft. per total roller volume, which is the second highest in the island.

Clarification and Filtration

Clarification difficulties were encountered in most factories. Mixed juice Gravity Purity was normal, 86.4 as against 86.3 in 1963, but juices are always more difficult to clarify when the cane has been damaged by a cyclone.

Following the installation of a continuous vacuum filter at Highlands, only four factories were still equiped with filter presses in 1964. Four other factories have adopted the Rapi-floc system, and several new orders have been placed for the 1965 crop.

Pol per cent cake has dropped by 1.6 points from 1959 to 1964, but as a result of the higher moisture content of vacuum filter cake compared to filter press cake, pol lost in cake per cent cane has decreased only slightly as shown in Table 49.

Table 49. Filtration Results, 1959—64.

	1959	1961	1962	1963	1964
Pol % cake ...	3.57	2.46	2.38	2.28	1.98
Cake % cane	2.4	2.8	3.2	3.1	3.4
Pol in cake % cane...	0.09	0.07	0.08	0.07	0.06

Certain authors rightly point out that sweetening off to a too low value will increase the quantity and viscosity of final molasses as a result of the increased re-solution of lime salts from the filter cake. Hence the best criterion to use for judging the extent of sweetening off should be the purity of the filtrate. According to Perk (1960) this purity should not be more than 1.5 points below that of clarified juice.

In 1964 the main difficulties encountered in filtration resulted from lack of sufficient bagacillo and from fouling of the filters. Little effort seems to be made for increasing the amount and improving the quality of the bagacillo used, conditions which must be fulfilled if high retentions are to be obtained.

At Riche en Eau, the Factory Manager successfully adopted chemical cleaning of the vacuum filter with the help of practically no additional equipment except a small caustic soda storage tank. Every week end, after the mills have stopped and filtration has ceased, the filter and its ancillary equipment are first fully cleaned with water. The vacuum pump is stopped and the caustic soda solution is transferred from the storage tank to the mud overflow tank, where its temperature is raised to about 90°C by steam injection. The solution is then pumped to the filter tank and the filter allowed to rotate in reverse direction for a few hours. At the end of the cleaning cycle the alkali solution is allowed to flow back to the storage tank for use the following week end.

This cleaning precedure was adopted at Riche en Eau about half-way through the crop, and was followed weekly until the end of the crushing season. No mechanical cleaning at all was necessary during that period, nor after the crop. The caustic soda solution used at the start was not renewed, but its strenght dropped from twenty to about five per cent.

In view of the success of this simple installation, other factories would be well-advised to follow suit.

At Union Flacq, where the Rapi-floc system is followed, the fine screen of the filter was replaced by a 30-holes per square inch screen to facilitate cleaning.

Boiling House Work

Following the recommendation made by Webre (1963) in the ninth edition of «Cane Sugar Handbook», several factories have raised the juice levels in quadruple effect evaporators by fitting rings to the top of each sealed downtake, the height of ring used being 4'' in the first three effects and 6'' in the last. Although evaporation figures before and after the modifications are not available, good results have been generally reported.

As may be observed from Tables 50 and 51, boiling house work was just about the same in 1964 as in 1963. Gravity purity of final molasses was half a unit higher, the percentage of reducing sugars being lower, but sucrose lost in molasses per cent cane amounted to approximately the same figure as a result of a smaller production of molasses. It may also be pointed out that only five factories, namely The Mount, Savannah, Bel Ombre, St. Félix and Union St. Aubin obtained lower purity final molasses in 1964 as compared to the previous year.

Table 50. Syrup, Massecuites and Molasses, 1959—64.

	1959	*1961*	*1962*	*1963*	*1964*
Syrup purity	87.9	85.3	86.5	86.6	87.0
A massecuite purity	81.7	82.0	82.2	83.0	82.8
Purity drop : A massecuite	20.1	22.3	20.3	20.3	20.7
B „	21.1	22.2	21.2	22.2	20.7
C „	23.6	24.6	22.9	24.3	23.6
Crystal % Brix in C massecuite ...	35.1	36.0	34.6	35.9	35.5
Magma purity	81.5	82.3	82.4	82.8	83.4
Final molasses : gravity purity ...	36.7	35.7	36.2	35.6	36.1
Red sug. % Bx ...	14.6	16.6	13.8	15.0	12.8
Tot. Sug. % Bx ...	51.3	52.4	50.1	50.4	48.9
Wt. % cane @ 95°Bx ...	2.53	2.81	2.67	2.72	2.55

Table 51. Losses and Recoveries, 1959—64.

	1959	*1961*	*1962*	*1963*	*1964*
Sucrose lost in final molasses % cane ...	0.88	0.96	0.92	0.89	0.91
Undetermined losses % cane	0.16	0.21	0.21	0.18	0.18
Industrial losses % cane	1.13	1.24	1.21	1.14	1.15
Boiling House Recovery	91.4	89.9	90.4	91.2	91.0
Reduced Boiling House Recovery ...	89.6	89.7	89.7	90.0	90.0

Several new centrifugal installations operated for the first time in 1964. Of these the following should be mentioned :

(a) Four Broadbent 48" × 30" × 1500 RPM fully automatic machines were erected at Riche en Eau for the curing of A and B massecuites. The electrical circuits of these machines were slightly modified so as to allow the doors to open as from the moment deceleration starts, the ventilation thus obtained decreasing the moisture content of the sugar.

(b) A fully automatic Broadbent centrifugal, 48" × 30" × 1800 RPM was installed at Belle Vue for the curing of C massecuites.

(c) Also at Belle Vue, an Allis Chalmers continuous centrifugal was operated on C massecuites for a few days towards the end of the crop. This machine presents a number of interesting features but the results obtained with it are too scanty yet to allow one to gauge accurately its advantages and disadvantages as compared to high speed, large capacity modern machines. Yet it would appear that this machine would be excellent for after-curing of the C massecuites if the double-cured C sugar is to be remelted.

Finally, in relation to double-curing, two most important points should again be emphasized, namely :

(a) Double-curing should only be practised if efficient fore-curing can first be achieved.

(b) The C-wash should be returned to the C and not to the B massecuite.

These points are stressed by Perk (1964) in the following terms : «Again we want to warn against the practice (in the case of double curing of the C-massecuite) of returning the wash of the C-sugar afterworkers to the B-massecuite, as it nullifies the advantage of double curing. We want to emphasize once more the importance of mingling the pre-cured C-sugar into a magna with fresh B-molasses and returning the wash of the after-workers for C-sugar to the B-molasses storage tanks. Do not label this liquid C-wash or advertise its purity, but call it B-molasses and no pan men will be tempted to draw it into a B- m.c. pan ..

Double-curing does not affect the circulation with regard to magnitude, it only limits the circulation to the system «C-m.c. pan and C-m.c. centrifugals», *if the C-wash is returned to the C-m.c. pan.*

When the single-cured C-sugar is used in the form of C-sugar magma for the A and B strikes, or when the single-cured C-sugar is remelted, the nonsugar adhering to the C-sugar crystals is boiled back into the A and B strikes.

Double curing may never be considered as a correction on poor fore-curing; fore-curing should remain the most essential operation.»

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2. THE USE OF MAGOX AS A CLARIFYING AGENT

E. C. VIGNES AND M. RANDABEL

Formation of scale on heating surfaces is one of the problems encountered in raw sugar manufacture. Although lime defecation is the most widely used clarifying process and is a very effective method of purifying cane juices, yet it leaves in solution lime salts which manifest themselves as the most troublesome non-sugars during evaporation. As the concentration of the treated juice progresses, certain slightly soluble impurities tend to come out of the solution and deposit on heating surfaces. In addition, certain salts of calcium which are more soluble in the cold, calcium sulphate for example, will precipitate as soon as the temperature is increased. Calcium sulphate scales are hard, difficult to remove and affect specially the last body of the evaporator. Apparently calcium sulphate entraps and brings down colloidal silica and organic components on precipitating since the latter are present in greater quantity than usual during periods of heavy scaling.

The degree of fouling of heating surfaces necessarily depends on the efficiency of the liming process. According to Honig (1953), the two most important factors to be considered when liming juices are the following :

(a) the amount of P_2O_5 in the clarified juice must not fall below 10 ppm, as below that level there is serious danger of overliming.

(b) 5-10% of the excess of lime in clarified juice will deposit as scales in the evaporator. It is calculated, for exemple, that

for a factory crushing 1000 tons of cane per day an extra 100 ppm CaO in the clarified juice means an extra 5-10Kg Ca0 separated as scales.

As the latter increase in thickness heat transfer decreases rapidly, causing a drop in evaporator efficiency and capacity, until crushing must be stopped to allow cleaning of the heating surface. In Mauritius this is usually effected during the week-end shutdown, but in other countries time wasted in cleaning equipment increases the total cost of manufacture. To these must be added the depreciation caused by damage to evaporator tubes during cleaning, whether by mechanical or chemical means. It is therefore of the greatest importance that the lime content of clarified juice should be as low as possible. Alternatively it may be worth adding certain chemicals designed to eliminate or at least reduce scaling.

Recently Magox, a grade of magnesium oxide, has become available on the local market. It is claimed by the manufacturers that Magox can be partially substituted for lime as a clarifying agent with beneficial results. Owing to the greater solubility of magnesium sulphate, scale formation is virtually eliminated. During the past few years Magox has been used in many countries of the western hemisphere, giving rise to considerable savings in cleaning costs and equipment replacements. In view of the excellent results obtained abroad, a number of local factories decided to assess the value of the new product in solving their scaling problem during the 1964 crop. It was decided that this Institute should work in collaboration with these factories and make recommendations concerning the use of Magox in the light of results obtained.

Magox was available for testing in seven sugar factories, three of which manufacture plantation white sugar, one by phospho-defecation and two by sulpho-defecation. The others produce raw sugar by the normal defecation process.

In order to determine to what extent the substitution of magnesium oxide for lime could influence the formation of scales it was necessary to ascertain (a) the increase in the (CaO + MgO) content of the juice, and (b) the effect of the relative proportions of CaO and MgO in mixed and clarified juices.

At Médine, one of the factories where Magox was tested, the clarification procedure is as follows : Mixed juice is heated to 55-60°C and limed, the liming process being automatically controlled. The limed juice is then heated to 104°C and sent to two Bach clarifiers of total capacity 145 tons/hr. The final pH of the clarified juice is around 6.9. Throughout the testing period, composite samples of mixed and clarified juices were collected every day and analysed for their CaO, MgO, and P_2O_5 content. In addition, gravity purity of mixed juice and daily tonnage crushed were recorded.

Two series of experiments were conducted. The first started on July 27 and extended over three weeks up to August 14. Forty-five per cent of Magox was applied during the first week, followed by 27% for the second week. No Magox was added during the third week. The second series took place at the end of the season from Wednesday, October 28 onwards. Magox at 45% was applied until November 6 when it ran out of stock. Lime was then employed exclusively until shutdown for the week-end on 7th November. Tests ended on November 14. All pertinent data are assembled in Tables 52 (a) and 52 (b), and it is now possible to correlate these results with observations of evaporator performance made during the same periods.

From July 27 to August 1 when liming was effected with a mixture of Magox/Lime in the ratio 45/55 an unusual decrease was observed in the (CaO + MgO) content from mixed to clarified juice. Normally a rise of about 150 mg/litre is noted in practice. At the end of the week's crushing an inspection of the evaporator tubes revealed their absolute cleanliness necessitating no brushing whatever. Elimination of scales had the advantage of maintaining maximum efficiency. The evaporator operated without difficulty, producing syrup of 65° Brix throughout the week even when imbibition was raised to 36% on cane.

In view of these encouraging results, a smaller proportion of Magox, i.e. 27%, was applied the following week. Under those

Table 52a. The Influence of Various Amounts of Magox on Juice.

Date	Magox%	Mixed Juice			Clarified Juice		
		CaO	MgO	P_2O_5	CaO	MgO	P_2O_5
27.7 — 1.8	45	257	449	148	245	456	12
3.8 — 8.8	27	247	427	121	262	453	10
10.8 — 14.8	0	261	419	85	355	380	6
'29.10 — 5.11	45	248	479	178	275	543	7
9.11 — 14.11	0	234	458	145	388	396	6

Table 52b. The Influence of Various Amounts of Magox on Juice.

Date	Mixed Juice			Clarified Juice		
	Gravity Purity	$(CaO+MgO)$ mg/l	CaO/MgO	$(CaO+MgO)$ mg/l	CaO/MgO	$(CaO+MgO)$ %Cane
27.7 — 1.8	84.8	706	0.57	701	0.54	0.49
3.8 — 8.8	85.1	674	0.58	715	0.58	0.35
10.8 — 14.8	85.1	680	0.63	735	0.93	0.32
29.10 — 5.11	86.3	727	0.52	818	0.51	0.71
7.11 — 14.11	85.8	692	0.52	784	0.97	0.41

conditions the average (CaO + MgO) content of the clarified juice rose to 715 ppm an increase of 41 mg/litre on mixed juice. The CaO/MgO ratio which had been 0.54 the first week went up to 0.58, pointing to an increase in the proportion of CaO relative to MgO in the clarified juice compared with the previous week. As a sequel slight incrustations occurred only in the 4th body of the evaporator. Consequently only 9 man-hours were consumed in cleaning as compared to a normal figure of about 45 man-hours. It must be stressed that this was the only time when cleaning had to be effected in two whole weeks' crushing. The amount of cane milled had then reached 36,200 tons.

Normal clarifying procedure with 100% lime was then resumed and normal descaling had to be carried out during the following week-end shutdown after only 15,410 tons of cane had been crushed. Average increase in (CaO + MgO) was 55 mg/litre while the CaO/MgO ratio had shot up to 0.93.

It is therefore reasonable to assume that, as long as there is an increase in lime salts in the clarified juice which is not counterbalanced by a parallel increase in magnesium salts, no reduction in the degree of scaling can be expected. As claimed by the manufacturers Magox provides a means of conditioning the clarified juice so that formation of incrustation can be drastically reduced and even eliminated altogether. This claim was further substantiated from observations made during the second series of tests as will now be shown.

As previously mentioned, 45% Magox was employed in liming on October 28. The factory had then been running on 100% lime for

2½ days. Addition of Magox was continued until October 31 when the factory shut down for the week-end. Because of the difficulty of obtaining labour, November 2 and 3 being estate holidays, the aim was achieved that no evaporator cleaning was necessary. Crushing was resumed on November 4 and Magox applied in the same proportion as before for 2½ days when it ran out of stock. For the rest of the 2nd week clarification was effected exclusively with lime. During these two weeks 29,000 tons of cane had been crushed.

Analytical figures show a rise in the (CaO + MgO) content of 91 mg/litre compared with an actual decrease when Magox at 45% was previously used. This unexpected rise suggests that a certain amount of overliming had taken place. Assuming that Magox contains 93% MgO and 3% CaO while lime contains 60% CaO, it is found that during the first series of tests addition of (CaO + MgO) % cane varied between 0.32 and 0.49 for a mixed juice purity of 84.8-85.1. It should be remembered that as the season progresses and the juice quality improves, less lime is needed for the clarification. However, during the period October 29 to November 5 when the mixed juice purity was 86.3, 0.71 (CaO + MgO) % cane was applied. As a consequence of overliming, the P_2O_5 content of the clarified juice fell to 6 ppm. In spite of the increase in CaO and MgO, as a result of the addition of Magox, the amount of scaling was greatly reduced as it was possible for the evaporator to work for 2 weeks without cleaning. It should be noted that at the time of Magox addition the CaO/MgO ratio in the clarified juice was only 0.51.

As a matter of interest, data were collected until the end of the following week, i.e. until November 14, in order to compare figures obtained when using Magox/Lime in the ratio 45/55 with those for 100% lime. With exclusive use of lime, increase in (CaO + MgO) amounted to 92 mg/litre but CaO/MgO ratio went up to 0.97.

The conclusion to be drawn from the results is that a rise in the (CaO + MgO) content from mixed juice to clarified juice is not in itself conducive to scaling. In order to produce detrimental effect there must be a parallel increase in the CaO/MgO ratio. By preventing an accumulation of CaO in the clarified juice relative to MgO, substitution of Magox for lime effectively inhibits scale formation at the evaporating station.

Experiments were carried out with Magox in six other factories for periods ranging from 4 days to three weeks, the proportion employed varying between 15 and 50%. All factories concerned reported satisfactory results. Incrustations were either non-existent or slight. In the latter case they were soft and needed only slight brushing. At the two factories where sulpho-defaction is in use, the sugar acquired a greyish tinge. In one case at least this was found to be due to the presence of iron. Otherwise in the remaining factories there was no change in the quality of the final product. Certain other slight side-effects, however, were noticed. For example, the clarified juice showed a reddish appearance. There was a small drop in the weight of molasses produced together with a slight rise in purity. No real significance can be attached to these observations as similar differences are often obtained in practice and Magox was not used for extensive periods. However, there can be no doubt that adequate substitution of Magox for lime during clarification effectively inhibits scale formation, thus eliminating cleaning altogether.

To go back to the case of Médine, 45% Magox seems too high a proportion to use. On the other hand 27% is rather on the low side as it did not keep the evaporator tubes entirely free of scales Assuming that a Magox/Lime mixture in the ratio 40/60 could be advantageously used in liming it is interesting to calculate at what price Magox should sell to justify its use in the raw sugar factories of Mauritius. Taking every factor into consideration an economic price for Magox works out at slightly less than Rs. 500/ton, assuming the mixture is used at the rate of 0.56% on cane It is therefore unfortunate, in view of the present market price of Magox, that it is not possible to recommend its use for surmounting cleaning difficulties. However, local mills would be well advised to keep a small stock of the chemical to tide them over bad scaling periods.

ACKNOWLEDGMENTS

The authors wish to express their thanks to Messrs. L. Lincoln and A. E. Bérenger for providing valuable technical data. The assistance of Mr. M. Abel in carrying out the analytical work is gratefully acknowledged.

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3. COMMENTS ON THE SUITABILITY OF LOAD CELLS FOR CHECKING MAXWELL BOULOGNE SCALES

ERIC PIAT

Description of Maxwell Boulogne Scale

The Maxwell Boulogne is a batch type scale which dumps the same amount of liquid each time. This result is achieved by applying the following principle :

A bin B is connected through the beam A to a counter-weight W. (See Fig. 21 (a)). Liquid is poured into B until the bin just tips over. Let the force acting downwards at C, at the instant the bin starts moving, be F_1.

When the bin is in position (b) liquid flows out of the bin until the latter just starts rising. If the force acting at C is then F_2, it is obvious that the amount of liquid dumped is $F_1 - F_2$.

The forces F_1 and F_2 will depend solely upon the size and shape of beam A, and the weight W.

In its construction, however, the Maxwell Boulogne scale is somewhat more complex. The valve controlling the inlet and outlet of liquid are shown in Fig. 22. When the bin moves downwards, the inlet valve closes and the outlet valve opens and vice-versa.

In order to increase the accuracy of the scale, the inlet flow should be reduced to a minimum before the bin tips over; the outflow should also be reduced before the bin rises. For the inlet valve this is achieved by lowering a baffle actioned by a float resting in the liquid inside the bin. If, however, the density

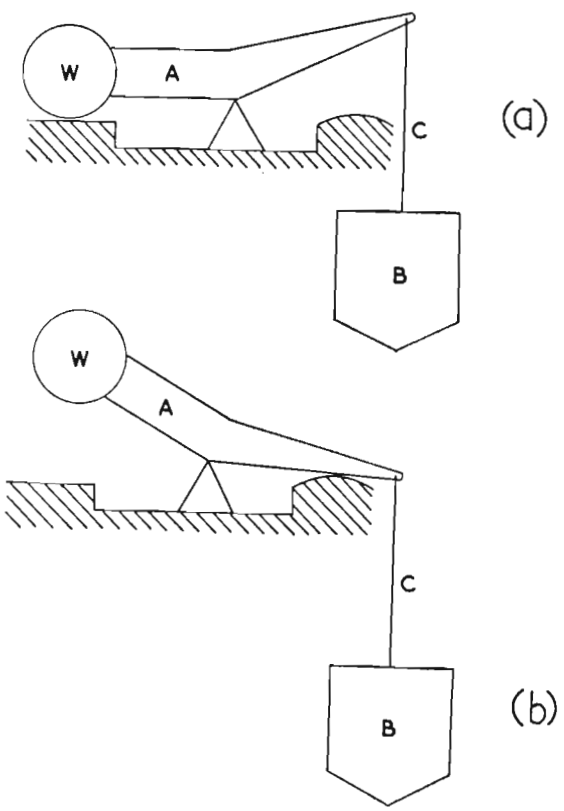

Fig. 21. Principal of operation of the Maxwell Boulogne scale.

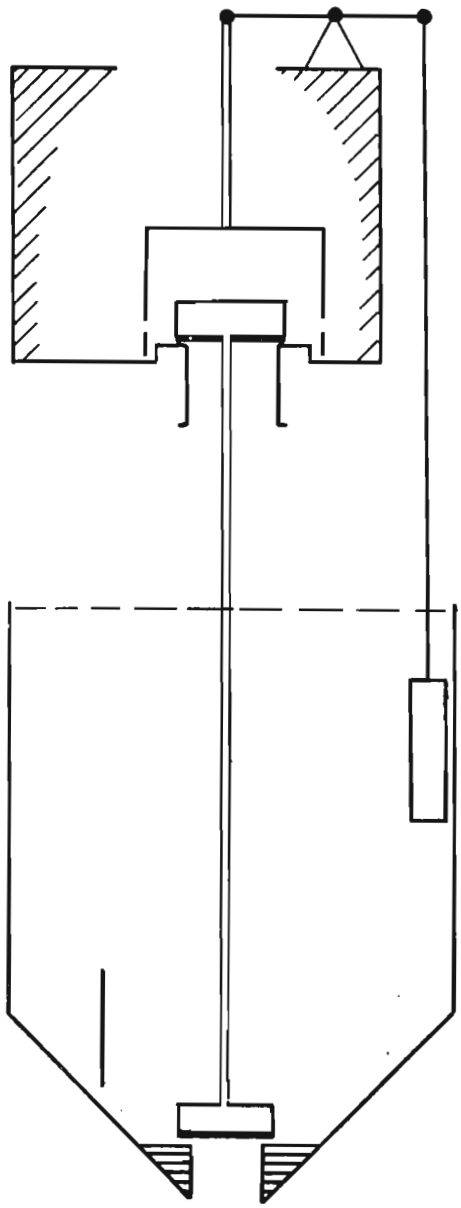

Fig. 22. Diagramatic layout of Maxwell Boulogne scale

of the liquid varies the weight of the float should be adjusted, since otherwise it will rise too early or too late resulting in either reduced capacity of the scale, or reduced accuracy.

The weight of one dump of liquid is consequently not $F_1 - F_2$, but $F_1 - F_2$ minus weight of valve minus buoyancy of float.

A built-in baffle at the bottom of the bin ensures that the outflow will be small at the time when the bin is almost empty and about to rise.

An important point to note is that when the bin moves upwards or downwards the valves do not close instantaneously (hence the reason for having the baffles).

In practice errors can arise from :

(i) Friction in knives and changes in dimension of beam A. These errors are negligible, beam A being very rigidly built and the knives being replaced periodically.

(ii) Floats and pipes dipping in the liquid inside the bin and having different buoyancies for liquids of different densities. These errors although small by themselves will indirectly affect.

(iii) Valves not closing instantaneously when the bin moves upwards or downwards. This error cannot be estimated; it will depend on the wear of the valve gasket, on particles of bagacillo getting stuck between the valve seat and the valve itself, and most important of all on the rate of flow of the liquid at the time when the valve is being closed.

The idea of having a check scale is to weigh the amount of liquid which has been dumped by the Maxwell Boulogne during several operations and to determine the average weight of liquid being dumped. This average is assumed to remain constant for a certain period of time (generally 24 hours).

Types of Check Scales

(i) One suggestion constists in installing 1 or 2 load cells in the link C, (Fig 21) the object being to measure the weight of the bin full of juice and the tare of the rising bin. The difference would give the weight of the liquid plus the weight of the valve and the buoyancy of the float etc.. But the modification provides no means of estimating the amount of leakage which takes place, i.e. the amount of liquid which flows from the instant when the bin starts moving until the valve is fully closed. In other words a weighing device placed in the position suggested above can only measure the effect of the counterweight on the bin and

nothing else. Such an installation would not even detect a valve which is not operating properly.

(ii) The other possibility consists in using a bin, mounted on load cells, and placed under the juice scale. By closing the outlet of the bin, the amount of juice dumped can be easily checked. The advantages of such a check scale over the conventional type, provided the load cells are accurate and reliable, are :

(a) Ease of operation : readings are obtained more readily from the dial than from the slider on which weights have to be moved.

(b) Ease of installation : no head room being required apart from the height of the bin itself, this type of checking device can be easily installed under any existing juice scale.

(c) The possibility of discarding the existing scale and replacing it, at low cost, by a completely automatic scale using load cells if the latter are shown to be sufficiently accurate and reliable. The additional equipment needed would be two automatic valves and a totaliser. The arrangement would be as shown in Fig. 23. The bin A is filled until it reaches a predetermined weight, when the supply valve B is closed automatically. After a few seconds the exact weight of the bin is transmitted to the totaliser C. The outlet valve D is then opened and when the bin is almost empty it closes again, when the exact weight of the bin is transmitted to the totaliser. By difference the true amount of juice dumped is recorded by the totaliser. The inlet valve then opens agains and a new cycle begins.

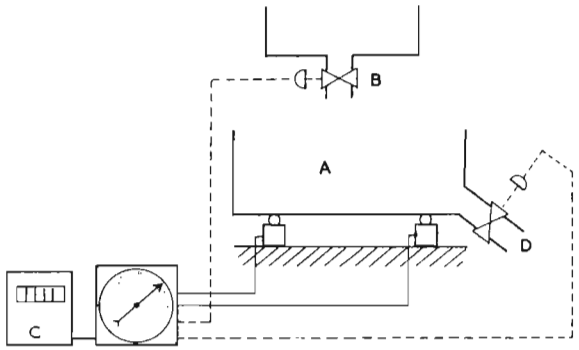

Fig. 23. Automatic scale using load cells.

Such an arrangement could be easily standardised and checked by dead weights at regular intervals. However tests would have to be carried out to ascertain whether checking under actual working conditions would yield results different from those obtained when the mill is not running.

4. JUICE PRESERVATION DURING SHUT DOWNS

J. D. de R. de SAINT ANTOINE & E. C. VIGNES

Storage of clarified juice over the week-end shutdown is normal practice in Mauritius, but the conditions under which this juice is stored vary considerably from factory to factory. A survey carried out in 1962 revealed that purity drops fell between the limits of 1.5 and 10.0 points, averaging 3.5 points for the industry as a whole. It is estimated that for a factory equipped with a 300-ton clarifier a purity drop of 3.5 points is equivalent to a loss of about Rs. 27,000 every year. Therefore in 1963 the problem of clarified juice deterioration was studied, first under laboratory conditions, then on an industrial scale, with the object of making recommendations for curtailing the financial loss incurred yearly by the industry.

Preliminary laboratory experiments, in which lime and sodium carbonate were added to clarified juice in concentrations of up to 1500 ppm for 40 hours at temperatures of 89°C and 82°C, showed that high alkali concentrations are not justifiable under local conditions. It was therefore decided to use much smaller concentrations and to adopt a storage period of 24 hours which is approximately the average obtaining in factories over the week-end. Up to 150 ppm of lime and 300 ppm of sodium carbonate were added to clarified juice and the latter kept at 90°C and 80°C for 24 hours. A grade of magnesium oxide known as Magox was also tested. Results obtained show that : (a) temperature control is more effective than pH control for preventing deterioration in clarifiers, (b) lime is almost twice as effective as sodium carbonate at the concentrations employed, (c) the most suitable method of control is to add 150 ppm of lime or 300 ppm of sodium carbonate while maintaining the temperature at 80°C, (d) under local conditions lime is the most economical chemical to use.

On an industrial scale, tests were carried out in four factories referred to as A, B, C and D. In factory A where the usual practice is to increase lime addition four hours prior to shutdown so as to obtain a pH of 7.4 by the time the mills stop crushing, the average purity drop is normally about 3 points. When the initial temperature was reduced to betwween 81° and 85°C this fell to 0.9. Addition of milk of lime to the clarified juice after the latter had been kept for a number of hours showed no marked improvement. In factory B purity drop is on the average 2.6 points. Usually no decrease in temperature and no lime addition are effected prior to shutdown, but a fairly large amount of lime is added on Sundays and the juice recirculated. When the initial juice temperature was reduced to about 85°C, purity drop amounted to only p.8. Similar results were obtained in factory C where the purity drop was 0.8 for an initial juice temperature of 82.8°C as against 2.2 when the initial temperature was 91.3°C. Finally in Factory D initial juice temperature could not be reduced. An average purity drop of 2.8 was observed, thus confirming that under conditions of high temperature, marked purity drops occur during storage.

In order to reduce purity drops to less than one point it is recommended to lower the initial juice temperature in the clarifier to such an extent that the final temperature does not fall below 71°C by the time the mills start crushing again. The use of a thermograph is also recommended. A polyelectrolyte, such as Separan AP 30, should be added a few hours prior to and following shutdowns if clarification difficulties are encountered Special care should be taken during sampling and the Brix should be determined by means of a precision refractometer.

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5. A PRELIMINARY EXAMINATION OF THE ORGANIC NITROGEN COMPOUNDS PRESENT IN CANE MOLASSES

Y. WONG YOU CHONG and D. H. PARISH

Although there are several analyses of the amino-acid content of molasses in literature, it was felt that the techniques used were inadequate. Certain amino-acids, though present in sugar-cane juice, have not been reported in molasses. Also, as amino-acids, being of comparatively low solubility, may influence the crystallisation of sugar in molasses, as they react with reducing sugars to form coloured compounds, and as molasses is universally used as an animal food, a detailed study of the nitrogenous components of molasses is needed.

Zerban (1912) identified only aspartic acid, glutamic acid and tyrosine from cane-molasses. Payne (1946), from work on Hawaiian molasses, added lysine to that list and found histidine, arginine, cystine, glycine and tyrosine to be absent.

Binkley and Wolfrom (1953), and Kelly and Thompson (1955) considerably enlarged that list (vide Table 53), whilst Ciferri et al (1955) found the same amino-acid picture in beet-molasses but did not report the presence of asparagine.

More recently, Kuwabara et al (1962) studied qualitatively the amino-acids present in Hawaiian cane syrup.

The technique described by Thompson, Morris and Gering (1959) was used for this work as the initial purification of the amino-acids on ion-exchange resins is essential and their subsequent chromatographic separation is good.

Table 53. Amino-acids identified in sugar cane products.

Amino-Acid	*Binkley & Wolfrom Molasses 1953*	*Kelly & Thompson Molasses 1955*	*Kuwabara et al Syrup 1962*	*Parish Juice 1964*	*Present Study Molasses 1964*
Neutral and acidic					
Aspartic	+	+	+	+	+
Glutamic	+	+	+	+	+
Serine	—	+	+	+	+
Glycine	+	+	+	+	+
Threonine	—	+	—	+	+
Alanine	+	+	+	+	+
Asparagine	+	+	+	+	+
Homoserine	—	—	—	—	+
β-alanine	—	—	—	+	+
Glutamine	—	—	—	+	+
Methionine	—	—	—	+	+
4-aminobutyric	+	—	+	+	+
Tyrosine	—	+	+	+	+
Valine	+	+	+	+	+
Pipecolic	—	—	—	+	+
Proline	—	—	—	+	+
Leucine	+	+	+	+	+
Isoleucine	?	+	+	+	+
Phenyalanine	—	—	—	+	+
Nor-leucine	?	+	?	—	—
Glucosamine	—	—	—	—	+
Basic					
Lysine	+	+	+	+	+
Histidine	—	—	+	+	+
Arginine	—	—	—	+	+
Tryptophan	—	—	—	+	+

Procedure

5 g. of fresh molasses from The Mount and Solitude factories were dissolved in water and made up with ethyl alcohol to give a solution containing 80% v:v alcohol. It was filtered and the filtrate evaporated to dryness at 40°C under vacuo. The residue was taken up in water and iso-propanol added to give 250 mls. of a 10% v:v iso-propanol solution.

An aliquot was taken for the analysis of the amino-acids.

Results

The same general picture was obtained for both samples of molasses, giving 36 ninhydrin-reactive spots. Plate 8 is a typical chromatogram of the neutral and acidic amino-acids and Plate 2 of the basic amino-acids.

The amino-acids that have been identified are labelled; spots A, B, E and F have been reported in sugar cane leaf laminae by Parish (1964). A was given the provisional classification of homoserine, B of 2 — amino — 5 hydroxyvaleric acid, E of 4-hydroxypipecolic acid and F of 5-hydroxypipecolic acid. Spots H,I,J,K,L, M,N,O and P, which have never been reported before, are undoubtedly artifacts produced during sugar manufacture.

From the Rf's, P is provisionally identified as glucosamine.

Table 53 summarizes the previous work done on amino-acids of sugar cane molasses.

β-alanine, glutamine, methionine, homoserine, pipecolic acid, proline, phenylalanine histidine, arginine, tryptophan and glucosamine are reported for the first time in cane molasses.

Further work on the qualitative and quantitative amino-nitrogen composition of molasses is continuing, as the work presented here demonstrates clearly the inadequacy of past research on this important subject.

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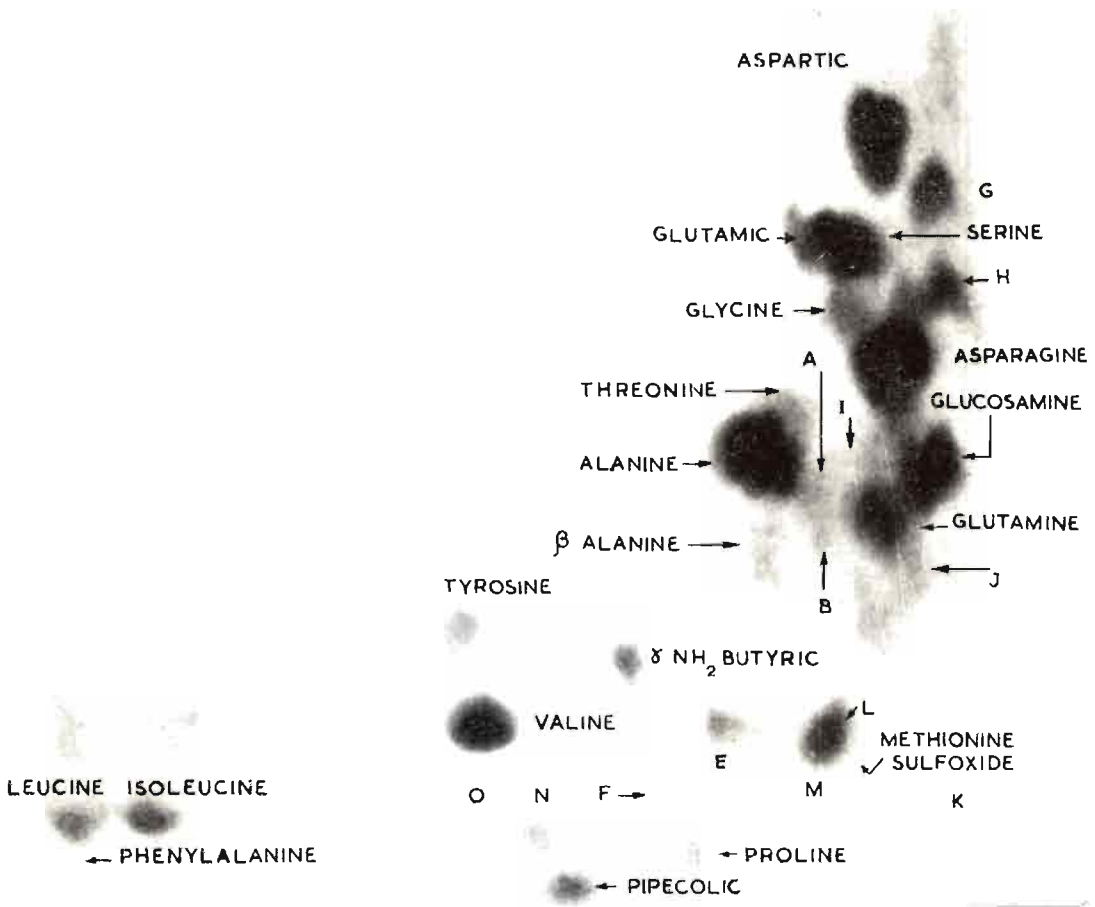

Plate 8. Neutral and acidic amino-acids of 80% alcohol-soluble fraction of sugar cane molasses.

BY-PRODUCTS

1. THE VALUE OF THE HEAT COAGULATE FROM CANE JUICE AS A SUPPLEMENTARY PROTEIN IN CHICK RATIONS

D. H. PARISH

STUDIES on the chemical composition and nutritive value of dried factory filter muds (Parish 1962 a and b) showed that this material would probably be of little nutritional value when fed to non-ruminants. This work did not support the claims of Staub and Darné (1962) that dried filter-press muds were a useful supplement to standard chick rations; more recently, however, these authors have confirmed that non-ruminants did not benefit from the incorporation of dried filter-press muds in their rations (Anon 1963).

The graph (Fig. 24) which compares chick growth when fed on a standard chick ration, with and without additions of dried scums, shows conclusive y that a significant depression of the growth rate occurs when dried scums are added.

The only way in which efficient utilization of the protein in cane-juice as a dietary supplement could be made is by the isolation of a protein-rich material suitable for use as a supplementary protein source for non-ruminants and particularly the laying hen.

The details of a feeding trial in which air-dried and de-waxed cane-juice coagulate was compared with a good quality white-fish meal are given below and the results in Table 54. The technique and basal ration composition were given by Carpenter (1963).

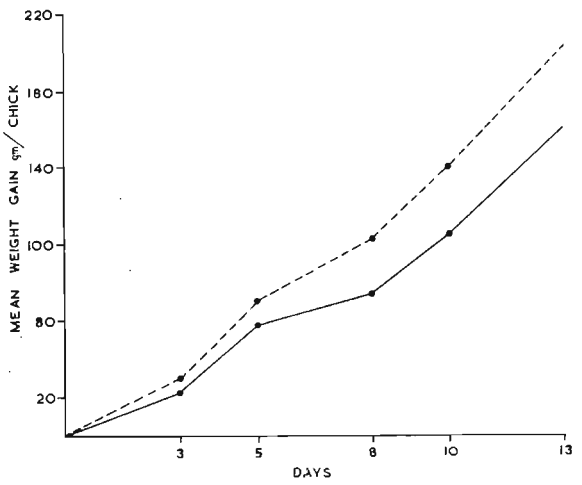

Fig. 24. Graph showing the mean gain live weight per chick with a normal ration (broken line) and the same ration with 27% of dried filter press mud incorporated (plain line).

Method

Chicks received test diets from 10 to 20 days of age. Diets consisted of a constant basal portion contributing approximately 12% of protein and designed to contribute all the vitamins needed, with starch *ad* 100. Test diets contained either a fish meal, of known good quality (as a standard of comparison) or cane coagulate, each contributing 3 and 6% crude protein.

Forty-five ten-day old 404-cockerels were selected for uniformity from a larger number; and divided into three strata (I, II and III) of heaviest, medium and least weight; each stratum was then divided amongst 5 cages (i.e. 3/ cage) and each cage allotted to one of the 5 experimental diets.

Table 54. Chick Experiment 1964.

Diet		*Negative Control*	*Fish Meal*	*Fish Meal*	*Cane Coagulate*	*Cane Coagulate*
Fish meal		—	56.0	111.9	—	—
Cane coagulate		—	—	—	96.9	193.8
Bone flour		23.5	15.7	7.8	23.5	23.5
Full basal		843.2	843.2	843.2	843.2	843.2
Maize starch		408.3	360.1	312.1	311.4	214.5
Supplementary protein % ...		0	3	6	3	6
Mean weight gain (g/chick)	I	24.0	32.7	61.5	34.0	40.7
	II	22.3	52.7	65.0	31.5	38.0
	III	24.8	32.0	50.8	23.0	38.7
Overall mean		23.7	39.1	59.1	29.5	39.1
Feed conversion efficiency	I	0.238	0.317	0.489	0.294	0.332
	II	0.223	0.387	0.524	0.297	0.345
	III	0.249	0.321	0.424	0.256	0.325
Overall mean		0.237	0.339	0.479	0.283	0.343

The diets were fed ad libitum as a dry powder and the live weight gains per chick and food consumption per cage recorded.

Diet

The constant «full basal» comprising 66 13% of each diet was made up of :-

Sieved ground oats ...	46.4
Ground oat husks... ...	5.0
Sodium chloride	0.4
Manganese sulphate ...	0.025
Vitamin pre-mix* ...	1.0
Choline chloride	0.1
Arachis oil	3.0
Groundnut meal	10.2

The results show that the cane-juice coagulate was about one half as efficient as the fish meal as a dietary supplement to the basic ration used.

The dietary value of any proteinaceous material depends on its digestibility, its amino-acid composition and the amino-acid composition of the basic ration with which it is fed.

The full amino-acid composition of the dewaxed heat-coagulate of cane-juice is given in Table 55, and shows that, although typically a plant protein material, the level of methionine is low and this fact may account for the comparatively low value of the coagulate; further trials in which methionine supplementation is used are being carried out.

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* Vitamin pre-mix contributed to kg. of final diet (in mg.) :—

Vitamin A (1,000,000 i.u./g.) 8.85, Vitamin D (1,000,000 i.u./g.) 2.2, B_1 10, riboflavin 10, B_6 10, nicotinamide 53.5, calcium pantothenate 30, biotin 1, folic acid 4, B_{12} 0.03, α –tocopherol acetate 20, menapthone 0.57 ; with maize starch to 1% of final diet weight.

The problem of isolating a useful dietary protein supplement from cane-juice has two distinct aspects, the technological difficulties of isolating a proteinaceous material from the juice, and the problems posed in the nutritional exploitation of the material produced.

With the advent of cheap amino-acid supplements the basic composition of a protein is becoming of less importance, and should methionine supplementation of cane-juice coagulate improve its value as a dietary supplement for non-ruminants, the problem of exploiting this material will be entirely technological.

Table 55. The amino-acid composition of cane juice coagulate

(*% amino-acid N in total N*)

(8.0 mg. N hydrolysed, 0.78 mg. N added to the column, N recovery % N applied to column 95%)

Amino-acid	
Aspartic acid	7.02
Threonine	3.78
Serine	4.60
Glutamic acid	6.97
Proline	4.01
Glycine	6.96
Alanine	6.95
Valine	5.09
Methionine	1.06
Iso-Leucine	3.37
Leucine	6.28
Tyrosine	2.14
Phenylalanine	2.75
Unknown (as leucine equivalent)	0.47
Tryptophan	0.97
Histidine	3.65
Lysine	7.78
Arginine	12.81
Amide ... ... Not	determined

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Table XVIII. Production and utilisation of molasses, 1948-1964

Year	Production	Exports	Used for production of alcohol	Available as fertilizer	N.P.K. equivalent in molasses available as fertilizer		
	M. tons	M. tons	M. tons	M. tons	M. tons		
					N	P_2O_5	K_2O
1948	85,308	—	42,640	42,768	222	107	2,198
1949	96,670	1,867	41,728	53,075	276	133	2,728
1950	98,496	79	25,754	72,643	378	182	3,734
1951	125,819	3,601	44,896	77,322	402	193	3,974
1952	113,756	40,537	29,878	43,339	225	108	2,228
1953	141,449	67,848	16,037	57,564	299	144	2,958
1954	120,495	89,912	8,300	22,383	116	56	1,145
1955	106,839	53,957	9,005	43,877	228	110	2,255
1956	118,716	52,694	8,661	57,361	298	143	2,948
1957	110,471	72,539	7,796	30,136	157	75	1,549
1958	113,811	59,158	8,435	46,218	240	116	2,376
1959	118,056	59,985	9,632	48,439	252	121	2,490
1960	72,991	45,180	8,871	18,940	98	47	970
1961	139,234	64,633	7,357	67,244	350	168	3,456
1962	122,890	76,800	7,750	38,340	199	96	1,955
1963	149,586	109,770	8,192	31,141(2)	162	78	1,588
1964(1)	113,781	96,830	7,172	9,333(3)	46	23	476

(*1*) *Provisional figures*

(*2*) *In 1963, 483 tons used in the preparation of animal foodstuff have been deducted*

(*3*) *In 1964, 446 tons used in the preparation of animal foodstuff have been deducted*

Table XIX. Importation of inorganic fertilizers, in metric tons, 1950-1964

	N	P_2O_5	K_2O
1950	3,990	870	1,930
1951	5,710	1,020	4,080
1952	5,800	1,140	2,960
1953	5,080	560	2,380
1954	4,170	1,110	3,340
1955	5,620	570	3,110
1956	8,870	2,170	3,940
1957	6,900	2,770	4,390
1958	6,210	3,020	4,690
1959	8,500	2,740	5,310
1960	8,170	4,382	5,765
1961	7,462	4,769	4,569
1962	9,467	5,377	6,373
1963	9,762	5,079	6,952
1964	10,095	5,698	8,838

Table XX. Sales of Herbicides, 1963-1964

HERBICIDES	1963			1964		
	Quantity		Sales in Rupees	Quantity		Sales in Rupees
	Imperial gallons	Kgs.		Imperial gallons	Kgs.	
MCPA — Metallic salt	9,626		123,838	9,859		130,558
2, 4 - D Amines	26,813		409,860	27,361		424,216
2, 4 - D Esters	9,386		312,788	11,029		419,869
Pentachlorophenol	969		14,523	595		8,330
Sodium Chlorate		276,502	357,866		398,053	539,155
Sodium Trichloroacetate (TCA)		339,981	970,747	—	389,449	1,201,856
Sodium 2,2 dichloro-propionate (Dalapon, Basfapon, Unipon)	—	5,070	48,906	—	6,670	76,740
Substituted Ureas DCMU	—	39,915	1,197,315	—	38,889	1,283,353
Substituted Triazines						
Simazine	—	26,833	388,777	—	15,097	243,444
Atrazine	—	2,377	40,144	—	22,507	395,941
Unclassified	339	250	11,287	602	425	34,384
			3,876,051			4,757,846

Table XXI. Importation of Major Herbicides, 1954-1964

YEAR	Inorganic Chemicals		Hormone type		Aliphatic acid Derivatives		Substituted phenols	Substituted Ureas	Substituted Triazines	
	Sodium Chlorate Kgs.	Sodium Arsenite Kgs.	2,4-D; 2,4,5-T M C P A		T C A Kgs.	Dalapon Kgs.	P. C. P. Imp. Gall.	D.C.M.U. Kgs.	Simazine Kgs.	Atrazine Kgs.
			Imp. Gall.	Kgs.						
1954	66,365	310	49,265	2,550	149,316	—	2,563	—	—	—
1955	81,494	124	49,706	5,600	254,300	—	3,448	—	—	—
1956	92,780	80	48,333	6,125	181,700	—	3,460	—	—	—
1957	107,961	4,000	36,142	645	163,278	—	1,824	—	—	—
1958	128,835	—	43,150	565	167,096	—	3,528	—	—	—
1959	173,383	7,050	60,261	72	264,389	—	1,534	—	—	—
1960	304,851	6,000	76,629	—	377,063	400	2,641	12,500	568	—
1961	214,301	8,000	59,272	—	363,716	9,553	1,403	30,000	1,812	—
1962	272,937	—	54,507	—	335,595	21,933	1,010	38,279	21,432	—
1963	276,502	—	45,825	—	339,981	5,070	969	39,915	26,833	2,377
1964	398,053	—	38,390	—	389,449	6,670	595	38,889	15,097	22,507

Table XXII. List of crosses made in 1963 and stored in deep freeze at —15°C Sown in October, 1964

CROSS	No. of Crosses	No. of Bunches
B.34104 x M.92/53	1	28
B.37172 x M.423/51	2	46
C.B.41-35 x Unknown	1	24
Co.281 x C.B.41-35	1	116
,, x M.69/56	1	56
Co.779 x M.376/54	1	23
Co.1208 x M.376/54	1	17
C.P.53-18 x M.376/54	1	90
D.109 x Unknown	1	50
Ebène 1/37 x M.196/31	1	581
,, x Q.58	2	23
Ebène 50/47x Co.1230	1	21
Ebène88/56 x John Bull	2	207
M.134/32 x C.B.41-35	1	106
,, x M.43/51	2	233
,, x M.69/56	1	14
,, x P.T.43-52	1	232
,, x 40 S.N.5819	1	113
M.241/40 x P.T. 43-52	1	1064
M.377/41 x M.147/44	2	158
M.31/45 x P.O.J.2940	1	36
,, x P.O.J.3016	1	130
,, x 47 R.2777	1	95
M.93/48 x C.B. 41-35	1	17
,, x Ebène 1/37	1	354
,, x M.55/55	1	305

CROSS	No. of Crosses	No. of Bunches
M.99/48 x C.B. 41-35	1	82
M.198/51 x P.T. 43-52	1	21
M.423/51 x Ebène 50/47	1	77
M.81/52 x Ebène 1/37	1	252
„ x M.92/53	2	33
„ x M.376/54	2	72
M.127/52 x John Bull	1	26
M.272/52 x John Bull	2	578
„ x M.147/44	1	183
M.97/53 x John Bull	2	24
M.194/54 x John Bull	1	142
„ x M.P.87	1	62
M.210/54 x M.99/34	1	128
M.323/54 x M.147/44	2	122
M.516/54 x M.41/55	1	908
M.117/55 x Ebène 50/47	1	39
„ x M.377/41	1	408
M.259/55 x John Bull	1	18
M.292/55 x M.43/51	1	37
„ x S.C.12/4	1	21
M.349/55 x Ebène 50/47	1	372
M.322/56 x P.T. 43-52	2	128
M.361/56 x 47 R.2777	1	155
„ x Unknown	1	20
M.6/57 x John Bull	3	41
„ x M.376/54	3	526

CROSS	No. of Crosses	No. of Bunches
M.351/57 x M.2/33	2	17
M.394/57 x M.84/35	1	147
M.576/59 x 47 R.2777	1	156
M.336 x M.99/53	1	357
„ x M.361/56	1	150
N. 10 x M.147/44	2	40
„ x P.O.J.3016	2	210
P.T. 43-52 x Unknown	1	264
Q.50 x M.147/44	2	40
Q.56 x P.T. 43-52	1	25
Q.58 x Unknown	1	26
Q.70 x M.69/56	1	378
S.W.499 x 57 N.G.208	1	21
Total bunches of 3	84	10.445
	No. of Crosses	No. of Seedlings
Crosses Kept	84	31.335
„ Not germinated	52	—
„ Discarded	94	876
Grand Total	230	32.211

Table XXIIa. List of 1964 Crosses — Sown in November 1964

CROSS	No. of Crosses	No. of Bunches
B.34104 x M.158/55	2	23
B.4362 x M.63/39	1	263
,, x M.147/44	4	45
,, x P.T. 43-52	2	210
Co.281 x 47 R. 4066	2	24
Co.331 x M.490/54	1	60
Co.421 x N. 55-176	3	70
C.P. 47-193 x M.55/55	2	30
,, x M.69/56	1	21
Ebène 1/44 x M.196/31	1	366
,, x M.361/56	2	15
Ebène 50/47x M.213/40	4	19
,, x M.147/44	12	188
,, x 47 R.2777	4	30
Ebène 3/48 x 47 R.4066	2	60
Ebène 17/56x 47 R.2777	1	109
Ebène123/56 x M.147/44	2	17
Eros x C.B. 41-35	2	450
,, x M.213/40	2	70
,, x N. 55-176	1	20
H. 50-7209 x M.108/30	1	12
,, x M.99/34	2	15
,, x M.147/44	2	48
,, x M.92/53	2	26
M.134/32 x C.B. 41-35	2	23
,, x M.490/54	2	16

CROSS	No. of Crosses	No. of Bunches
M.134/32 x 57 N.G. 208	2	257
„ x P.T. 43-52	2	24
M.112/34 x 57 N.G.208	2	50
M.47/38 x M.147/44	2	15
„ x M.490/54	2	190
„ x Mol.5904	1	60
„ x 57 N.G.208	2	143
„ x P.T. 43-52	2	16
M.31/45 x M.147/44	2	19
„ x 47 R. 2777	1	30
M.197/46 x P.T. 43-52	2	73
„ x 47 R.2777	2	34
M.93/48 x C.B. 41-35	2	30
„ x 47 R.2777	4	23
„ x 47 R.4066	2	21
M.99/48 x C.B. 41-35	1	435
„ x M.158/55	1	237
„ x 47 R.2777	3	1172
„ x 40 S.N.5819	2	290
M.12/49 x 47 R.4066	2	17
M.423/51 x Co.213	2	179
M.81/52 x C.B.41-35	2	114
„ x M.84/35	4	20
„ x P.O.J.3016	2	50
„ x Selfed	4	155
M.127/52 x C.B. 41-35	1	30

CROSS	No. of Crosses	No. of Bunches
M.127/52 x M.147/44	2	36
M.128/52 x Ebène 1/37	2	90
,, x M.147/44	3	513
,, x M.403/54	1	290
,, x M.158/55	1	220
,, x P.T. 43-52	1	397
,, x Vesta	2	1910
M.232/52 x M.147/44	2	54
M.85/53 x M.109/26	1	60
,, x N.55-176	4	290
,, x Unknown	3	16
M.97/53 x Ebène 50/47	2	28
,, x 47 R.2777	2	182
,, x 47 R.4066	2	640
M.13/54 x M.147/44	2	34
,, x M.41/55	2	1013
,, x M.158/55	2	62
,, x P.T. 43-52	2	30
,, x 47 R.4066	2	120
M.101/54 x M.147/44	4	120
M.115/54 x M.147/44	2	17
M.159/54 x M.147/44	2	29
,, x P.T. 43-52	2	23
M.403/54 x 47 R.2777	2	201
M.461/54 x C.B. 41-35	2	82
M.506/54 x D.109	2	20

CROSS	No. of Crosses	No. of Bunches
M.506/54 x Vesta	2	123
M.516/54 x Ebène 1/37	3	316
,, x Ebène 50/47	3	138
,, x M.147/44	3	345
,, x M.403/54	2	108
,, x P.T. 43-52	2	710
M.518/54 x C.B. 41-35	2	58
,, x M.147/44	4	219
,, x Vesta	2	1035
M.55/55 x C.B. 41-35	2	190
,, x M.147/44	2	96
M.107/55 x M.147/44	4	80
,, x P.T. 43-52	2	80
,, x 47 R.2777	2	60
,, x 47 R.4066	2	50
,, x Vesta	2	320
M.117/55 x Ebène 1/37	1	310
,, x M.490/54	1	240
M.262/55 x 47 R.4066	2	87
M.292/55 x M.69/56	2	35
M.296/55 x M.147/44	2	73
M.340/55 x M.147/44	2	40
M.349/55 x C.B. 41-35	2	267
M.351/55 x C.B. 41-35	2	310
M.382/55 x M.147/44	2	130
,, x M.158/55	4	224

CROSS	No. of Crosses	No. of Bunches
M.382/55 x 47R.4066	4	314
M.15/56 x M.99/34	2	45
,, x M.213/40	2	210
,, x M.147/44	7	750
M.29/56 x M.147/44	2	138
,, x 47 R.4066	2	116
M.198/56 x C.B. 45-6	2	140
,, x 57 N.G.208	2	450
M.212/56 x M.167/32	2	280
,, x M.147/44	2	303
,, x P.T. 43-52	2	472
,, x 47 R.4066	2	233
M.245/56 x M.99/34	2	70
,, x M.147/44	2	150
,, x P.T. 43-52	2	120
M.332/56 x M.72/31	1	503
M.361/56 Selfed	4	1060
,, x Unknown	1	990
M.392/56 x M.41/55	2	263
M.6/57 x M.147/44	2	1016
,, x M.376/54	2	87
,, x Q.68	1	995
,, x 47 R.2777	2	1960
M.7/57 x M.147/44	1	280
M.137/57 x C.B. 41-35	2	76
,, x M.147/44	4	260

CROSS	No. of Crosses	No. of Bunches
M.137/57 x 47 R.2777	2	430
M.361/57 x M.147/44	2	34
,, x M.92/53	2	440
Vesta x M.147/44	2	132
Total (bunches of 3)	296	30,352

	No. of Crosses	No. of Seedlings
Crosses dept	296	91,056
,, stored	56	—
,, not germinated	171	—
discarded	420	3,703
Grand Total	943	94,759

Table XXIII. List of Approved Cane Varieties, 1965

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.253/48

M.442/51

Ebène 1/37

Ebène 50/47

*B.H.10/12

**B.3337

**B.34104

B.37161

B.37172

* To be uprooted before 31st December, 1969.

** To be uprooted before 31st December, 1970.

Mauritius Sugar Industry Research Institute

Annual Reports

1954 - 1963

Combined Table of Contents and Indexes

FOREWORD

This Index of the first ten Annual Reports of the M.S.I.R.I., 1954-1963 has been planned in two parts : a combined table of contents and alphabetical indexes of subjects.

The combined table of contents has been classified on the same principles as those followed in the preparation of the *Index of the Proceedings of the International Society of Sugar Cane Technologists* v. I - X (1924 - 1959). The subjects are arranged in the following order : Agriculture, Breeding, Entomology, Pathology and Factory ; within each section, articles have been grouped in logical sequence according to subject matter.

The indexes in the second part have been classified according to subjects as outlined in the preceding paragraph, and in alphabetical order.

This Index was prepared by the Senior Staff of the M.S.I.R.I. in collaboration with the Librarian.

Director

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