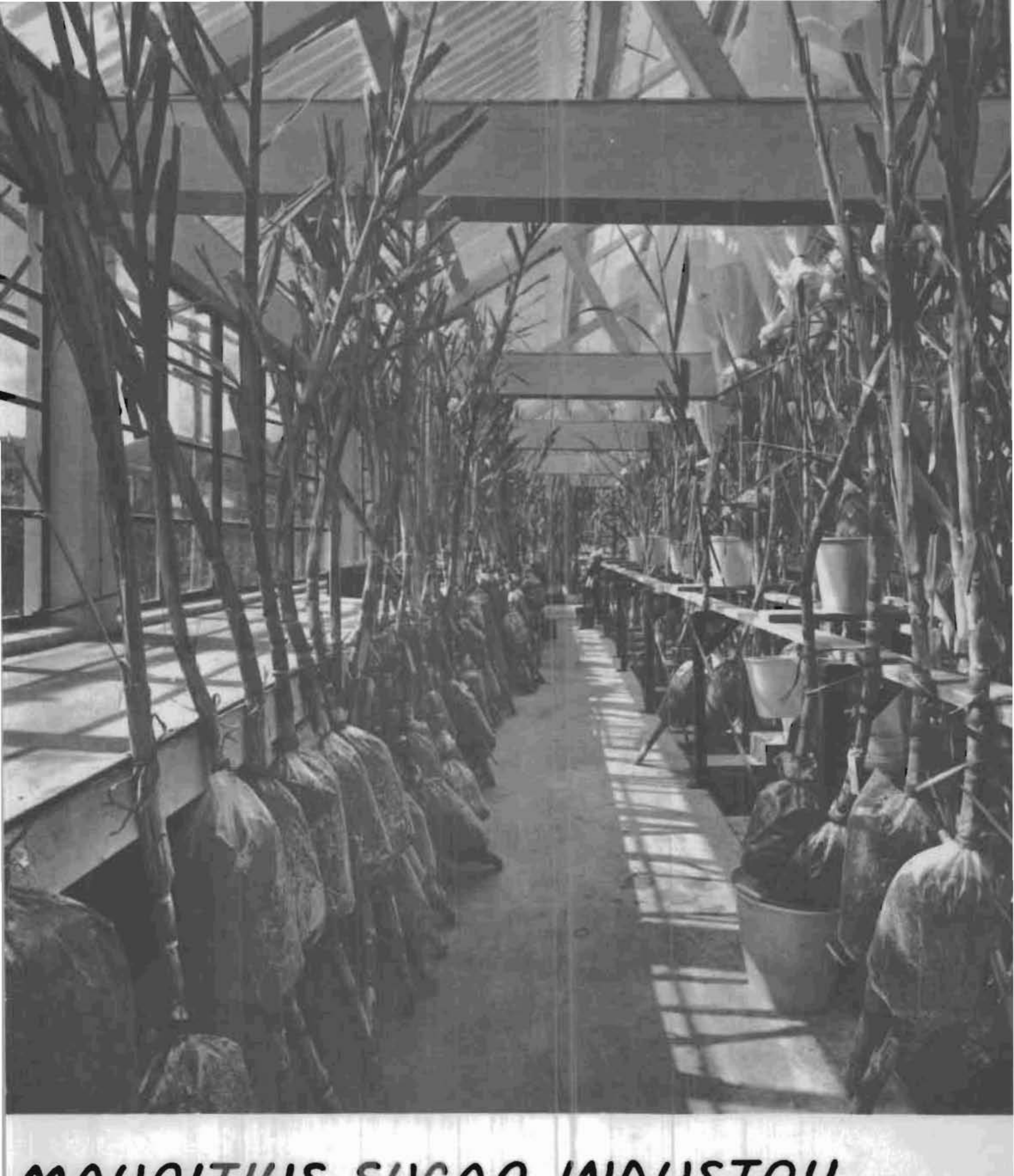

MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE

ANNUAL REPORT 1960

Mauritius Sugar Industry Research Institute

ANNUAL REPORT 1960

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SUGAR MANUFACTURE

APPENDIX

The photograph on the cover is a view of part of the Plant Breeding greenhouse, taken during the crossing season in 1960. The line of canes on the left are marcotted in polythene tubes and arrows are about to emerge. Other canes, rooted in drums and arrows isolated in preservative solution in plastic buckets, are on the right of the picture. Crossing lanterns hang from the roof of the house.

MEMBERS EXECUTIVE BOARD

Mr. Raymond Hein, Q.C. *Chairman, representing the Chamber of Agriculture.*

Mr. M. N. Lucie-Smith, *representing Government, January to July.*

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Mr. G. P. Langlois, *representing the Chamber of Agriculture.*

Mr. P. de L. d'Arifat, Mr. A Wiehe — *representing the Société de Technologie Agricole et Sucrière.*

and the senior staff of the Research Institute.

STAFF LIST

Director	P. O. Wiehe, C.B.E., D.Sc., A.R.C.S., F.L.S.
Agronomist	P. Halais, Dip. Agr. (Maur).
Botanist	E. Rochecouste B.Sc., Dip. Agr. (Maur.)
Asst. Botanist	C. Mongelard, B.Sc., (as from 1. 1 61.)
Chemist	D. H. Parish, B.Sc., M.Agr. (Q.U.B.) A.R.I.C.,
Senior Asst. Chemist ..	S. M. Feillafé, Dip. Agr. (Maur.)
Asst. Chemist	L. Ross, Dip. Agr. (Maur.)
Plant Breeder	Ir. W. de Groot
Asst. Plant Breeder ...	G. Harvais, B.Sc. (Aberd.)
Geneticist	E. F. George, B.Sc., A.R.C.S.
Asst. Geneticist	J. A. Lalouette, Dip. Agr. (Maur.)
Plant Pathologist	R. Antoine, B.Sc., A.R.C.S., Dip.Agr.Sc. (Cantab), Dip.Agr. (Maur.)
Asst. Pl. Pathologist ...	C. Ricaud, B.Sc., D.I.C. (as from 1. 1. 61.)
Sugar Technologist ...	J. D. de R. de Saint Antoine, B.S. Dip. Agr. (Maur.)
Associate Sugar Technologist	J. P. Lamusse, B.S. (Resigning on 28. 2. 61.)
Associate Chemist (S.T.) ...	C. Vignes, M.Sc., Dip.Agr. (Maur.)
Asst. Chemist (S.T.) ...	M. Randabel, Dip.Agr.(Maur.)
Asst. Sugar Technologist ...	R. H. de Froberville, Dip.Agr.(Maur.)
Asst. Sugar Technologist ..	F. le Guen, B.Sc., (as from 1. 1. 61.)
Entomologist	J. R. Williams, M.Sc., D.I.C.
Chief Agriculturist ..	G. Rouillard, Dip.Agr.(Maur.)
Senior Field Officer ...	G. Mazery, Dip.Agr.(Maur.)
	P. R. Hermelin, Dip.Agr.(Maur.) *i/c Reduit Experiment Station.*
Field Officers :	
Headquarters ...	A. Lagesse, Dip.Agr.(Maur.)
	M. Mamet, Dip.Agr.(Maur.)
North	R. Béchet, Dip.Agr.(Maur.) *i/c Pamplemousses Experiment Station*
South	F. Mayer, Dip.Agr.(Maur.) *i/c Union Park Experiment Station*
Centre	L. P. Noel, Dip.Agr.(Maur.) *i/c Belle Rive Experiment Station*
Laboratory Assistants :	
Chemistry ...	L. C. Fig[illegible]n
Entomology ...	M. A. Rajabalee
Foliar Diagnosis ...	Mrs. G. Caine
Sugar Technology ...	Vacant
Secretary-Accountant ...	P. G. de C. Du Mée
Asst. Secretary-Accountant ...	M. M. d'Unienville
Librarian	A. Jauffret
Draughtsman-Photographer ...	L. de Réland
Clerks	Mrs. A. d'Espagnac
	Mrs. A Baissac
	Miss. L. Kingdon
	Mrs J. Danjoux

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	Mrs. A Baissac
	Miss. L. Kingdon
	Mrs J. Danjoux

BUILDINGS

The Library-Lecture Hall was formally opened on 26th September, 1960 by His Excellency the Governor, Sir Colville Montgomery Deverell, and named « Philippe Bonâme Hall ». This formal opening was followed by an official reception which included a visit of the Institute's laboratories. The text of the speech made by the Chairman at the opening ceremony follows this Report.

In view of the extension of the Plant Breeding Division the Board has decided to provide additional laboratory space and it is hoped that this addition to the Plant Breeding Laboratory will be completed before the end of 1961.

By agreement with the Department of Agriculture it has been decided to build a house at Réduit which will be exchanged with the Department's house at present occupied by the Senior Agricultural Officer. This will bring to eight the number of houses belonging to the Institute, four of which will now be situated at Réduit.

SPECIAL STUDIES FUND

The Special Studies Fund served to finance Messrs. Mongelard, Ricaud and Le Guen's studies in England and also Dr. Hayward's visit to Mauritius.

FINANCE

One of the results of the 1960 cyclones has been to underline the fact that the Institute has not yet reached a sound financial basis. The shortfall of sugar production in 1960 reduced the Institute's revenue considerably, almost halved the Accumulated Funds and rendered our financial position very insecure.

It should be pointed out that the expansion and development of the Institute since its inception in 1953 has been carried out from revenue, which explains why it has not been possible to establish a cash reserve.

In order to remedy the position temporarily the cess on sugar exported has been increased to Rs. 4.50 per ton on sugar produced in 1961.

Once again it is a pleasure for me to record my appreciation of the most valuable assistance given to me by my colleagues of the Board, and of the loyal cooperation of every member of the staff.

To our Director I should like to add a special word of gratitude for the remarkable work he has accomplished during the most difficult year that the Institute has known.

Raymond Hein

Chairman.

28th January 1961

Fig. 1. Opening ceremony of Philippe Bonâme Hall on the 26th September, 1960.

SPEECH MADE BY MR. RAYMOND HEIN, Q.C., CHAIRMAN OF THE BOARD OF THE M.S.I.R.I., AT THE OPENING CEREMONY OF THE PHILIPPE BONAME HALL ON 26th SEPTEMBER 1960.

Your Excellency,
Lady Deverell,
Gentlemen,

Looking back upon the achievements of those who came before us in the field of agricultural research in Mauritius, one is struck by the fact that research always seems to have occupied a prominent place in the minds of local agriculturists. It may not have been research in the very sense in which we use the word here today, but it was a determination to explore and investigate which opened the door to more scientific and specialized achievements. Poivre, Céré and Cossigny, in the 18th Century were followed by Telfair and Bojer in the first half of the 19th; they, in turn, were followed by others whose names are familiar to all; the most famous of these being Philippe Bonâme.

From an early date it seems that Mauritian agriculturists realized that sugar was the pivot of the Island's economy and that every effort should be made to obtain increased returns from the land.

As far back as 1885, Sir William Newton, then President of the Chamber of Agriculture, had suggested that an experimental station be established to study the means of increasing agricultural production. The suggestion was gone into and accepted and it was felt that the services of a first class technician should be secured to assume the directorship of the station. This is why in December 1892, a French agronomist of international repute, Philippe Bonâme, arrived in Mauritius and durin_ 20 years gave the best of his knowledge and ability to the scientific development of local agriculture. The «Station Agronomique», as it was called, was administered by a special Committee appointed by the Chamber of Agriculture, and it was, from the start, financed by sugar producers. The Colony's production was then in the neighbourhood of 120,000 tons.

In 1913, the «Station Agronomique» was taken over by the Government with the view of widening the field of agricultural investigation, and it became the Department of Agriculture. Fourteen years later, at the first local sugar conference organised by Dr. H. A. Tempany — later Sir Harold Tempany — it was recommended that a special section of the Department of Agriculture should be created which would devote its activities exclusively to research on the sugar cane.

The Sugar Cane Research Station was the outcome of this recommendation and it started to operate in January 1930. I do not propose to dwell on the beneficial effects to the Industry of this newly created Research Station, apart from recalling that the Island's production passed from about 2 tons of sugar per acre in 1930 to nearly 3 tons per acre in the early 1950's, while the area under cultivation increased by approximately 30,000 arpents.

The next landmark along the road to progress bears the date 1947. In that year the Mauritius Economic Commission expressed the view that the Mauritian Sugar Industry should undertake and organize its own research. «Sugar cane producers would be well advised», the Report ran, «to press on for measures for establishing their own research organization for sugarcane, because the production of good cane varieties and the improvement of cultural methods are vital to the future success of the Industry».

In 1950, on the occasion of the laying of the foundation stone of the new building erected by the Sugar Cane Research Station, Sir Hilary Blood, referring to this recommendation, advocated that the Industry should organize and administer its own sugar research.

The Industry responded and the transfer of the Station took effect on the 29th of August 1953.

In October our present Director was appointed, and lost no time in organizing the programme of research and recruiting adequate staff to carry out this programme. The first years, of course, were not easy ones. Our staff had to work under difficult conditions, but they drew inspiration from the leadership and devotion of their Director and were determined to make the Institute a success. After 5 years of make-shift arrangements, the result of the Board's policy to develop gradually according to its financial resources, we are now at last in a position to inaugurate the Institute's building. It is interesting to recall that this building in which we are assembled today was originally presented to Government by the sugar planters to serve as a bacteriological laboratory for investigations into human and animal diseases occurring in Mauritius.

The activities of the Sugar Industry Research Institute cover all spheres of production, from the breeding and selecting of new cane varieties to the improvement in methods of manufacture and in the quality of the product. They even extend to projects of national economic importance, beyond the sugar industry, such as soil mapping and water resources.

I should also mention that we are custodians of a Herbarium of considerable scientific value derived mostly from the plant collection formerly housed at the Mauritius Institute in Port-Louis.

The original staff of 20 members in 1954 has now passed to 45 as a consequence of development made necessary by the requirements of modern agriculture in a highly competitive world.

But, however promising the results anticipated, it may not be out of place to utter a word of caution. Patience and continuity of effort are at the bottom of all scientific research and spectacular results are not to be expected overnight. We should remember, for example, that a minimum period of 10 years is required before a new variety can be recommended for commercial cultivation.

It is to the credit of the Mauritian Sugar Planters that ever since 1885, at a date when even the world-renowned Experiment Station of the Hawaiian Islands was not yet in existence, they recognized the need for research which found its expression in the appointment of Philippe Bonâme. It was he who by initiating and organizing agricultural research in Mauritius laid the solid foundations upon which rational cultivation of the sugar cane developed.

In recognition of his valuable services, the Sugar Industry Research Institute has thought fit to attach his name to this Hall which we would like to see becoming the focus from which scientific and technological advance applied to the sugar cane will radiate to field and factory alike for the benefit of the Colony as a whole.

May I now, Gentlemen, thank his Excellency for kindly accepting to declare open this Hall and may I invite His Excellency to unveil the plaque which commemorates this occasion?

REVENUE & EXPENDITURE ACCOUNT

YEAR ENDED 31st DECEMBER. 1960

Running and administrative expenses ...	1,360,729.48	Cess on sugar exported	914,876.37
Interest paid	27,116.75	Miscellaneous receipts	60,037.80
Leave and Missions Fund	100,000.- -		974,914.17
Depreciation	100,480.56		
Contribution to A. de Sornay Foundation ...	1,000.- -	Excess of Expenditure over Revenue for the year, carried to Accumulated Funds ...	614,412.62
Rs.	1,589,326.79	Rs.	1,589,326.79

BALANCE SHEET

AS AT 31st DECEMBER, 1960

ACCUMULATED FUNDS	854,136.56	FIXED ASSETS (At cost less depreciation and amounts written off)		
REVENUE FUNDS	54,593.93	Land and Buildings ...	1,620,678.50	
SPECIAL STUDIES FUND	7,816.01	Equipment & Furniture: (laboratories, houses & offices)	42,237.97	
AIMÉ DE SORNAY FOUNDATION ...	25,000. –	Agricultural Machinery & Vehicles	32,428.	
GROUND WATER RESEARCH FUND...	140,852.14			1,695,344.47
LOAN FROM ANGLO MAURITIUS ASSURANCE SOCIETY LTD. ...	493,178.	CURRENT ASSETS		
		Sundry Debtors ...	36,729.77	
GOVERNMENT OF MAURITIUS (Purchase of Buildings)	178,807.30	Aimé de Sornay Foundation Account	25,000.	
RETENTION MONEY ON BUILDINGS	13,000.—	Cash at Bank and in hand (Ground Water Research Fund Account) ...	140,852.14	
BANK OVERDRAFTS	149,539.67	Cash at Banks and in hand ...	18,997.23	
				221,579.14
Rs.	1,916,923.61		Rs.	1,916,923.61

AUDITORS' REPORT

We have examined the Books and Accounts of the Institute for the year ended 31st December, 1960, 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, 1960, 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) RAYMOND HEIN
(sd) G. S. DE LA HOGUE } *Board Members*
(sd) P. O. WIEHE *Director*

Port Louis,
Mauritius,
18th February, 1961

(sd) P. R. C. Du MÉE
C.A.(S.A.),A.S.A.A.
p.p. DE CHAZAL DU MÉE & CO.
Chartered Accountants.

INTRODUCTION

THE work of the Sugar Industry Research Institute in 1960 is presented in this eighth Annual Report following the pattern adopted in previous issues. The total staff numbered 41, the vacant post of Plant Breeder being filled by the appointment of Ir. W. de Groot, a graduate of Wageningen Agricultural University. Several junior posts in the division of Sugar Technology are still vacant and will be filled as necessity demands. The resignation of Mr. J. P. Lamusse, Associate Sugar Technologist, which will be effective on 1st March, 1961, is recorded with regret. On the other hand his appointment as Consulting Technologist to the M.S.P.A. will no doubt strengthen the already close ties existing between those two organizations of the sugar industry.

A major event during the year was the formal opening, by H.E. The Governor, of our lecture hall cum library thus marking the completion of the main building programme which for several reasons has taken seven years to achieve. This ceremony, which included conducted tours of the various divisions in which exhibits had been staged, provided an excellent opportunity of giving a broad perspective of the range of activities of the Institute.

It is gratifying to record that apart from the Geneticist's house at Vacoas, the buildings of the Institute, either at Réduit or on the various stations, suffered relatively little damage from the intensely severe February cyclone. The Director's office was the only room which was seriously flooded but thanks to prompt action by the staff, in his absence, losses of books and documents were kept to a minimum. The effect of the January and February cyclones however has been disastrous on all the field experiments in progress with the result that 1960 has been a «hollow year» in particular for observations on varieties having reached the pre-release stage of selection. Similarly the results of final variety, fertilizer trials and irrigation experiments are such that it would be unreasonable to attempt an interpretation of the data obtained.

Cane production at the four stations totalled 732 tons (Réduit 177 tons, Pamplemousses 359 tons, Belle Rive 128 tons, Union Park 68 tons), a reduction of 61% on the previous year.

Staff visits to sugar estates and planters numbered 1577 during the year.

THE 1960 SUGAR CROP

The results of the 1960 sugar crop have justified the worst pessimism expressed after the occurrence of the intense cyclones of the 19th January (Alix) and of the 28th February (Carol). Indeed, if one bears in mind the normal production of a given period, the yields of cane and sugar in 1960 are proportionately the lowest on record since the very beginning of the sugar industry in the 18th century.

Although these two cyclones have been fully described elsewhere* some essential facts relating thereto are given below (cf. also figs. 2, 3, 14 and 15). In this connection it is worthy of note that much valuable information on wind speed was obtained from the Dines anemometers purchased by the Institute, and which have been under the care of the Meteorological Department.

* *Davy, E., Rev. Agr. & Suc. Maurice, 39, pp. 124 - 129, 1960.*

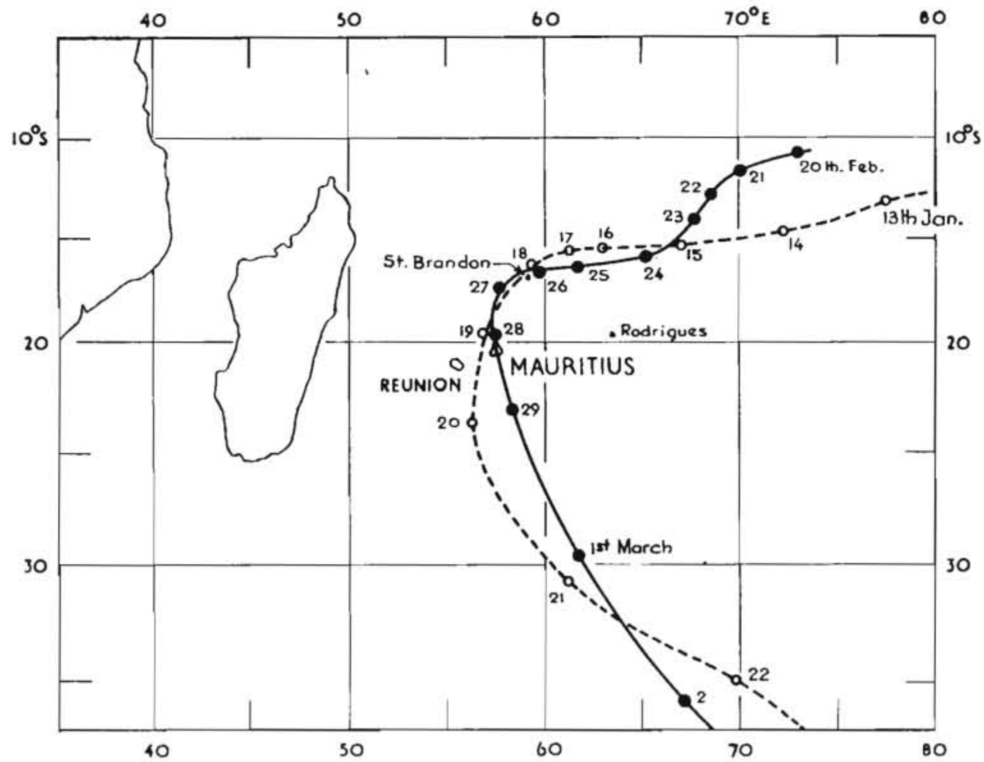

Fig. 2. Tracks of the two cyclones Alix (broken line) and Carol (plain line) in the Indian Ocean.

	Highest gust m.p.h.		Highest mean over 1 hour m.p.h.		Lowest Barometric Pressure	
	Jan. (Alix)	Feb. (Carol)	Jan. (Alix)	Feb. (Carol)	Jan. (Alix)	Feb. (Carol)
West	124	159	60	83	—	—
N. West	—	160	—	105	—	707
North	89	148	49	82	727mm.	—
East	97	148	43	78	—	—
S. East	104	130	60	74	—	—
Centre		118	—	55	—	—

It will be recalled that in 1945 the highest gust recorded was 98 m.p.h. at Vacoas, while in 1892 wind velocity reached 134 m.p.h. at Port Louis.

There is no doubt that the wind speeds indicated above were largely exceeded locally on account of topographical features. It is not improbable that velocities of 200 m.p.h. were reached. Under the violent turbulence the canes were broken, the leaves shredded and in many cases the stools had completely disappeared, having been washed away by heavy rains and lifted bodily by the wind. The damaged plants were more vulnerable to attacks by the stalk borer, while red rot, gummosis and leaf scald were far more prevalent than in a normal year. In fact it is surprising that a crop of any sort was reaped several months later, a clear example

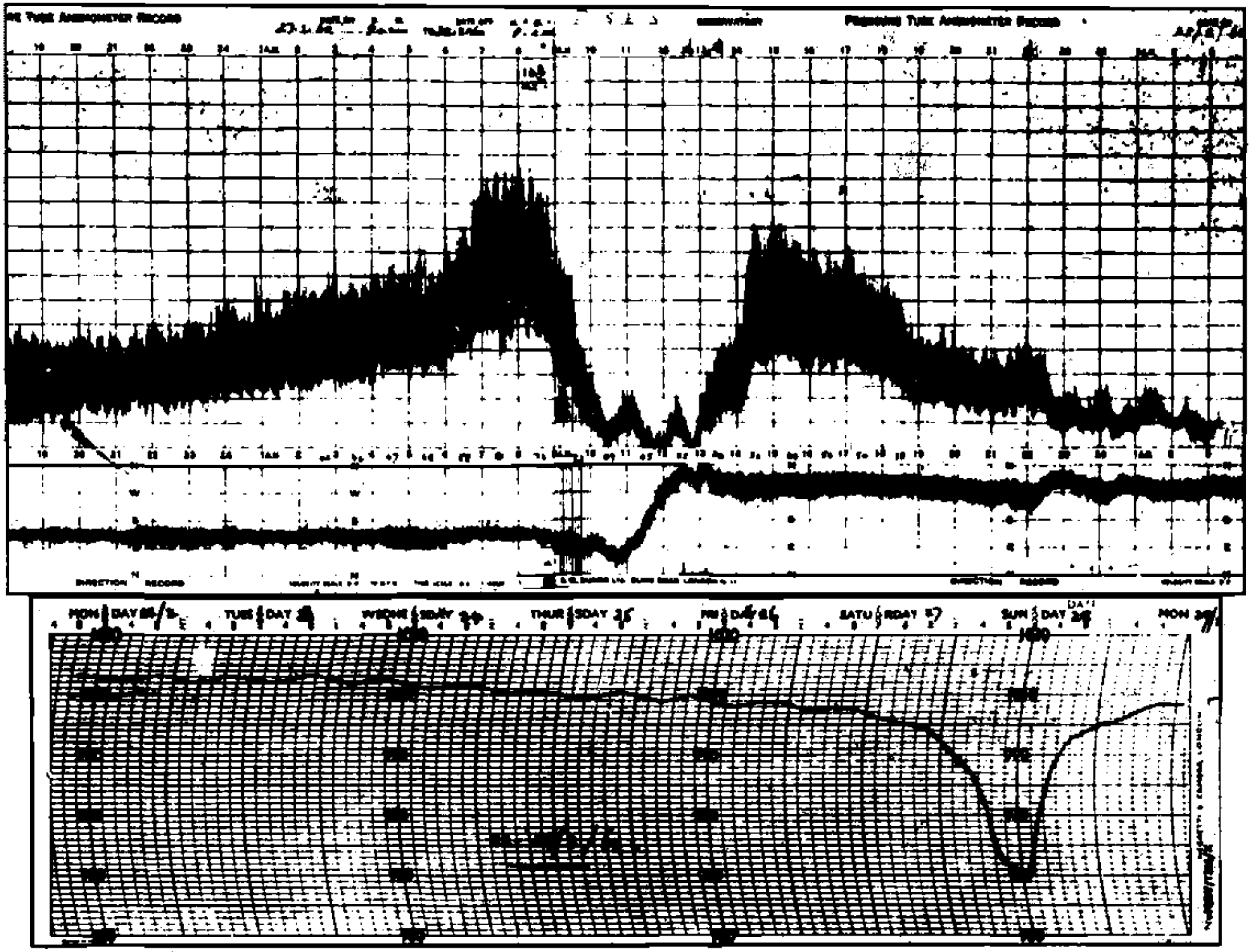

Fig. 3. Above, wind speed at Pamplemousses Station on the 27th and 28th February, 1960. The vertical scale, in miles per hour, is from 0 to 160. Below, atmospheric pressure in millibars at Réduit on the same days.

of the tolerance of the sugar cane plant to adverse conditions and providing another illustration of the reason underlying monoculture in Mauritius.

Climatic conditions prevailing after the February cyclone were bad for cane growth in both April and May, these two months being deficient in rainfall. As a consequence it is estimated that two tons of cane per acre were lost, a reduction of approximately 8% on a normal crop. To aggravate matters the harvest season was abnormally wet, rainfall in September being the highest on record, and causing a reduction of 0.7 on commercial sugar manufactured % cane, or about 6% on a normal crop. Maturation of the cane in 1960 compared to normal conditions is shown in fig. 4.

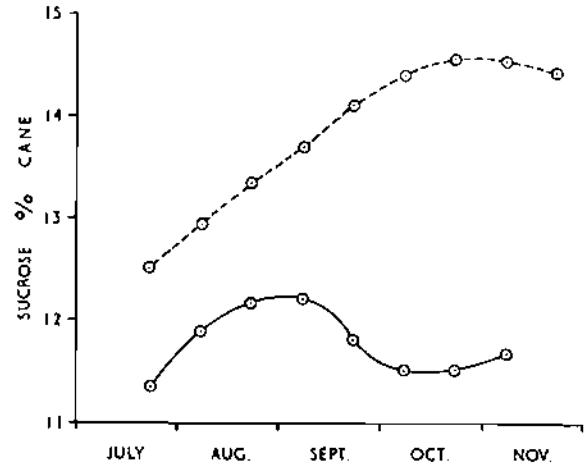

Fig. 4. Maturation curves, island average. Plain line: 1960; broken line: 1947 - 1959.

The area harvested in 1960 was 186,000 arpents which produced at an average yield of 12.8 tons and 9.84 sugar manufactured % cane, 2,393,000 tons of cane and 235,578 metric tons of sugar at 98.6 pol.*

Yields on estates averaged 15.3 tons per arpent while those of planters were 4.9 tons below. These figures are equivalent, respectively to 1.50 and 1.02 tons commercial sugar per arpent.

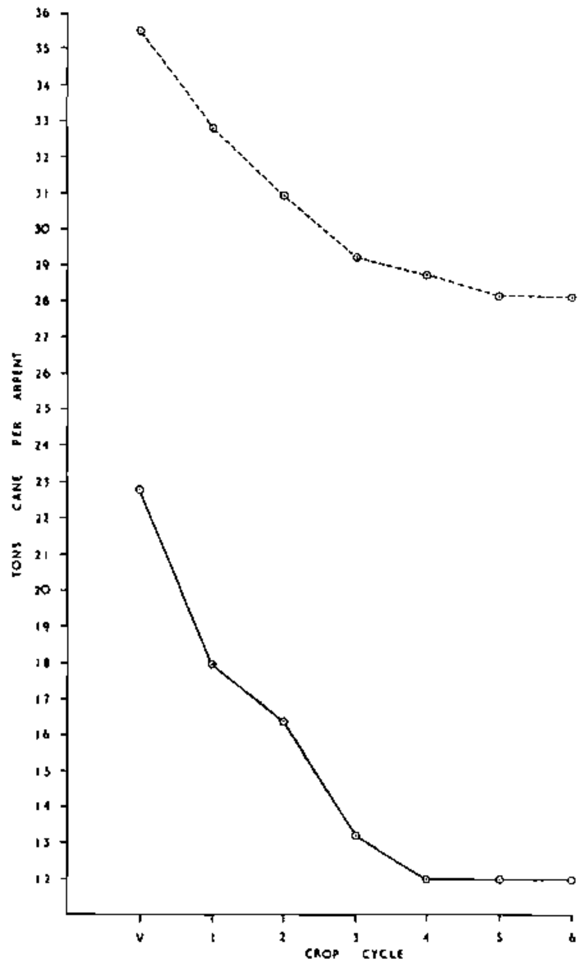

Fig. 5. Average yield of cane on estates in virgins and succeeding ratoons. Plain line: 1960; broken line: 1947 - 1959.

Average yields of virgin and ratoon canes are shown graphically in fig. 5 (see table XIII of Appendix). Losses were proportionately greater in ratoons than in virgins ranging from 34% in virgins to 58% of normal yields in older ratoons (fig. 6).

Twenty-three factories were in operation during the year, about half the canes of the Belle Vue factory area being crushed at Labourdonnais which worked for the last season, prior to the dismantling of the factory which will be

* *Equivalent to 266,735 short tons at 96 pol.*

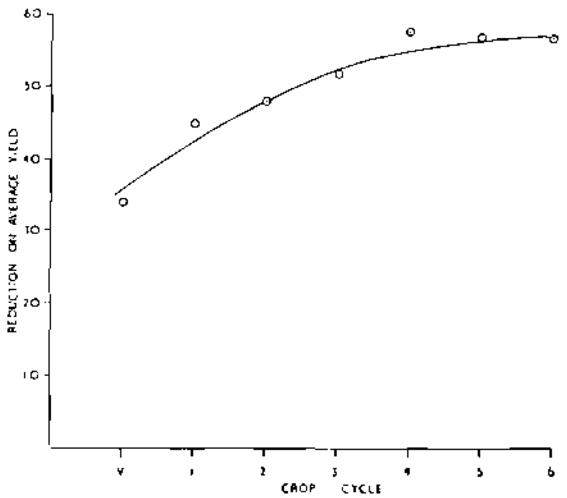

Fig. 6. Percentage reduction in normal yields of virgin and ratoon canes in 1960.

re-erected at Hippo Valley in Southern Rhodesia. Grinding began on the 1st July and extended over an average period of 89 days. The last factory stopped work on the 3rd December. Supply of cane to factories was well below normal mostly because of difficulties of harvesting low yielding fields. Cane quality reached the full expectation of an abnormally bad year: low sucrose content, low purity, high fibre, high viscosity of massecuites, high proportion of molasses resulting in total losses per cent cane exceeding the normal figure of 1.70 by 0.41% As a consequence of all these negative factors each ton of cane ground in 1960 produced 27.3 kgs sugar less than during the previous years.

The reduction in cane and sugar produced in different sectors of the island is shown diagrammatically in fig. 7. These figures show that losses increased from the West to the North, South and East to reach the highest level in the central plateau. By comparing the data with those on wind velocity it will be observed that no simple relationship can be established between these two factors. Once damage is caused to sugar cane by cyclones, the determining factor in their recovery is temperature, provided moisture is not limiting to growth. Plantations on higher grounds of the central plateau and elsewhere, which are subjected to a cooler climate, are therefore more vulnerable because growth is slowed down by the lower temperatures which prevail normally in these areas.

The more essential data of the 1960 sugar crop are summarized below in comparison with those relating to the 1955-59 period. These figures show the measure of loss sustained by the industry as a whole as a result of the exceptionally adverse meteorological conditions which prevailed during the year.

	Average 1955 - 59	1960	% Reduction
Area harvested (arpents) (i) 1955	168,590		
(ii) 1959	183,100	186,000	
Canes reaped (M.T.) on 186,000 arpents	(4,743,000)*	2,393,500	—49.5
Tons cane per arpent	25.5	12.8	—49.8
Sugar manufactured % cane	12.57	9.84	—21.7
Sugar at 98.6 pol. (M.T.) on 186,000 arpents ...	(593,000)*	235,578	—60.1
Tons sugar per arpent	3.20	1.26	—60.6
Crushing days	109	89	
Cane crushed/hour	78.1	77.0	
Sucrose % cane	13.76	11.83	
Sucrose lost % cane	1.70	2.11	
Fibre % cane	11.85	14.38	
Purity 1st expressed juice	89.7	85.9	
Molasses % cane	2.55	3.08	

* *Canes reaped and sugar produced are not average figures, but corrected to the acreage harvested in 1960.*

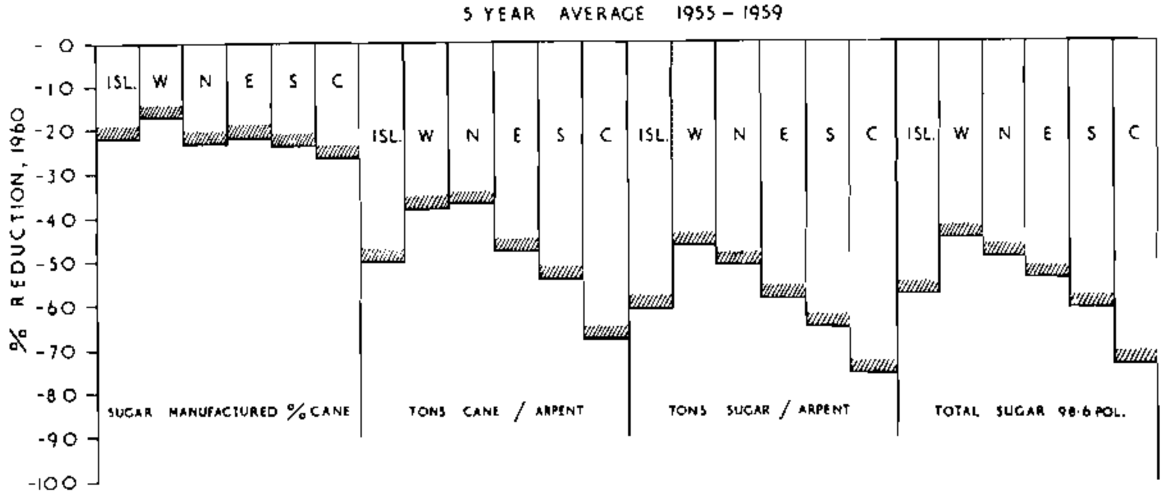

Fig. 7. Reduction of cane and sugar yields in 1960 in different sectors of the island compared to the period 1955 - 1959

It may not be out of place in concluding this chapter to quote the following extract* which relates to the 1892 cyclone, in the hope that the years ahead of us will provide a similar inspiring parallel:

«Terrible as the privations were, they marked the commencement of a new era in the history of Mauritius, an era of progress and industrial development such as the island had never seen before. The courage with which the community faced this awful disaster has often been referred to by those who have written its history, but no testimony, however just, can equal that which the steadily increasing yield of cane and sugar supplies. Mills have been rebuilt, their extraction increased, the cultivation of the cane improved and the total output has risen by 65%».

THE CANE VARIETY POSITION

Before commenting on statistics pertaining to the varietal composition of the 1960 crop and plantations, it is useful to study the data presented in fig. 8. Cane yields for six varieties cultivated on a large scale on estates have been averaged for 1959 and 1960 and individual deviations calculated. It will be seen that for a normal, or nearly normal year, both M.147/44 and Ebène 1/37 were above average; B.37172 and M. 31/45 showed little deviations while M.134/32 and B.3337 were below. These facts are in agreement with current observations, bearing in mind such considerations as:

(a) M.134/32 being on its decline, a larger proportion of older ratoons was harvested,

(b) M.31/45 suffered severe attacks of stalk borer,

(c) B.3337 is confined mainly to inferior lands.

The performance of varieties in 1960 differed widely from that of the preceding year and provided an excellent yardstick for assessing their tolerance to cyclones. In this respect M.147/44 and B.37172 are outstanding having produced respectively 10.6 and 6.3 tons of cane per arpent in excess of the average of 16.25 for the six varieties considered. At the other end of the scale M.31/45, B.3337 and Ebène 1/37 occur in increasing order of susceptibility. The tolerance of M.134/32 is indicated by the fact that its yield coincided approximately with the average.

* *Walter, A. The Sugar Industry of Mauritius, London 1910, p. 39.*

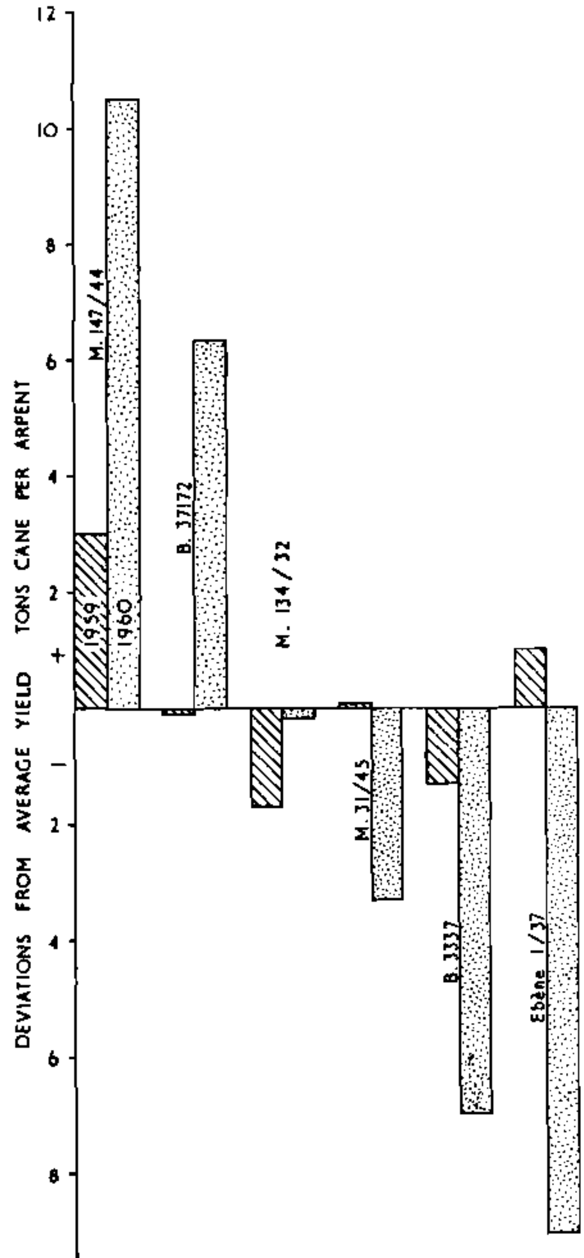

Fig. 8. Yield deviations from the mean of six commercial varieties in 1959 (normal year) and 1960 (cyclone year).

It should be noted, however, that the distribution of these varieties in different climatic sectors tends to exaggerate their respective reactions to cyclones. Thus M.147/44 and B.37172 occur mostly in sub humid and humid areas where conditions for recovery are better than in the super humid zone in which Ebène 1/37 and B.3337 are dominant. Another illustration of varietal reaction to cyclones is provided by the relative contributions of Ebène 1/37 and M.147/44 to the total crop on estates. The former produced 18% out of 28% of the area reaped, while the latter's production was 24% derived from 20% of the area harvested. The composition of the crop in different sectors is shown in fig. 9

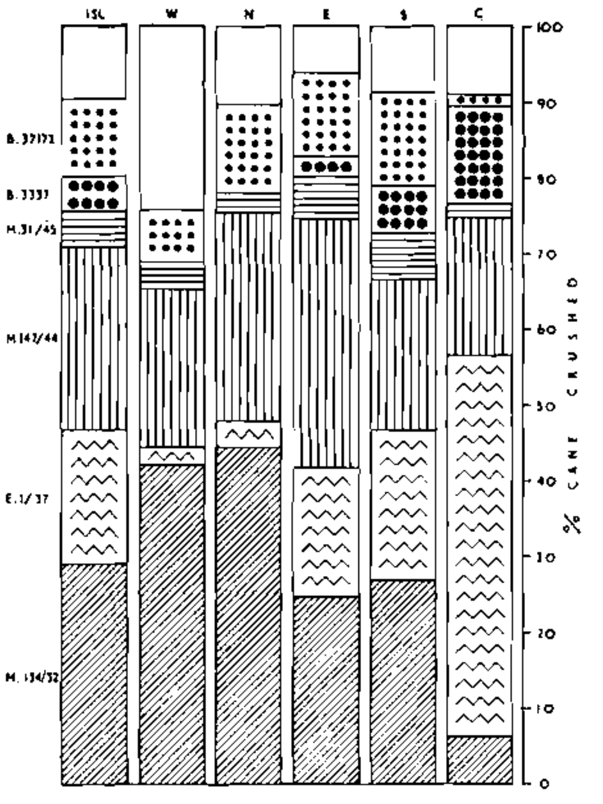

Fig. 9. Varietal composition of 1960 crop in different sectors (Estate grown canes).

and is summarized below for the island as a whole. Data for the more important varieties are given with the corresponding figures for 1959 in brackets:

M.134/32	29%	(34)
M.147/44	24%	(13)
Ebène 1/37	18%	(28)
B.37172	10%	(7)

The total area planted in 1960 exceeded that of 1959 by approximately 900 arpents. Observations made by planters after the occurrence

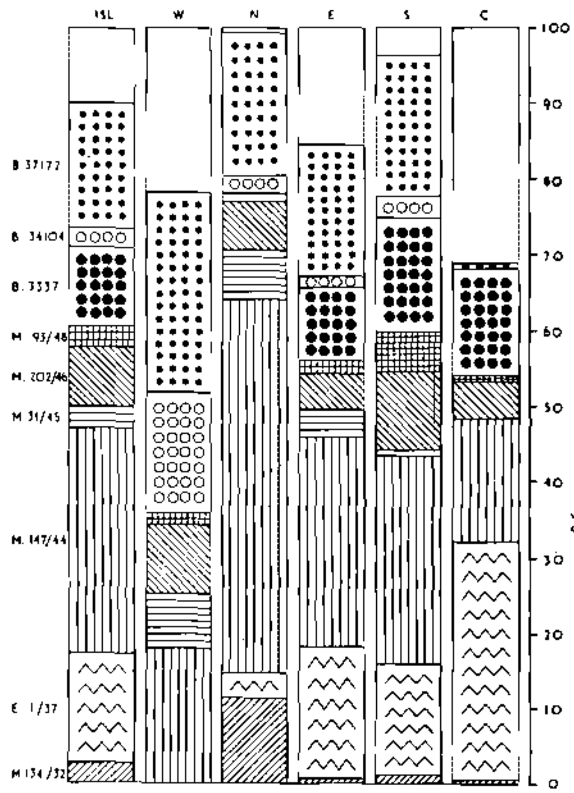

Fig. 10. Varietal composition of plantations made in 1960 on estates.

of the cyclones have undoubtedly influenced to some extent the planting programme for 1960 which is shown in fig. 10. Thus the proportion of Ebène 1/37 was significantly reduced while there has been a revival of M.134/32 chiefly in the North; these trends are at variance with the views of the Research Institute.

The new varieties M.202/46 and M.93/48 were planted over approximately 1500 arpents fairly evenly distributed over the island except on the central plateau. Two other varieties, M.253/48 and Ebène 50/47, which have not yet been officially released, were planted over several hundred acres in certain sectors.

Until further data are available to pronounce judgment on more recent varieties, the standard canes of Mauritius are still M.147/44 for sub humid and humid areas, B.37172 for the humid zone, and Ebene 1/37 in super humid regions. In this connection it is interesting to note that varietal changes during the last few years have resulted in an increase of net recoverable commercial sugar per arpent by the following amounts:

(a) **Super humid zone:**

From M.134/42 to Ebène 1/37 + 660 kg

(b) **Humid and sub humid zones:**

From M.134/32 to B.37172 + 420 kg

From B.37172 to M.147/44 + 180 kg

In computing these data, derived from final variety trials, due allowance was made for transport and processing costs by deducting the factor 4* from the amount of recoverable sugar contained in the cane.

Attention is drawn once more to the fact that M.147/44 should be harvested during the first half of the crop in order to obtain the best economical results. The maturation curve of M.147/44 in 1959-1960 is shown in fig. 11, in comparison with B.37172.

Accessory varieties are B.34104 which is well adapted to irrigated lands and restricted areas of the humid zone, B.3337 on poor cropping lands. Because of its susceptibility to the stalk borer, M.31/45 should not be cultivated on a

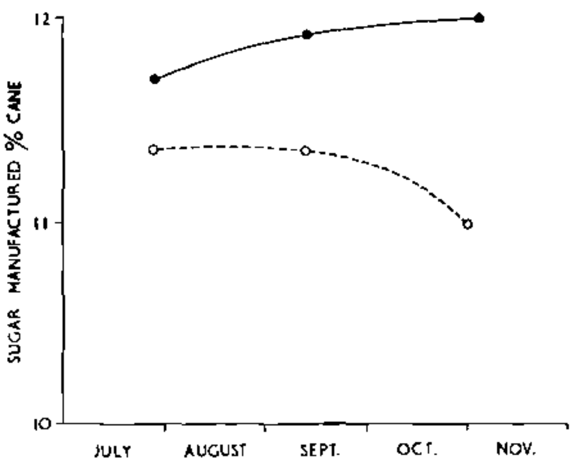

Fig. 11. Maturation curves of M. 147/44 (broken line) and B. 37172 (plain line).

* *Hugot, E., Rev. Agr. & Suc. Maur.*, 39, *212-216, 1958.*

large scale. The varieties M.202/46 and M.93/48 released in 1959 have performed satisfactorily and on the whole they have recovered well from wind damage. Further observations are needed, however, in order to give more precise information on the climatic zones which suit them best. It will be recalled that M.202/46 is a heavy arrower, while M.93/48 is slow to germinate but grows rapidly once it is established. Excellent yields were obtained from M.253/48 but additional data are required on its juice quality before its release may be finally considered. This variety showed abundant symptoms of chlorotic streak during the year.

Ebène 50/47, bred at Highlands S.E., was included in 10 final variety trials laid down during the year with cuttings free from ratoon stunting disease. Data from these experiments, supplemented by observations on estates, will form the basis of recommendations to the Cane Release Committee in due course. As stated in a previous report, the main purpose of these final variety trials is to elucidate the interaction between variety, fertilizer and environment. They are distributed as follows: sub humid 2, irrigated 2, humid 3, super humid 3. The standard varieties are Ebène 1/37 and M.147/44 while those under study are M.202/46, M.93/48, M.253/48 and Ebène 50/47. Individual plot size of the latin square is 3000 sq. ft. (12 lines of 50 feet at 5 ft. interrow), each plot being divided in 3 sub-plots for fertilizer studies.

Further information on cane varieties is given in the following chapter as well as in other sections of this Report.

CANE BREEDING AND SELECTION

The policy of the Sugar Industry Research Institute in the matter of variety improvement is to widen the range of parent varieties, increase the number of crosses made annually, and test a larger number of seedlings under the two main environments prevailing in sugar cane lands. This applies in so far as routine cane breeding and selection are concerned. In addition to the above, fundamental investigations are in progress with the ultimate object of improving the progeny through a better understanding of the laws governing inheritance of desirable characters in sugar cane.

It is gratifying to record that, in spite of extremely difficult conditions in 1960, the crossing work was carried out as planned and showed a decided improvement on previous years as indicated by the following figures:

	1960	**1959**
No. of crosses made	780	366
,, parents used	96*	50
,, seedlings produced	175,000	40,800
,, ,, planted	98,000	36,000

Some major changes were introduced, after a thorough study of all the factors concerned, in the bieeding and selection programme during the year. The more important of these are:

(a) The majority of crosses are now made in a greenhouse under controlled conditions of temperature.

(b) Most of the seedlings are planted in bunch.

(c) Seedlings are planted only under optimal environmental conditions until the first selection. Thereafter each selected seedling is propagated under two environments: humid and superhumid.

(d) Selection procedure then follows the normal course, but two sets of data are available before variety trials are established on estates.

In order to achieve this programme it was necessary to secure more land. With the kind co-operation of two estates, FUEL and Britannia, arrangements have been finalised whereby part of the selection work will be carried out at sub-stations situated on these estates. In addition to normal plantations at Réduit and Pamplemousses stations, about 18000 seedlings were planted at

* *The figure includes 65 varieties bred in Mauritius and 31 foreign varieties.*

each of the two sub-stations in December. The table below indicates the number of seedlings and varieties at various stages of selection, while the main phases of selection are shown in fig. 19.

(i)	Seedlings raised in 1960 for selection in 1962	...	98,000
(ii)	Seedlings raised in 1959 for selection in 1961	...	36,400
(iii)	Seedlings raised in 1959 now in bunch selection plots	...	678
(iv)	1960 selections:		
	(a) from 1958 seedlings	...	332
	(b) „ bunch selection plots 1957	...	10
	(c) „ propagation plots 1957 series		118
	(d) „ propagation plots 1956 series	...	53
	(e) „ first selection trials		
	M/57	...	2
	M/55	...	7
	M/54	...	26
(v)	Varieties in replicated trials on estates*	...	103

In view of abnormal conditions prevailing in 1960, it is deemed unwise to comment on the merits and defects of varieties undergoing trial before any of them may be considered for release for commercial cultivation.

CANE QUARANTINE

As a result of cyclone damage to the quarantine greenhouse, 9 varieties imported in 1958 have had to be destroyed but repairs to the house were carried out promptly by the Institute. Through the kind co-operation of the U.S.D.A., H.S.P.A., Queensland Bureau of Sugar Experiment Stations, B.W.I. Central Breeding Station, Cane Breeding Institute, Coimbatore and South African S.A. Experiment Station, 51 varieties were imported. Forty-eight of these are now well established. They are: B.39246, B.41211, B.45151, B.47225, B.47258, B.49119, B.52298, B.5650; 28 NG 101, 51 NG 2, 51 NG 63, 51 NG 140, 51 NG 11, 51 NG 56, 57 NG 208; Saccharine (N.10), Salvo (N.50-211), Salute (N.52-219), N.55-176, N.Co.382; P.R.980,Kassoer, Mol.5801, Mol.5904, S. spontaneum Krakatau, S.spontaneum Mandalay; M.1900, Luna, Q.67, Q.68, Q. 70, G.362; H.39-7028, H.44-3098, H.49-5, H.50-7209, CB.41-35, CB.45-6; Cp.47-193, Cp.48-103, Cp.53-18; Co.331, Co.1177, Co.1186, Co.1190, Co.1202, Co.1208, Co.1230.

Cuttings of several varieties were exported to Australia, India and Madagascar.

Problems relating to the importation of cane varieties were discussed in detail with the Director of Agriculture who is the authority under the law in all matters pertaining to cane quarantine.

It was agreed that the cane quarantine greenhouse will henceforth be administered, managed and maintained by the Mauritius Sugar Industry Research Institute, the officer in charge being the Plant Pathologist of the Institute. It was also decided that a standing advisory committee should be constituted to study all matters relating to plant importation and the quarantining of imports. The membership of this Committee consists of the Deputy Director of Agriculture, Chairman, the Pathologist and the Entomologist of the Department of Agriculture, the Plant Breeder, Pathologist and Entomologist of the Institute. Two meetings were held during the year and rules for the management of the cane quarantine greenhouse were prepared and adopted.

* *The figure includes 87 M varieties, 5 Ebène varieties and 11 foreign varieties.*

NUTRITION AND SOILS

A review of fertilizer practices in Mauritius is discussed elsewhere in this report and details of fertilizer importations are also given for the first time in the Appendix (cf. Table XIX). It should be noted that the value of these materials is approximately Rs. 20,000,000 and that the sugar industry consumes almost the total amount of fertilizers imported, as indicated in the figures below.

	N	P_2O_5	K_2O
Total imports of nutrients 1956-1960 (tons) ...	7,000	2,500	5,500
Maximum quantities used for tobacco, tea, food crops etc. (tons) ...	250	200	200
Approximate % of imported nutrient used by sugar industry ...	96%	92%	96%

It is often said that the future lies in the past, and nowhere possibly is this more true than in soil fertility, past treatment of the soil being reflected in current and future fertilizer practices. Looking back upon the use of fertizers in Mauritius as depicted by the amounts of NPK applied per arpent (see fig. 27), we have two such eloquent examples. At the turn of the century the trend was more Nitrogen, more Potash and less Phosphate. Neglecting Nitrogen, which has always been accepted by all classes of planters as essential, applications of potash increased steadily while the amounts of P_2O_5 used fell as low as 5 kgs per arpent in 1920 and were of the order of 8 kgs during the period 1950-1956. It is not surprising therefore, that when this Institute was founded in 1954 phosphate nutrition was a serious problem while potash was being used in excess on many fields.

Nitrogen. It is now widely accepted that surface applied urea may lose considerable quantities of nitrogen due to ammonia volatilization. Field experiments carried out by the Institute have shown that in practice nitrogen losses may vary from 50% down to negligible quantities, the extent of loss being governed by climatic conditions before and after applying the urea. Laboratory experiments have shown that losses are at a maximum when the urea is applied immediately after heavy rains and with light showers during the week following application. It is probable, therefore, that in the months of September, October and November, the period during which most of the nitrogenous fertilization of sugar cane is made in Mauritius, climatic conditions may be such that heavy losses of nitrogen could occur. The best performance of urea seems to be when fairly heavy rains follow application of the fertilizer and drying conditions are minimal.

As urea will become more and more competitive with sulphate of ammonia as regards price, it is essential that the best methods of using the fertilizer should be studied. With this aim in view field experiments have been laid down in which the urea has been applied as solution or buried in «pockets», two methods of application which should cut down volatilization losses. Results of these experiments are awaited with interest and, should placement of urea prove encouraging, then, on a price efficiency basis, urea may become of economic interest to the local sugar industry.

Phosphate. The widespread acceptance of the phosphate fertilizer programmes recommended by the Institute is reflected in the rapid rise of phosphate imports since 1954. These have increased from about 1,000 tons of P_2O_5 to almost 4,000 tons, the general phosphate picture being now much healthier than it was when the Institute was founded.

Soluble phosphates are now widely used as boosters at planting and in many areas, where the soil pH is around seven or higher, they are replacing guano entirely.

Soil analysis for pH and available phosphate have been carried out on more than 200 samples this year and the results have shown that such analyses are helpful in guiding correct choice and dressing of phosphate fertilizer.

Potash. With the low price of molasses this year heavy dressings of this material before planting have been the rule. Owing to the cheapness of potash salts and molasses, and to the accuracy of control of the potash status of the crop by foliar diagnosis, the potash picture for estates and large planters is generally excellent but conditions on small planters' lands is far from satisfactory.

It is difficult to ascertain accurately how much extra cane would be obtained if all the cane lands of Mauritius were fertilized correctly, but there can be no doubt that it would be a very large amount indeed, considering that yields can be doubled on many deficient fields merely by addition of potash and phosphate.

Organic Matter. Four permanent trials were laid down in 1954 (cf. Ann. Rep. M.S.I.R.I., 1954 p. 13) to compare the effect of mineral fertilizers and factory residues on cane yield, soil structure and microflora. Results obtained on yields in virgins and four succeeding ratoons were analysed in 1960. They showed that molasses and scums have caused a small but significant increase of commercial sugar per arpent in virgins. There is, however, no residual effect in ratoons. This beneficial effect is beyond that attributed to the major nutrients, and confirm previous findings. A screening of pathogenic fungi has started in the different plots of this series of trials and population level studied in relation to the various treatments. The experiments were replanted in 1960 according to the original plan.

Soil Survey. Progress in field mapping has been slow this year owing mainly to the absence of the Senior Assistant Chemist from the Colony between April and October.

Field work is, however, now going ahead quickly and a preliminary map covering the whole island on a 1" scale will be ready early next year and publication of the first stage of the survey will then be possible.

Detailed surveys of certain estates, which have accepted to send their chemists to work with our soil survey staff, are progressing well and maps of these estates will be completed at the end of 1961.

The analytical side which proceeded slowly in the first years of the survey has now improved considerably, a fact which is reflected in the number of soil samples collected.

Year	*No. of Soil Samples*
1957	37
1958	99
1959	74
1960	414

Analyses currently being made on all samples are pH in water, pH in N.KCl, organic matter, total exchangeable bases, exchangeable calcium, magnesium, potassium and available phosphate. In addition, determination of silica, iron, aluminium and titanium are made on the samples from profile pits.

Twelve samples covering the range of soils occurring in Mauritius have been sent to Rothamsted for mineralogical analysis of the clays by X-ray and differential thermal analysis methods. These results when available will be most useful in classification work.

Mention should also be made here of investigations started in 1960 on root growth of the varieties M.147/44 and Ebène 1/37 in relation to soil types. Observations are made on root development at different horizons and data collected on root volume and dry weight.

CANE DISEASES

Two major sugar cane diseases, gummosis and leaf scald, came again into the picture in 1960 and, were it not for the policy of cultivating only varieties immune or highly resistant to gumming disease, a major epidemic might have prevailed during the year. Several susceptible varieties, cultivated formerly, were severely infected in the variety collections, with a large number of dead stalks, even in the sub humid area where gummosis is seldom encountered. *Thysanolaena maxima*, an alternate host, was heavily infected with gummosis which was also responsible for several cases of top rot in palms.

A few varieties showed acute symptoms of leaf scald, including the commercial variety M.112/34, the seedling M.216/55 in a first selection trial, a promising variety M.81/52, and the breeding cane H.37 - 1933.

As was to be expected the incidence of red rot was much higher in 1960, chiefly on M.134/32 and M.112/34.

Results obtained in the ratoon stunting disease trials this year were such that no significance could be attributed to differences in experimental results due to the large reductions in yield brought about by the cyclones. Two trials were so badly damaged that they had to be replanted.

With a view to elucidating factors involved in the transmission of chlorotic streak, a carefully planned experiment was started towards the end of the year at Belle Rive Experiment Station and will be reported in detail in due course.

It has been observed that plants derived from cuttings infected with chlorotic streak, growing in a locality where the disease does not prevail, will lose disease symptoms after a time and that the causal agent will disappear from the stalks. Experimentation has now revealed that the plant may remain infected even in the absence of symptoms.

Several cases of Pokkah-boeng were again reported this year during the period of active growth and cases of top rot were observed on Ebène 1/37.

Studies on Bacterial Cane Pathogens. In view of the severe epidemic of gumming disease prevailing in Réunion Island and the susceptibility there of the important commercial variety M.147/44, resistant in Mauritius, a study was started in 1959, with the co-operation of the Commonwealth Mycological Institute, on the possible occurrence of two different strains of the pathogen in Mauritius and Réunion.

A standing sub-committee of the «Comité de Collaboration Agricole Maurice-Réunion-Madagascar» having been appointed to study diseases of the sugar cane, it was agreed to extend the studies on gumming disease to the three territories and obtain the co-operation of Natal, where gummosis has been reported on N.Co.310.

Resistance trials have been established in Réunion, Madagascar, Natal and Mauritius, with a range of varieties common to the four sugar countries in order to study their reactions and the expression of disease symptoms under a wide range of environmental conditions.

The Commonwealth Mycological Institute is co-operating in screening the various isolates obtained in the different sugar areas. In that connection, it is a pleasure to record our thanks to the Director of the C.M.I. for agreeing that Dr. A. C. Hayward should visit Mauritius, Madagascar and Réunion. This visit took place in October and November and, in company with the pathologists concerned, Dr. Hayward toured the cane areas of the three territories. He later visited the sugar belt of Natal. More than sixty bacterial cultures isolated during this tour are now being studied by him.

Preliminary results obtained so far at the C.M.I. indicate that the Madagascar and Natal strains are alike, and differ from the Réunion and Mauritius ones. The latter two are indistinguishable culturally and physiologically and can be separated only by inoculation into suitable varieties of sugar cane.

As the taxonomy and nomenclature of some of the bacterial pathogens of the sugar cane are still rather obscure, isolates from sugar cane plants affected with leaf scald, red stripe and mottled stripe were also obtained for comparative studies.

FIJI DISEASE IN MADAGASCAR

A preliminary assessment of varietal reaction was made, in virgins, in the Fiji disease resistance trial, established at Brickaville in July, 1959 in co-operation with the "Institut de la Recherche Agronomique de Madagascar"*.

Twenty-one varieties are included in the trial, the controls being the susceptible M.134/32, the tolerant N:Co.310 and the resistant Pindar. The trial was laid down in a highly contaminated field of M.134/32. The infection material is

* *cf. Ann. Rep. M.S.I.R.I., 1959, P. 59.*

provided by rows of cane which were left standing and so far, the distribution of the disease in the trial has been very homogeneous.

Twenty-three stools have contracted infection, in virgins, in the plots of varieties under test. These include: M.134/32, N:Co.310, M.147/44, B.34104 and Q.42. The trial has been ratooned and a proportion of the material obtained was planted to observe disease symptoms, thus supplementing the assessment to be made in ratoons later. In addition a second resistance trial was planted in July, 1960.

The eradication campaign against the disease on the East Coast of Madagascar is progressing satisfactorily. It is significant to note that surveys carried out over two months in the commercial canes of the district of Tamatave, have failed to reveal a single case of Fiji disease.

The three varieties, recently released for commercial planting, M.202/46, M.93/48 and M.253/48, and two promising varieties, M.423/51 and Ebène 50/47, are now undergoing quarantine in Madagascar and will be included in a resistance trial in 1961.

HEAT TREATMENT OF CUTTINGS

The hot water treatment campaign against ratoon stunting disease was started in June, 1958 and by the end of 1959, 3,515 tons of cuttings had been treated at the central hot water treatment plant and 800 acres of nurseries established. The treatment target for 1960 was 2,700 tons of cuttings. As a consequence of the cyclones, however, planting material was of poor quality and in very short supply. It was therefore decided to close down temporarily the central plant at Belle Rive and to carry out treatments on a limited scale in the small tank of the Institute at Réduit. As a result, only 125 tons of cuttings were treated during the year. It was however recommended to planters, as an exceptional measure, to establish a second set of nurseries with material obtained from the original nurseries, while ensuring that cane knives were properly disinfected during the preparation of setts.

Studies were continued on the germination of heat treated setts with particular emphasis on the addition of an antioxidant to the hot water bath. Experiments were carried out on four commercial varieties. Stalks were selected from stools 10 to 12 months old and, after elimination of the immature upper portion, top, middle and bottom cuttings were prepared. The addition of urea, at 0.25% concentration to the hot water, consistently improved the germination of the treated setts. Top cuttings, corresponding to the second cutting normally taken for commercial plantations, withstood the heat treatment best. The germination capacity decreased from top to bottom of the stalk. It has therefore been recommended to add urea as routine practice to the hot water bath.

CANE PESTS

Contrary to cane diseases, the cyclones of January and February, did not cause any temporary disturbance of insect populations as might have been expected.

Moth borers were again the most prominent cane pest during the year. There are actually five species of moths in Mauritius whose larvae tunnel in sugar cane, and growers often confuse them. The vernacular names of these borers are descriptive of the larvae, the only stage of the life cycles which is injurious and the only stage which is commonly seen. In order of importance the species are:

(a) the spotted, or stalk borer (*Proceras sacchariphagus*),
(b) the pink borer (*Sesamia calamistis*),
(c) the white borer (*Argyroploce schistaceana*),
(d) the brown borer (*Opogona subcervinella*),
(e) *Crambus malacellus*, which seldom attacks cane and has no common name.

The stalk borer is by far the most injurious of the borers on account of its habit of tunnelling the stems of cane at all stages of growth. The pink and white borers attack chiefly the very young shoots of virgin and ratoon cane and cause dead hearts; they are unimportant at later stages of stalk development. The brown borer may destroy the eyes of cane stalks but it is usually secondary and found, often in large numbers, in stems which have been attacked by the other borers. It is often confused with the stalk borer.

One of the results of stalk borer attack is a weakening of the cane stems where borer galleries occur, thus rendering them more vulnerable to wind action. The borer may be considered to have contributed substantially to the loss which resulted from the 1960 cyclones.

The pink and white borers were injurious in new plantations in some upland areas towards the end of the year. The former was chiefly to blame for the repeated recruiting necessary in infected fields. Attacks of lesser intensity occurred in other regions. It may be remarked that the pink borer tends to be most numerous in the higher altitudes because of the abundance, in these regions, of wild grasses upon which it lives to a large extent. The white borer apparently lives only upon cane and is uniformly distributed in the island.

A few outbreaks of the army worm (*Leucania loreyi*) occurred again in 1960, always in recently burnt fields as described in the Annual Report for 1959.

Research. The research programme in entomology was revised and emphasis is now being given to work upon cane moth borers, in particular to investigations upon the stalk borer. Other research work, such as that on nematodes which attack cane roots, will be inevitably curtailed.

Experimental introduction of moth borer parasites from India was continued with the aid of the Commonwealth Institute of Biological Control and several species were received, bred, and released in borer infected fields. Tentative arrangements were also made for an extension of the work to include introduction of *Proceras* parasites from Java where *P.sacchariphagus* originated.

It is of interest to note that the stalk borer parasite *Agathis stigmatera* (Cress.) which had been introduced between 1949 and 1953 from Trinidad was recovered for the first time from a parasitized larva collected at Mon Trésor Estate in December.

Data upon the incidence of stalk borer damage in variety trials, which had been accumulated in recent years, was studied to determine if counts of bored stalks and bored joints made at harvest can provide an indication of the resistance of new varieties to the pest. Empirical counts of bored stalks and bored joints leave much to be desired as a means of damage assessment, but they are the only definite criteria which can be obtained in a routine manner when harvesting trials. Small intermingled plots of different varieties also do not duplicate the conditions offered to the insect in commercial plantations. The available data indicate nevertheless that such counts are of value and should be taken into consideration when assessing the qualities of a new and promising cane variety.

Recent work on soil nematodes is embodied in two publications. Many of the phytophagous nematode species found associated with cane roots have now been identified, but their importance to cane growth remains to be carefully investigated. The faunistic work so far accomplished represents a sound basis for further work on the subject. Of particular interest is the discovery in Mauritius of a protozoan parasite of root-knot nematodes (*Meloidogyne spp.*) which had hitherto been unknown.

Experiments with soil insecticides against *Clemora smithi* have been discontinued. When started some years ago the use of aldrin or chlordane seemed to offer a simple and cheap method of preventing white grub infestation. Reports from other sugar countries also indicated that growth improvements might result from their effect upon other soil insects; the results of local investigations have been disappointing, however, and the prospect of an effective, cheap and safe treatment has not been realised.

WEED CONTROL

Substituted ureas and triazine compounds. Experimental work with the substituted ureas and triazine compounds for the control of weeds in virgin and ratoon canes of the superhumid localities were continued this year. D.C.M.U., C.M.U., Simazine and Atrazine used alone and in combination with sodium chlorate or dalapon were compared, in pre-emergence application, to a standard formulation consisting of an M.C.P.A. or 2,4-D derivative, sodium chlorate and T.C.A. Results obtained showed that at equivalent rates of application, the commercial product D.C.M.U. was the more effective herbicide. It showed longer persistence in the soil and its effectiveness extended over a wider weed spectrum. The combination D.C.M.U. and sodium chlorate was the best treatment in plant canes. In ratoon canes the formulation consisting of D.C.M.U. and sodium chlorate or dalapon gave the best results. It must be pointed out however, that in the dalapon treatments cane growth was affected, as exemplified by malformations in young developing shoots. D.C.M.U. also gave excellent control of several noxious annual weeds occurring in these areas, the more important being «meinki» (*Digitaria timorensis*), «millet sauvage» (*Setaria pallide-fusca*), «herbe bambou» or «herbe bassine» (*Setaria barbata*) and «gros mota» (*Kyllinga polyphylla*). Simazine, C.M.U. and Atrazine were found effective during the first two to three months following the treatment after which weed invasion began, whereas with D.C.M.U. weed growth was checked for a longer period ranging from 4 to 6 months.

Outstanding results were obtained with a new technique for chemical weeding in ratoon canes using substituted ureas. Spraying of the trash-free interline was carried out immediately after harvest, followed a week later by the transfer of trash to the sprayed interline and herbicidal application on the interline originally covered with trash.

Further studies on Cynodon dactylon. Investigations on the four clones of *Cynodon dactylon* existing in the island were continued this year. Water culture experiments showed that they differ in their tolerances to dalapon and T.C.A. and that in general the tetraploids were more resistant to these chemicals than the triploids as measured by morphogenic effects and dry weight. Of the two tetraploids, the «Constance» biotype was found to be the more resistant, and of the two triploids the «Bel Ombre» biotype proved the more susceptible. It was also established that the «Réduit» strain, although more resistant than the triploid strains, showed higher sensitivity to scorching by those chemicals. Other studies showed that these herbicides may enter the plant either through the shoot or roots, thus bringing evidence that the mode of entry of T.C.A. in Cynodon is not, as is generally believed, through the roots only.

T.C.A. and Dalapon. The most effective way of controlling *Cynodon dactylon* in sugar cane plantations being to treat the grass with fairly high rates of T.C.A. or dalapon, experimental work was carried out in order to determine the tolerance of sugar cane to these herbicides. The treatments consisted in applications at rates varying from 10 to 200 lbs per arpent to the field at one and two months before planting and in plant canes at the time the canes close in. Cane yield was not affected by T.C.A. and dalapon at rates used in this experiment when the herbicides were applied before planting. On the other hand application of dalapon in plant canes caused malformation of shoots while T.C.A. caused no evident injury to cane growth. It must be observed, however, that at harvest no adverse effect on yield was recorded in all treatments with both herbicides.

New Herbicides. The Chesterford logarithmic sprayer was used this year to evaluate the herbicidal properties of the new herbicides C.M.P.P., Benzac, Fenac, Promethone Emid, Fisons 18/15, Atrazine, Weedazol and T.B.A. in pre-emergence application. Of these herbicides, only Benzac, Fenac and T.B.A. affected cane growth at the higher rates of application as assessed by shoot length measurements.

GROUND WATER

Work on the geophysical survey of the island was continued during the year under the supervision of Mr. R. Sentenac of the "Compagnie Générale de Géophysique". Electrical resistivity measurements were carried out over an approximate area of 250 square kilometres distributed as follows: Flacq 72 sq. kms; Black River and Plaines Wilhems 94 sq. kms; Grand Port 85 sq. kms. The areas surveyed are indicated in fig. 12. This map also shows regions which it would be desirable to study at a later date. As a result of the 1959 investigations, which covered the districts of Pamplemousses and Rivière du Rempart, it was possible to locate eight distinct volcanic systems in the Northern part of the island. These are shown in fig. 13 reproduced from a report of the C.G.G. to the Chamber of Agriculture.

In order to test the water bearing possibilities of these volcanic systems, a programme of core drilling and pumping tests was decided upon and the successful tenderer for this work was Messrs. George Stow (Irrigation) Co. Ltd., Sir Alexander Gibb and Partners Co. Ltd. acting as Consulting Engineers to the Institute. Core drilling began on 18th July instead of early May as expected, and a total of 2,526 feet of core samples were obtained from 10 sites, from which preliminary information was obtained on the nature of the different strata. These results were also correlated with the electrical resistivity survey carried out the previous year. The maximum depths at which samples were obtained was 312 feet. Core samples obtained from these sites were indexed and stored in standard boxes and form a valuable collection for future reference. The first boring rig arrived in Mauritius later than expected and work began in September. Unfortunately, the progress of this machine was unsatisfactory, and at the end of the year only two complete holes had been bored. A second boring rig arrived at a later date and has started operations.

As a result of core drilling and boring tests at three sites it was concluded that two of the volcanic systems studied offer little possibilities of economic water utilisation while the third is very promising.

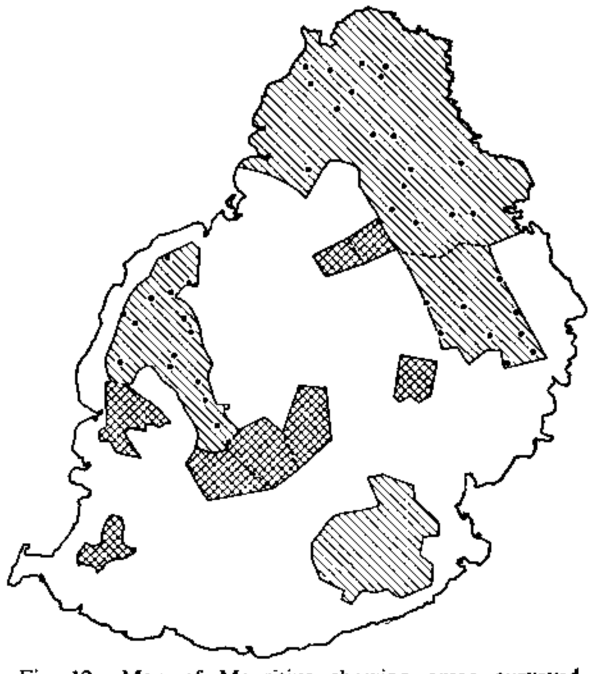

Fig. 12. Map of Mauritius showing areas surveyed for ground water (shaded) and those where it is desirable to continue the electrical resistivity survey (cross hatched). Dots indicate sites of proposed core drillings and borings.

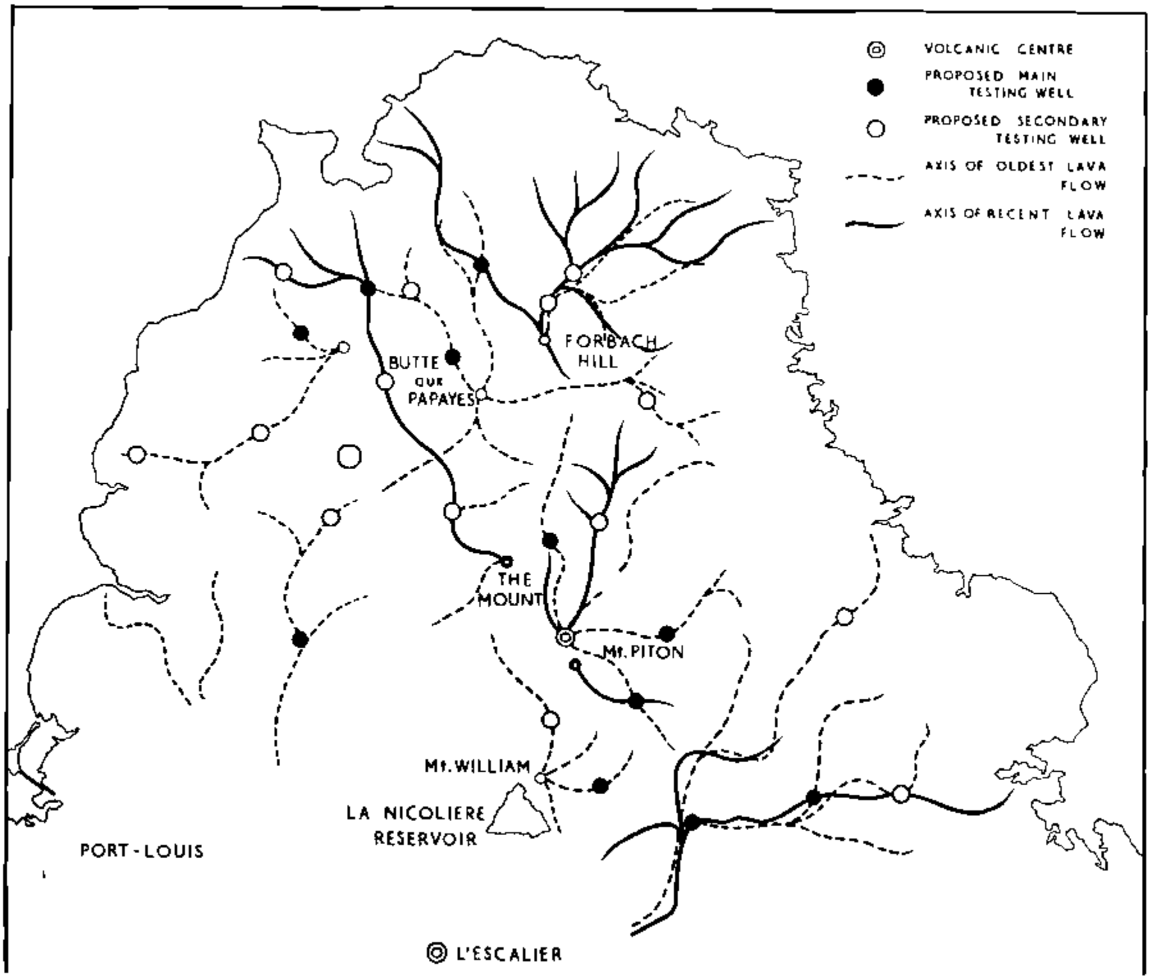

Fig. 13. Map of the north of Mauritius showing the different volcanic systems and sites at which borings and pumping tests are being carried out.

FIELD EXPERIMENTATION

As stated previously, the programme of field experimentation was severely handicapped during the year, both from the point of view of results obtained as well as difficulties in laying down new trials because of the scarcity and poor quality of planting material. For these reasons the irrigation experiments at Palmyre are not discussed, as is usual in this introduction. It should be mentioned also that sampling for foliar diagnosis of experiments in progress could not be carried out, as the cyclones occurred precisely during the period when leaves and stalks are collected for analysis.

Of the 160 established trials only 44 were weighed at harvest and several had to be abandoned. Excluding first selection trials, disease observation plots and weed control experiments, 69 new trials were planted during the year. Experiments standing for harvest in 1961 are as follows :

Variety trials (one date of harvest) ...	27
Pre-release variety trials (3 dates of harvest)	~~18~~ 9
Ratooning capacity	2
Final variety/fertilizer trials (3 dates of harvest)	18
Growing period of cane	2
Clean v/s selective cutting	6
Fertilization and amendments :	
(i) Form used and mode of application of nitrogen	12

(ii)	Application of phosphates in ratoons	8
(iii)	High and low fertilization (demonstration)	2
(iv)	Balanced and unbalanced fertilization	2
(v)	Basalt on highly leached soils ...	2
(vi)	Gypsum	2
(vii)	Bagasse amendment	3
(viii)	Organic matter	15

Ratoon stunting disease	12
Chlorotic streak	2
Control of Clemora by insecticides ...	1
Varietal resistance to stalk borer ...	3

In order to arrive at a more realistic assessment of recoverable sugar in experimental plots, various modifications were introduced during the year in the calculations from analytical data. These are reviewed elsewhere in this report.

SUGAR MANUFACTURE

Research. The main research projects studied during the year are briefly discussed below.

(a) **Protein Extraction from Cane Juice.** Preliminary analyses carried out during the intercrop showed that about 0.08% by weight of protein could be extracted from juice by bringing the juice to boiling and centrifuging the coagulated nitrogenous substances. It was also shown that the removal of these substances had no detrimental effect on juice clarification. It was decided to proceed with the investigations as it is believed that a cheap source of protein could be valuable in Mauritius where over-population and chronic protein deficiency are major problems. Consequently, pilot plant experiments were carried out at Médine sugar factory during the crop with a small discontinuous Westfalia separator, and the following average results were obtained:

Protein extracted % juice ...	0.06
Dry cake % juice	0.7
Protein % dry cake	14.22

Detailed analyses of the cake protein have been made by the Chemistry Division and, although feeding trials have not yet been carried out, it would appear that protein extracted from cane juice could advantageously be used in animal feed. However the industrial separation of protein from cane juice can only be obtained through the use of a continuous separator. It is hoped that such a separator will be available next year when further experiments will be carried out.

(b) **Cooling of A and B massecuites in crystallizers.** It is the usual practice in Mauritius to cool A and B massecuites in crystallizers before centrifugalling, whereas in many other sugar producing countries massecuites are centrifuged hot. Experiments carried out in five sugar factories to compare these two processes gave the following results:

Purity drop between massecuite and molasses is higher by 6.2 points on the average for A massecuites and 4.4 points for B massecuites when these massecuites are cooled in crystallizers. Similarly, the crystal content of A massecuite increases in crystallizers by 7.4 points and that of the B massecuite by 5.3 points on the average. An attempt was made to calculate the volumes of massecuite involved in the two processes. It was found that if the high grade strikes are not cooled, 16.9% more A massecuite and 13.5% more B massecuite would have to be boiled to achieve the same molasses exhaustion. For a 100 T.C.H. factory this would require 450 cu. ft. of additional pan capacity plus one 42" × 24" centrifugal and would bring about an increase in steam consumption of one ton per hour. On the other hand, if A and B massecuites are cooled, seven additional crystallizers of 1000 cu. ft. each would be required.

(c) **Magma Quality on Recycling of Final Molasses.** The general boiling practice of raw sugar manufacture in Mauritius is to use magma — C sugar mixed with syrup — as footing for the A and B strikes. In all factories except two, single curing of the C sugar is practised, when the average magma purity is about 80 degrees only. It would appear that factory chemists do not all realize how large is the recirculation of final molasses in a factory when the magma purity is low. The percentage of final molasses recycled with the C sugar has therefore been calculated for a given set of average conditions. With C sugar purities of 86, 82 and 79 the percentage increase in final molasses recycling in excess of that taking place with a C sugar purity of 90 is about 60, 140 and 245 per cent. respectively. An equation has been worked out from these data to determine the approximate amount of final molasses recycled at different C sugar purities.

(d) **Refractometer v/s Densimeter Brix for the Chemical Control of Sugar Factories.** All chemists agree that chemical control of sugar factories would be more accurate if refractometric brixes were used instead of densimetric brixes. This practice is currently followed in Hawaii, but the relatively high cost of precision refractometers has precluded this method from being used elsewhere.

Towards the end of the crop a Bausch and Lomb precision refractometer was used in two factories for one week each and parallel chemical controls worked out with refractometric and densimetric brixes. As a result of the interesting data obtained, it would appear that several factories will order precision refractometers for carrying out parallel controls next crop, and it is anticipated that with n a few years refractometric brixes will be used in all sugar factories of the island.

(e) **Calculation of 1st Mill Extraction.** The extraction of the first mill of a tandem can be readily calculated with the help of a simple formula, often referred to as Stuart's formula. Doubt on the accuracy of this formula having been voiced by certain workers who expressed the views that cush-cush return before the 2nd mill affects the results of the calculation, it was shown that such is not the case. A series of tests were made at Médine sugar factory during the crop, and the extraction of the first mill was calculated by the formula and by direct analysis of the cane before and after the first mill. Although comparative values for each run differ slightly, probably as a result of difficulties in sampling correctly the cane fed to, and the bagasse leaving the mill, exactly the same extraction has been obtained by the two methods for the average of the eight runs carried out.

(f) **Power Consumption of Cane Knives and Shredders.** Further data were obtained during the crop on the power consumption of cane knives and shredders (vide Ann. Rep. 1959 pp. 82-85). Measurements were taken at three factories, one, Factory F, newly equipped with a Gruendler shredder, the second, Factory G, in which both sets of knives are driven by the same motor and the third, Factory B, where the single set of knives is placed at the top end of the cane carrier and where the power consumption of knives and shredder had been measured in 1959. The results obtained show that:

(i) Power consumption of knives and of shredder per ton of fibre was about the same at Factory B in 1960 as in 1959.

(ii) At Factory G about 50% of the rated horsepower available is consumed on the average.

(iii) The power consumption of a shredder is affected to a small extent by the number of knives used. Thus at Factory F when the number of knives at the first and second sets were decreased from 32 and 32 to 12 and 8, respectively, the HP consumed per ton of fibre increased from 12.1 to 12.8 only.

(g) **Miscellaneous.** 21 samples of raw sugar were analysed for starch and silica, and their Nicholson filterability determined. Following the breakdown of the constant temperature room, the filterability study could not be completed but will be terminated this intercrop. Detailed and time-consuming complete analyses of bagasse and molasses samples were carried out for the By-Products Committee. Due to unforeseen circumstances the Committee's report could not be issued in 1960, but will be released in 1961. Preliminary viscosity studies carried out during the intercrop with the help of Mr. P. Menagé, Chemist of Union S.E., indicate that the viscosity of molasses is reduced by about 50 per cent. on removal of insoluble solids from the sample. This study will be resumed in 1961.

Advisory Work. The advice of the Institute was sought on a number of occasions both by individual factories and by corporate bodies. Studies carried out and recommendations made covered a wide field. Special mention should be made of the compilation of factory data for the Economic Commission; improvement in the quality of raw sugars including a system of penalisation based on Dilution Indicator; the possible use of local sugar for the manufacture of high boiled sweets; the manufacture of «Hi-Test Molasses» and dehydrated cane juice. Apart from advice on chemical control, specific questions were studied for several factories including the choice of new mills, milling work, filtration, clarification and boiling problems.

Routine. The Sugar Technology routine work included the compilation of weekly chemical control figures, the analysis of 868 cane samples from the experimental plots of the Institute (as against some 3000 samples in a normal year), the standardization of hydrometers, the setting of thermo-regulators and the dilution and distribution of hydrochloric acid to laboratories. In addition, a lot of time, especially that of the Associate Sugar Technologist, was devoted to the organisation of the local sugar congress and the editing of the proceedings. The Associate Sugar Technologist also edited the Colour Scheme Report of the "Société de Technologie Agricole et Sucrière".

LIBRARY

In September, 1960 the library was transferred to the Bonâme Hall, which is a pleasant room providing seated accommodation for 25 readers. The library is open to all those interested in the sugar industry and it is hoped that the staff of sugar estates, sugar planters and manufacturers will derive full benefit from its stock. The library subscribes to 137 current periodicals and receives 107 serials in exchange for publications of the Institute; 63 periodicals cover sugar cane agriculture, sugar manufacture and sugar economics. Other journals received are: journals of general scientific interest, 29; Agriculture, 57; Soil Science, 15; Chemistry, 14; Botany, 21; Entomology, 17; Genetics & Plant Breeding, 14; Pathology, 14.

There is now a total of 5185 volumes on the shelves, of which 2726 are bound volumes of periodicals. During the year there were 900 new accessions. The library has also received a number of valuable gifts particularly from Messrs. Louis Baissac, Henry Adam, and the Mauritius Chamber of Agriculture.

In 1961 a complete card catalogue of the library stock will be completed and placed at the disposal of enquirers and readers. A microfilm reader is available and bibliographies of important subjects are also being compiled in order to facilitate research work.

THE MAURITIUS HERBARIUM

The arrangements necessary for the foundation and organisation of the new Herbarium (to be known in future as The Mauritius Herbarium) were completed towards the end of the year and the Herbarium is now open to the public; prior to the opening, the honorary Curator, Dr. R. E. Vaughan gave a talk on the scope and function of the collections. Visitors wishing to consult the Herbarium or its library should apply to Mr. E. Rochecouste, Botanist in Charge.

During the year the herbarium library was enriched by a valuable collection of books and original papers on the vegetation of the Mascarene Islands, presented by Dr. Vaughan. Other additions to the library include photo-copies of some of Philibert Commerson's botanical manuscripts in the Archives of the "Museum National d'Histoire Naturelle", Paris. It is hoped in the near future to complete the photo-copying of these documents which are indispensable for the study of Mascarene botany.

Among overseas visitors who made use of the Herbarium may be mentioned Dr. Mary A. Pocock, a marine algaelogist of international repute, who made extensive collections of marine algae from various sites. Mr. Johnathan Sauer, Department of Botany, University of Wisconsin, made a return visit to Mauritius to continue his studies on beach vegetation with particular reference to the effect of Cyclones «Alix» and «Carol».

An increasing number of queries concerning Mascarene plants and requests for material were received from overseas indicating a growing inteterest in this region. Specimens sent on loan or duplicates donated included *Loranthaceae* (Melle S. Balle, University of Bruxelles) *Cuscuta* (Prof. F. G. Yuncker, Indiana, U.S.A.) *Dombeya* (M. J. Arenes, Museum National d'Histoire Naturelle, Paris) and *Desmoduim* (Jardin Botanique de l'Etat, Bruxelles). In addition other material was sent to specialists for determination. We are glad to be able to record here the valuable assistance received from botanists who have undertaken this work.

Although the re-organisation of the collections and the combination of the different herbaria has been the main task during the year, the routine activities of the Herbarium have been expanding. Some two hundred specimens have been laid in, many queries answered, and specimens submitted for examination determined.

Weed Flora — Publication of the Weed Flora of Mauritius was continued and Leaflet No. 4 on *Argemone mexicana* appeared in June.

Other books or original papers of interest on Mascarene vegetation which were published during the year were:

Rivals, P. (1960). Les Espèces Fruitières Introduites de l'Ile de la Réunion. Notes Historiques & Biologiques. Toulouse.

Straka, H. (1960). Uber Moore und Torf auf Madagascar und den Maskarenen. *Erdkunde, Arch. Wiss. Geogr.* **14:** 81-98.

Arenes, J. (1959). Les Dombeya des Iles Mascareignes. *Mem. Inst. Sci. Madagascar.* Sér. B. **9:** 189-216.

PUBLICATIONS, REPORTS AND CIRCULARS

Annual Report for 1959. An abridged French version was also issued.

Occasional Paper No. 4. Williams, J. R. 1960. Studies on the nematode soil fauna of sugar cane fields in Mauritius. 4— Tylenchoidea (partim.)

Leaflet. No. 4. Rochecouste E. & Vaughan, R.E. Weeds of Mauritius, No. 6 *Argemone mexicana* Linn. pp. 3, fig. 1. June, 1960.

Technical Circular No. 13. Halais, P. Registre du développement et diagnostic foliaire des repousses de canne à sucre. Janvier 1960.

No. 14. Parish, D. H., & Feillafé, S. M. Considération sur la nutrition azotée et sur l'utilisation de l'urée dans la culture de la canne. Mars, 1960.

No. 15. Saint-Antoine, J. D. de R. de & Le Guen F. Cane analysis, May 1960.

No. 16. Parish, D. H., Sugar cane fertilization: a summary of present practical knowledge. (A French version was also issued).

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

Antoine, R. The thermotherapy of sugar cane plants infected with chlorotic streak disease. **39:** 321-327.

Froberville, R. de & Saint-Antoine, J. D. de R. Consommation de puissance des coupe-cannes et des "shredders" menés par moteurs électriques. **39:** 318-320.

George, E. F. Factors affecting the initiation of flowering in sugar cane. **39:** 328-340.

Mazery, G. Transport et chargement de cannes. **39:** 191-197.

Parish, D. H. & Feillafé, S.M. Considérations sur la nutruition azotée et sur l'utilisation de l'urée dans la culture de la canne. **39:** 6-8

Rochecouste, E. Future trends in the chemical weeding of cane fields in Mauritius. **39:** 264-270.

Rouillard, G. Les dommages causés aux cannes par les cyclones Alix et Carol. **39:** 174-181.

Miscellaneous.

Antoine, Robert. 1960. La gommose de la canne à sucre à l'Ile de la Réunion. *Informations Agricoles, Ile de la Réunion.* Juin 1960.

Antoine, Robert. 1960. Les bactérioses de la canne à sucre. *Informations Agricoles, Ile de la Réunion.* Dec. 1960.

Parish, D. H. 1960. Protein from sugar cane. *Nature* **188.** 601.

Parish, D. H. & Feillafé, S. M. 1960. A comparison of urea with ammonium sulphate as a nitrogen source for sugar-cane. *Tropical Agriculture.* **37:** 223-225.

Williams, J. R. 1960. Studies on the nematode soil fauna of sugar cane fields in Mauritius. Notes upon a parasite of root-knot nematodes. *Nematologica.* **5:** 37-42.

Williams, J. R. 1960. The Control of black sage, (*Cordia macrostachya*) in Mauritius: the introduction, biology and bionomics of a species of Eurytoma (Hymenoptera, Chalcidoidea). *Bulletin of Entomological Research.* **51:** 123-133 (With an appendix by P. O. Wiehe).

GENERAL

1. **11th Congress of the I.S.S.C.T.** The planning of the 11th Congress of the International Society of Sugar Cane Technologists, which is to be held in Mauritius from the 23rd September to the 12th October 1962, received careful attention. Much time was spent by the Organising Committee assisted by three sub-committees: programme, itinerary and entertainment to study the various aspects of holding this conference in Mauritius.

Plenary and technical sessions will be held at Réduit and a comprehensive programme of visits is being organised. With the co-operation of Mr. Emile Hugot, a three-day tour of Réunion island will also be included in the itinerary.

2. **Meetings.** The Research Adivsory Committee met twice during the year: on the 6th August for a visit of the laboratories and station at Réduit, and on the 15th December for discussing the Research Programme for 1961.

Regional Meetings were held at Belle Rive, Pamplemousses and Union Park in April when the Geneticist gave an account of the cane breeding work and the release of new varieties. In October, the Chemist reviewed sugar cane fertilization practices in Mauritius and in November Dr. A. C. Hayward of the C.M.I. gave a lecture on bacterial diseases of the sugar cane. Both these last meetings were held in the Bonâme Hall. In December, the Pathologist addressed members of the M.S.P.A. at Belle Rive on Progress in the Control of Ratoon Stunting Disease.

3. **Lecturing at the College of Agriculture.** The senior staff of the Sugar Technology Division continued to be in charge of the lecturing programme in Sugar Technology and Engineering. Similarly, the course of Plant Pathology and Botany of the sugar cane was given by Mr. R. Antoine, Statistics and Field Experimentation by Mr. S. M. Feillafé, while Mr. Guy Rouillard lectured on Cane Cultivation.

4. **Staff Movements.** The Director and following members of the staff went on overseas leave during the year: Messrs. J. R. Williams, S. M. Feillafé, E. F. George and P.G. du Mée.

Mr. F. Le Guen left in April and was admitted to study Electronics and Instrumentation at the Northampton College of Technology, and Messrs. C. Ricaud and C. Mongelard returned to Mauritius in September, the former after obtaining the Diploma of the Imperial College and the latter a B.Sc. degree in Botany at University College London. These courses of studies were financed by the Special Studies Fund.

Mr. J. R. Williams attended the 7th Commonwealth Entomological Conference held at London in July. Mr. S. M. Feillafé attended the 7th International Congress of Soil Science held at Madison, Wisconsin, in August. Before proceeding to the U.S.A. he visited several research centres in the U.K., France and the Netherlands, while on his return journey he spent 4 weeks in Hawaii studying soils of these islands with the staff of the Soil

Conservation Service, and at the H.S.P.A. Experiment Station and University of Hawaii.

The Director attended the 10th meeting of the «Comité de Collaboration Agricole Maurice-Réunion-Madagascar» which was held this year in Réunion in the month of October.

Mr. E. Rochecouste attended the British Weed Control Conference in the U.K. and was absent for three weeks in November.

Mr. R. Antoine visited Réunion and Madagascar in February and for three weeks in October and November accompanying Dr. Hayward.

Mr. J. Dupont de Rivaltz de Saint Antoine spent 10 days in Réunion in November under the auspices of the "Comité de Collaboration".

I should like in conclusion, to express my gratitude to all members of the staff for their loyal cooperation during a year which has proved difficult and so full of disillusions for all those concerned with agriculture.

Director

5th February, 1961.

Fig. 14. Effect of cyclone on experimental field at Réduit Experiment Station (above) and field of Ebène 1/37 at Moka.

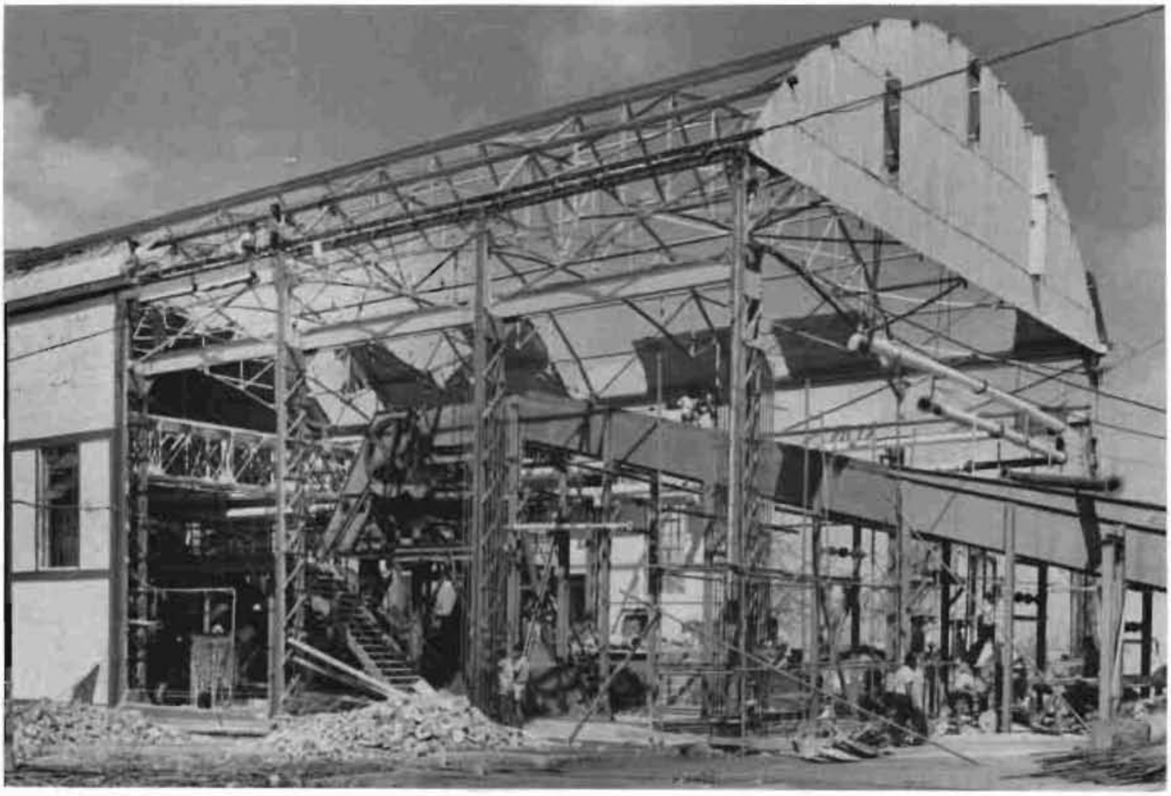

Fig. 15. Union St Aubin factory after cyclone 'Carol' (above) and Solitude factory after cyclone 'Alix' (below).

CANE BREEDING

E. F. GEORGE & W. de GROOT *

1. ARROWING

(i) Conditions in 1960.

AS was to be expected, arrowing in 1960 was very sparse occurring only on stalks that survived the cyclones. Other shoots were too young for flower initiation to take place during the critical season, which in Mauritius, is in March. The questionnaire circulated to estates was completed with great care, as usual, and once again it is a pleasure to record our thanks to Estate Managers for the help received in that connection.

The results of flower counts on different varieties in various parts of the island, are given in table 1, while in table 2, a comparison is established with results obtained in 1959. It is clear from these data that some sections of the island were more affected than others, the proportion of arrows having been much lower in the South and Centre where the canes were taller when the cyclones occured and where the highest reductions in cane yields were also registered, (vide fig. 6).

The relation between age of ratoons and flowering percentage is shown in fig. 16. It will be noted that time of harvesting the preceding year has had little influence on flowering in 1960 as opposed to normal conditions when a higher proportion of arrowing is found in the oldest fields (c.f. fig. 15, Ann. Rep. M.S.I.R.I., 1959). It is probable that a larger proportion of more advanced stalks from the earlier ratoons were broken by wind than in fields harvested in November and December.

(ii) Flower initiation.

Studies on the time of flower differentiation were continued this year on the same varieties. The date in the past three years on which the development of inflorescences first began and the day length on each particular date are given in table 3. It will be apparent from the table that the cyclones had very little influence on time of formation of floral primordia.

Analysis of variance on the dates of flower formation and corresponding daylengths, reveals that initiation was significantly (5% level) earlier in 1958. Between varieties, both the differences in times of initiation, and likewise the differences in daylengths are highly significant (0.1% level). The latter result shows that the daylength at the time of flower formation is not the same for all varieties and also suggests that of many environmental factors, length of day is closely connected with the onset of flowering.

However, while daylength is probably mainly responsible for determining the periodicity of flowering its effect is also modified by other environmental factors (the most important probably being temperature and rainfall). This can be seen from the significant variation in daylength at the time of formation from one year to another.

Several photoperiodic experiments in progress at the time of the cyclones were spoilt but some interesting facts emerged from another experiment which was designed to investigate the findings of Yusuf (1958) that varieties given continuous light treatment throughout the night, from the period just after the formation of the primordia, gave higher fuzz fertility than untreated canes.

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* *Sections written by E. F. George : 1 (ii). 3.*
Sections written by W. de Groot : 1 (i). 4. 5.
Sections written jointly : 2

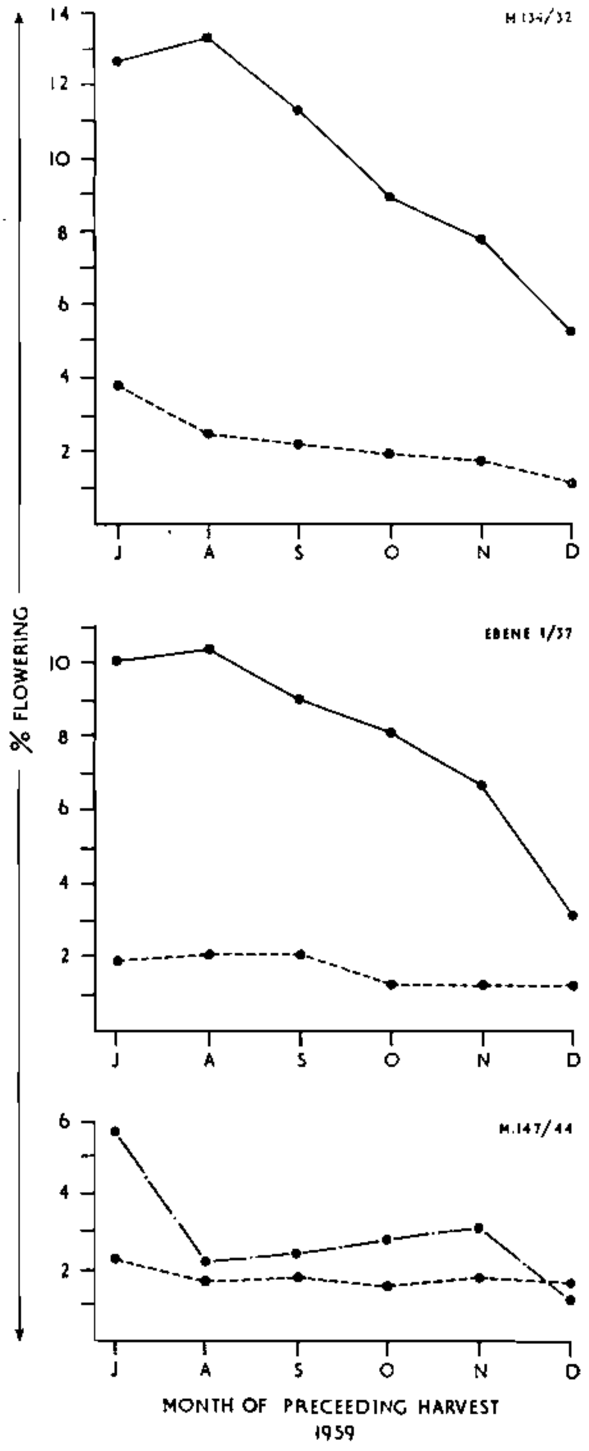

Fig. 16. The relationship between date of previous harvest and percentage of flowering in the varieties M. 134/32, Ebène 1/37 and M. 147/44.
Plain line : Average of 4 years' data 1956 - 1959.
Broken line : Results of 1960 census.
Dash & dots line : Results of 1959 census.

The experiment was conducted as a simple 2 × 2 × 3 factorial, the main effects being:

Presence or absence of extra light at night.

Canes kept inside or outside the green house.

Varieties M.241/40, R.397, N.Co 310.

Canes of the three varieties were marcotted in polythene tubing and transplanted to cement pipes prior to the commencement of the experiment on 11th April. Continuous light treatment throughout the night from dusk to dawn was provided in the lighted treatments by four 100 w. tungsten lamps suspended 2-3 feet above the treated canes. Light treated canes inside the green house were first to reach the «boenting» stage, closely followed by the unlighted canes inside. It was initially thought that the light treated stalks in the greenhouse would be the first to flower, but arrow emergence took place first in the unlighted stalks inside the greenhouse. Emergence here was highly significantly earlier than in the unlighted treatment outside the greenhouse, the canes of which were next to come into flower. This difference was almost certainly due to the higher growth rate of flower stalk under the warmer greenhouse temperature. The experiment was terminated on 30th July on which date *no flowers had emerged* in the light treated plot inside the greenhouse, and only one flower showed the very first signs of protusion in the light-treated group outside.

It may be concluded that the light treatment was responsible for retarding arrow emergence in treated canes. Within one cane of M.241/40 a large flower had reverted to vegetative growth. The flowers of some canes were still alive and healthy, but a majority of the remaining flowers were attacked by *Fusarium* top rot, and had died. This fungus attack was noticed to follow any upset in the normal process of flowering and greatly hampered the crossing programme this year. The flowers of the treated stalks, which stayed suspended at the same stage of growth for some 6 weeks, were then particularly prone to attack.

Thus although the effects of extra light treatment on fertility could not be investigated, it was found that retardation of flowering by a shorter period of continuous light treatment, *after* the differentiation of an inflorescence, might be a practical possibility.

Table 1. Average percentage arrowing in 1960*

Variety	North	South	East	West	Centre	Average
M.134/32	1,43	1,69	4.24	2,02	(0,09)	2,08
Ebène 1/37 ...	—	1,54	2,52	—	0,40	1,45
M.147/44	1,18	1,13	3,29	2,47	0,43	1,65
M.31/45	—	0,21	(0,51)	(4,72)	—	0,58
B.3337	—	0,13	(0,00)	—	—	0,11
B.37172	0.01	0,16	0,28	(0,00)	—	0,15
M.112/34	(1,02)	—	—	—	—	(1,02)
E.50/47	—	—	(0,00)	—	—	(0,00)
E.3/48	—	—	(0,00)	—	—	(0,00)
B.34104	—	(1,57)	(0,00)	(3,38)	—	(2,26)
B.37161	—	(0,88)	(0,00)	—	—	(0,76)

* *Results derived from less than 5000 canes are placed in brackets.*

Table 2. Percentage of flowering in the various sectors of the island in 1959 and 1960.

	North	South	East	West	Centre	Island
Flowering in 1959 ...	2,65	6,17	5,21	4,23	2,47	4,85
Flowering in 1960 ...	1,06	1,02	2,61	2,30	0,38	1,41
Flowering in 1960 as a percentage of flowering in 1959 ...	40,0	16,5	50,1	54,4	15,4	29,1%

Table 3. The date of the first recognised flower initiation in 5 varieties during the years 1958-1960. The day-length (in hours) on each date is given in brackets.

Variety	1958	1959	1960
U.S. 48-34	—	1/3 (12.46)	26/2 (12.52)
C.P. 36-13	4/3 (12.39)	5/3 (12.38)	6/3 (12.35)
Co.421	4/3 (12.39)	10/3 (12.28)	9/3 (12.29)
M.241/40	4/3 (12.39)	18/3 (12.14)	11/3 (12.27)
Ebène 1/37	21/3 (12.08)	26/3 (11.99)	1/4 (11.85)

2. CROSSING

(i) Programme.

The number of flowers available for crossing was seriously curtailed on account of the cyclones, but in spite of this difficulty, the crossing programme was carried through very successfully and approximately 170,000 seedlings were produced in accordance with the new policy of the Institute to increase the number of seedlings to be selected year by year.

The various stages in this year's crossing programme may best be divided under the following headings:

A. Isolation of Arrows for Crossing

(a) Canes rooted before external signs of flowering.

Successful indoor crossings have been made for several years now at Canal Point, Florida, using flowering canes rooted in stove pipes. (Dunckleman, 1959). The method employed there is to root many thousands of canes, either first of all in marcottes and later transplanted, or else directly into stovepipes. This rooting is performed before any signs of a flower can be noticed externally. This method is practicable only on varieties which flower freely because a high proportion of rooted canes may be expected to flower.

Stalks of the varieties N.Co.310, R.397, Uba Marot, N.Co.376, M.241/40, Co. 421 were treated in this way and flowered very satisfactorily inside the greenhouse. Subsequently, with the exception of those of No.Co.376, which appear to be genetically male sterile, these arrows gave copious pollen, due to the development of the arrow at favourable temperatures.

With the money and labour available this method cannot be used for other breeding canes which do not flower so freely. The great handicap of the crossing programme has been the shortage of male fertile parents. Many varieties are potentially male fertile but are rendered sterile by low temparatures. If the arrows of such varieties could be made to develop inside the heated greenhouse they would then give viable pollen.

Last year, stalks showing the earliest indication of flowering were cut in the field and placed in a preservative solution inside the greenhouse. Rooting was induced on these canes while they were still dipping into the solution. Such technique which proved completely unsuccessful on that occasion was tried again with only very limited success.

In the light of last year's failures it was decided early in the year to endeavour to bring *previously rooted* flowering canes into the greenhouse. The isolation of flowering stalks by this method has been tried in the past in Mauritius with little success. So this year, experiments to investigate the best methods for rooting canes in the field were started well before the crossing season.

(b) The rooting of marcottes.

Five experiments were conducted prior to, and during the crossing season, to find better methods of inducing rooting in marcottes. In each of these experiments factorial designs were used to investigate the most suitable rooting media, containers and hormone treatments for several sample varieties. Each experiment demonstrated very clearly that varieties differ in their rooting capacity and that some media are much better for root formation than others. Among the most successful mixtures discovered were rotted sawdust alone, or various mixtures of coarse bagasse, soil and sand.

A very surprising result was a significant variety/medium interaction in one experiment. This result is shown in Table 4. The varieties used in the experiment were Ebène 1/37 (E), M.134/32 (M) and Co.421 (Co) and the media rotted sawdust (d); bagasse, soil, sawdust, 1:1:1: (btd) and bagasse, soil and sand 1:1:1:(*bts*).

It will be remarked that Ebène 1/37 with the *bts* mixture gave significantly more roots than with the *btd* mixture. With M.134/32 the reverse was true. The inferior rooting of Co. 421 in this experiment is also well demonstrated.

The most beneficial hormone treatments discovered were a 0.45% solution of indol - 3 - yl - acetic acid in 50% alcohol and «Aretan toothpicks». (Fig. 17). These latter were prepared by soaking wooden toothpicks in concentrated Aretan solution under reduced pressure and subsequently drying them.

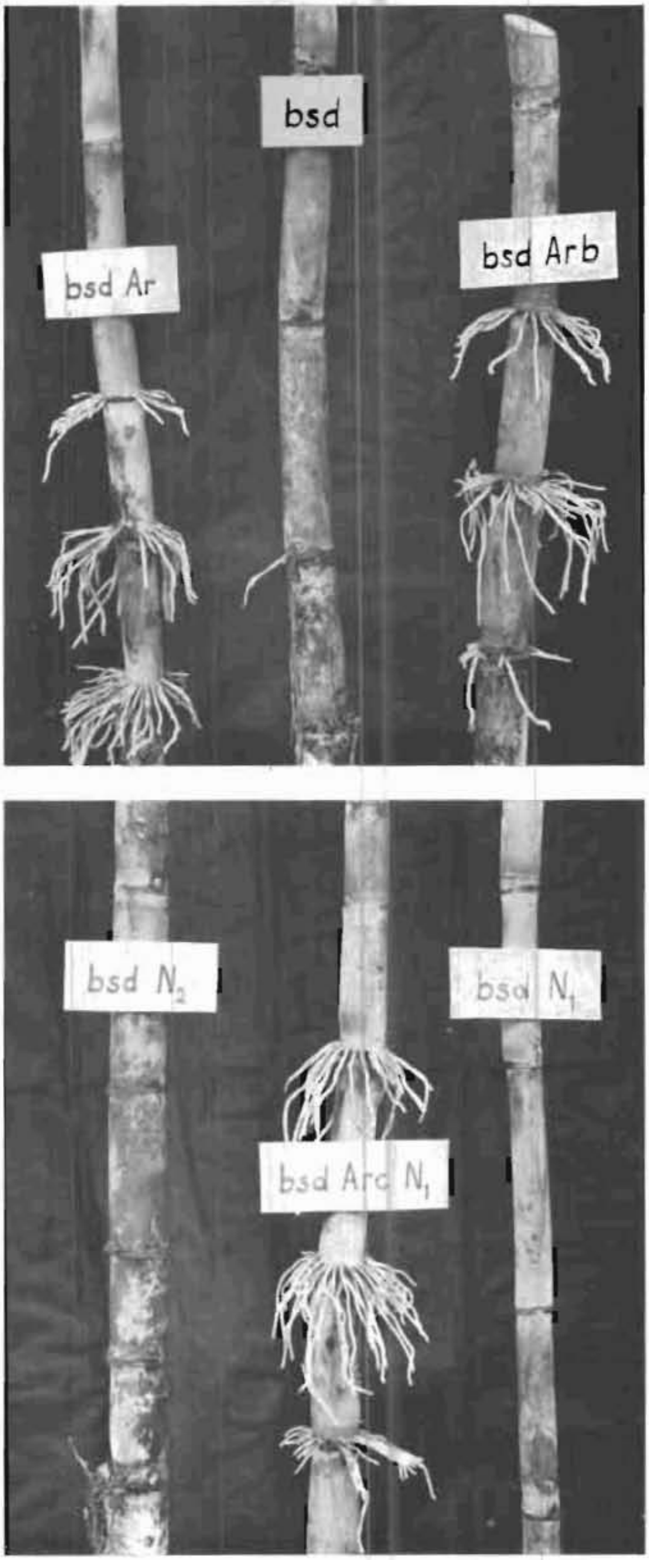

Fig 17 Effect of different treatments on the rooting of cane stalks in bagasse, soil and sawdust mixture (bsd)
Ar, Arc. Aretan applied with toothpicks.
Arb, Aretan solution brushed on nodes.
N_1, Naphtyl Acetic acid 0.1%
N_2, " " " 0.2%

Fig. 18. Above, cement pipes and below, polythene tubing used for the early rooting of canes prior to flowering.

The IAA was painted around the root bands of the nodes from which rooting was required, while the toothpicks were inserted in internode tissue in a small prepared hole. Unfortunately variety/hormone interactions were also discovered in these experiments. One such result is shown in Table 5. Here it will be seen that the Aretan toothpick method gave excellent results in the variety Ebène 1/37 while IAA was much more suited to root induction in M.134/32. Aretan in lanolin paste which gave the smallest total weight of roots in Ebène 1/37 was significantly better than the control and Aretan toothpick methods in M.134/32.

Yet another significant interaction which was discovered was between the hormone used to stimulate rooting and the rooting medium employed. An illustration of this is shown by the results given in Table 6. Best results with IAA hormone were obtained with a bagasse/soil mixture, while with Aretan toothpicks sawdust was most suitable.

This series of significant interactions make it impossible to determine, without experiment, the best hormone or rooting medium to use with any variety; and unfortunately it is impossible to perform experiments on all varieties used for breeding. It was found however, that Aretan toothpicks could be used to stimulate rooting with more uniform results than could be obtained with other hormones, even though they did not always give the results which could have been obtained with other methods. It was unfortunate that although those toothpicks gave rooting initially they subsequantly often permitted entry of the red rot fungus into flowering canes which resulted in the abortion of the developing inflorescence.

Table 4. The significant first order interactions between variety and rooting medium in one experiment on rooting.

Combination	Root Wt. (g)	Co.btd.	Co.bts.	Co.d.	M.bts.	Md.	E.d.	Ebtd.	M.btd.	E.bts.
E.bts ...	249.0	***	***	***	***	**	*	*	N.S.	
M.btd ...	198.8	**	**	*	*	N.S.	N.S.	N.S.		
E.btd ...	185.9	**	*	N.S.	N.S.					
E.d ...	185.7	**	*	N.S.						
M.d ...	151.7	N.S.	N.S.							
M.bts ...	142.7									
Co.d ...	123.3									
Co.btd ...	110.9									

Significant differences :— 0.1% level ***
1.0% " **
5.0% " *

Table 5. Significant variety/hormone interactions from one of the series of rooting experiments.

Hormone \ Variety	Total root wt. (g) E. 1/37	M.134/32
IAA sol. 0.45% in alcohol	802.4	1049.4
Aretan in lanolin paste	595.2	991.2
Control. No. treatment	740.5	442.7
Aretan toothpick	1295.0	759.3

Significant differences :— 0.1% level 313.0 g.
1.0% " 243.0 g.
5.0% " 186.4 g.

Table 6. Interactions between hormone and rooting medium.

Hormone \ Medium	Total root wgt. (g) Bagasse soil 2:1	Sawdust
IAA sol. 0.45% in alcohol	953.7	898.1
Aretan in lanolin paste	598.0	988.4
Control. No treatment	522.5	660.7
Aretan toothpick	781.7	1272.6

Significant differences :— 0.1% level 442.7 g.
1.0% " 346.5 g.
5.0% " 363.7 g.

(c) Marcottage of flowering canes

With the results of the series of experiments on rooting to serve as a general guide, canes of many varieties were rooted in the field as signs of flowering were noticed. Polythene tubing of various grades and widths was used in the main for this purpose. Successful isolation of arrows was achieved by this method if the arrow was allowed *to emerge in the field prior to severance of the stalk.*

Severance before full arrow emergence, even though a large number of roots were present in the marcotte, usually resulted in the immature arrow being attacked by *Fusarium* top-rot and being killed. This diseased state was not always immediately noticeable externally, as the leaves usually remained quite healthy. Later however, the «flower sheats» assumed a characteristic appearance. It was noticed that a few varieties (e.g. N:Co.376, M.147/44) did often give arrow emergence inside the greenhouse when treated in this way, which would indicate a varietal resistance to the attack of this fungus.

The *Fusarium* fungus attack appeared to occur when the cane suffered any slight set-back or water stress. Although polythene tubing was a most convenient container for initial rooting (it is easy to see when roots have been formed and to transport the rooted cane) it was found not to be a very suitable container for later root growth. Afterwards marcottes made in polythene were all transplanted into metal cylinders, and this treatment gave a greater percentage success.

Another technique which was tried, was to induce roots directly within these metal cylinders which were slipped down over cane stalks to ground level and then filled with rooting medium. The disadvantage with this method is that one is unable to see when sufficient rooting has taken place for the cane to be cut.

B. Crossing Technique

The total number of crosses made this year was 780; of these 149 were made in the open at Pamplemousses in glass lanterns, and 631 were made at Réduit, 94 in glass lanterns and 537 inside the greenhouse. Crosses inside the greenhouse were isolated in linen lanterns suspended from the roof. These lanterns are made of a close-weave farbic and are supposed to be satisfactorily pollen when tied at the bottom. Pollen shedding inside these lanterns was very satisfactory and many were stained yellow at the base by the copious pollen shed by the «male» arrow. It was possible to keep a close watch on all the indoor crosses and records were kept on the amount of pollen in each cross.

The number of seedlings obtained at each of the experimental stations is shown in table 7, and the list of crosses done in 1960 is given in the appendix (table XXI).

Many new parental varieties such as E.50/47, M.19/51, M.98/54, M.349/55, M.146/56, M.103/57, M.440/57, M.442/57 and M.204/58, were utilized in crossing and in addition during this year's selection programme other varieties have been added to the breeding plots for testing as parents.

Table 7. Summary of Crossing Work in 1960.

Selection Station	No. of crosses made		No. of seedlings obtained		Total	No. of pots planted in field with	
	In green-house	Outside	In green-house	Outside		Single	Bunch*
Réduit	537	94	108,150	23,250	131,400	2,835	3,494
Pamplemousses ...	—	149	—	43,000	43,000	1,915	6,579
F.U.E.L.	—	—	—	—	—	—	2,948
Britannia	—	—	—	—	—	—	2,559
	537	243	108,150	66,250	174,400	4,750	15,580
	780		174,400				

Approximate number of seedlings planted 98,250

* For number of seedlings, this number should be multiplied by 6.

(ii) Transplantation of Seedlings.

Cane leaf pots have been used for transplanting seedlings since 1932, the main advantages being their cheapness, and the fact that seedlings can be transplanted directly in the field inside the pot which then rots away. Unfortunately the pot often rots prematurely and the soil falls away from the young plant before placing in the field. This takes place especially when transport from one place to another is necessary.

Thin gauge polythene bags appeared to offer many of the advantages of the straw pots, would be more durable, and were comparable in price.

A factorial experiment to test the germination of single eyed cuttings in polythene pots had the following main factors:

Type of pot.	Polythene pot, v. usual cane leaf pot.
Planting medium.	Soil + compost (as normally used) v. Soil + compost + high fertilizer dose.
Varieties	Ebène1/37, M.147/44, B.37172.
Time	Half the experiment harvested after 2 months. Remainder then placed outside greenhouse and harvested after 3 months from planting.

Characters measured on each date of harvest were length of shoot, weight of shoot and weight of roots; of these, weight of shoot is probably the most important.

The significant differences between important main effects and interactions are summarized as follows:—

(*a*) *Varieties*[1]

	Total wt. (g)	B	E	M
				—
M.147/44 (M)	405.6	**	*	
Ebène 1/37 (E)	298.8	N.S.	—	
B.37172 (B)	266.6	—		

Variety M.147/44 germinated best.

(*b*) *Containers*

Polythene pots gave significantly (1% level) superior growth than that in cane leaf pots.

(*c*) *Medium*

The usual soil + compost medium was highly significantly superior (0.1% level) to the mixture with a high fertilizer dose.

(*d*) *Container/medium interaction*[1]

	Total wt.	TFP	TFS	TS	TP
					—
Ordinary soil, polythene pot (TP)	536.6	***	***	***	
Ordinary soil, straw pot (TS)	286.3	***	***	—	
Fertilized soil, straw pot (TFS)	113.2	NS	—		
Fertilized soil, polythene pot (TFP)	34.9	—			

Polythene pots with the usual medium gave highly significantly superior weight shoot than any other combination.

Following these encouraging results, the plan was made to plant a number of this year's seedlings in polythene pots. Unfortunately the polythene pots arrived at the end of the potting season, and so only a small experiment could be done.

From 4 crosses half of the seedlings were potted in bunches in straw and half in polythene pots. After 2 months the number of pots in which all the seedlings had died was counted. The results are given in table 8.

(1) *Significant differences.*
0.1% level ***
1.0% **
5.0% *

Table 8. Effect of kind of pots on mortality of seedlings.

Cross	No. of pots planted		% of pots in which all seedlings had died	
	Straw	Polythene	Straw	Polythene
A	48	59	6.3	3.4
B	72	70	11.1	7.1
C	56	46	0	7.1
D	120	136	22.5	20.5

The results seem to indicate that there is no difference between these two kinds of pots. More information has to be obtained however, before final conclusions can be drawn.

This year a great number of seedlings were planted in bunches of about ten seedlings per pot. This was necessary because the number of seedlings produced was so great, that it took too much time to pot these seedlings separately. For the potting of bunches of seedlings, a bunch of about ten seedlings is lifted out of the seedling flat and planted in a pot.

At the time of transplanting, due to competition in the bunch, three to four seedlings had died, so that an average number of 6 seedlings per bunch at the time of planting in the field is a reasonable estimate.

(iii) Experiments on the male and female fertility of flowers.

The effect of hot water as a method of sterilisation of male fertile flowers was tested again this year. The results obtained were the same as last year. Male fertility could be destroyed in M.147/44 with the right combination of time and temperature. However the female fertility of the flowers was also impaired and only a very small amount of seedling were produced in some cases.

The effect of various hormones was also tested, but due to the time of the flowering season, no results were obtained. An earlier start is necessary for next year's experiments.

3. STUDIES ON SEEDLING POPULATIONS

(i) Selection in bunch planted seedlings.

The results of the 1956 experiment have shown that from the progeny of the cross B.34104 × M.213/40 (erroneously described as B.34104 × M.63/39 in the 1958 Annual Report) selection for yield could be practised very effectively in bunch planted seedlings by first potting each seedling individually and subsequently placing 7 such pots together in a bunch in the field. Although not quite significantly different ($p=0.2 - 0.1$) than in seedlings bunch planted by the usual method, selection for yield was consistently better due to a superior ($p=0.05 - 0.01$) selection for stooling capacity. In the cross in question however, there was a fairly consistent negative correlation between yield and brix. In consequence of this, the percentage of final selections was eventually generally lower in the «bunch potted» group than in the normal bunch planting, where selection for yield was not so extreme. This is shown in table 9. Another experiment, with seedlings of different parentages is planned, to further investigate the best method of bunch planting.

(ii) The elimination of varieties from bunch planted seedlings.

Although about 10 seedlings are originally planted per bunch in pots, it is usual to have about 6 seedlings left at the time of planting in the field, and 3 distinct varieties at the time of selection in first ratoon; the remainder having been eliminated naturally. An experiment was attempted in 1959 to investigate whether superior varieties, from a commercial standpoint, survive until selection. Random selections from stalks in bunch planted seedlings of five crosses, were compared in a randomised trial with random selections from the same crosses, singly planted. Measurements were made on these selections in virgins in 1960, but it will be necessary to wait for results from a non-cyclone year before offering any definite conclusions on survival and selections rates from within the 5 bunch planted crosses.

Table 9. Selection percentages from the first vegetative generation based on:-
(a) all characters
(b) yield alone in the various original selection groups.

Groups of original selected stalks	Selection percentage from bunch selection plot: Final selection all characters	Yield alone
Single planting	1.11	2.22
Best stalks bunch planting ...	1.96	0.92
,, ,, ,, potting ...	1.59	2.32
Medium stalks bunch planting ...	0.92	0.92
,, ,, ,, potting ...	0.63	0.48
Poor stalks bunch planting ...	0.39	0.13
,, ,, ,, potting ...	0.32	0.32
Random stalks bunch planting ...	0.26	0.52
,, ,, ,, potting ...	0.63	1.43
Weighted mean of four groups		
Bunch planting ...	3.53	2.48
Bunch potting ...	3.17	4.28

4. SELECTION

(i) Selection policy

The results of observations in seedling populations indicated that selection efficiency could be improved if the policy of selection could be changed.

Hitherto, seedlings were planted at the four stations of the Institute under humid and super-humid conditions. It was found however that in the latter environment a large number of seedlings die because of poor growth conditions. It is highly probable that valuable material is lost in this way while at this stage adaptation of a seedling is of little importance.

The basis of the new policy for the testing of varieties is to grow the seedlings under the most favourable conditions during the initial stage of selections and then when enough material is available to test all the selected varieties in different environments. The various stages of selections are illustrated diagrammatically in fig. 19.

Seedlings are planted in the humid region under optimum growth conditions for 8 months, cut without selection and selected 12 months later in first ratoons. The main criteria for selection are vigour, growth habit and brix. Bunch planted seedlings are planted in a bunch selection plot to give more material before planting in propagation plots. The next stage of selection, the propagation plots, are planted in two places, so that each variety is tested in both the humid and the super-humid regions. They are selected in virgins and in 1st Ratoon. The same criteria of selection are used, but more emphasis is laid on sugar content. From this stage testing in both regions follows the normal procedure of first selection trials followed by trials on estates in all the regions of the island. This new programme imposed a much larger area of land to be devoted to selection work, and through the kind cooperation of the management of two estates, seedlings are now also planted at FUEL and Britannia.

STAGES IN THE BREEDING PROGRAMME

DUAL SELECTION OF PROMISING SEEDLINGS IN CONTRASTING ENVIRONMENTS

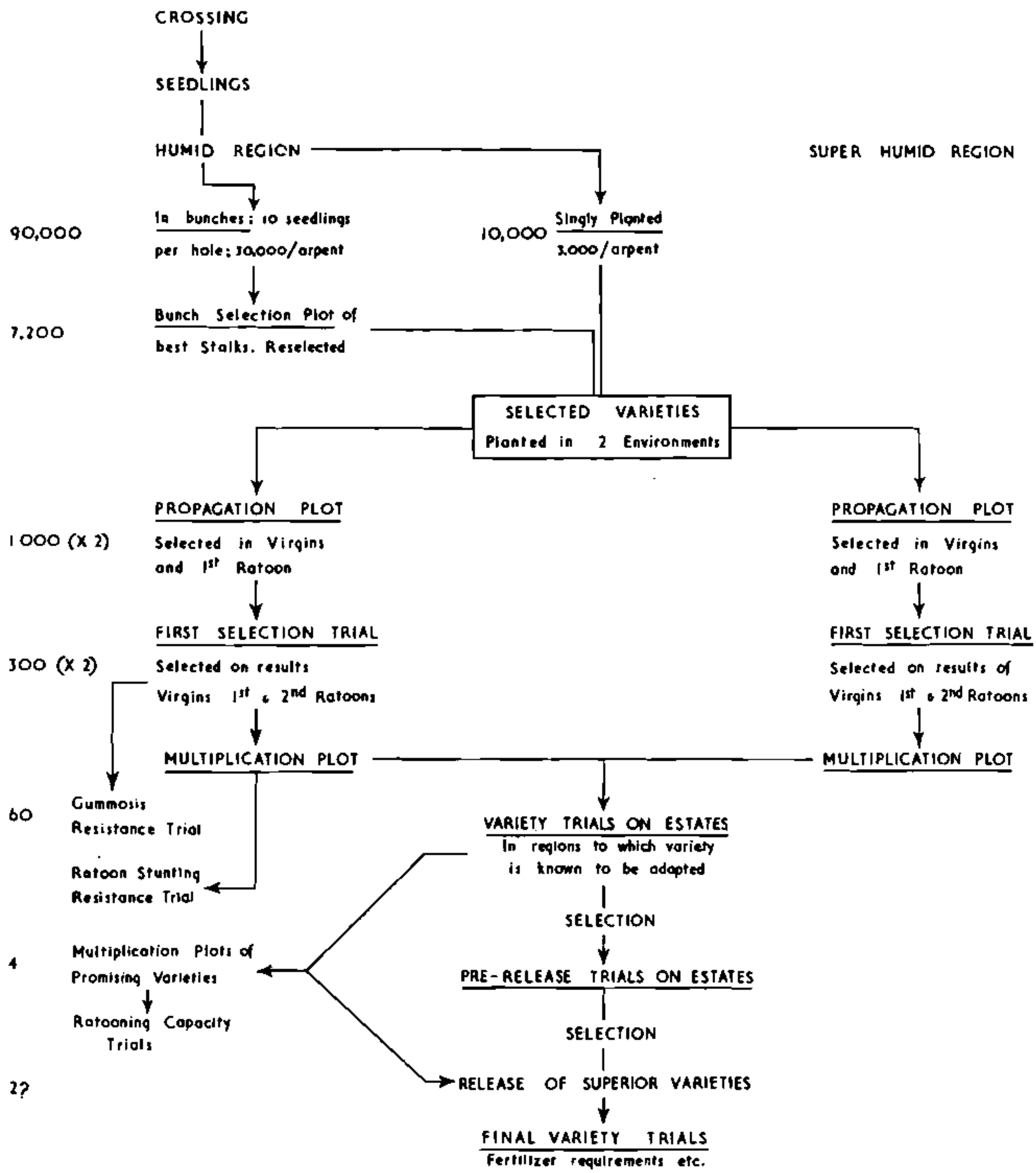

Fig. 19.

(ii) Selection in 1960

The selection work, this year was greatly handicapped. Propagation plots and first selection trials at Bell Rive and Union Park were so bad, that selection could not be carried out. Only one propagation plot in virgins at Belle Rive was selected. At Réduit and Pamplemousses conditions were more favourable and selection was possible.

Selection of seedlings was done at the 4 stations and a total of 332 seedlings of the M-/58 series were planted in propagation plots together with 10 varieties from a bunch selection plot of 1957 series.

One hundred and seventy-one varieties were planted in 1st selection trials this year. The number of varieties now in the various 1st selection trials is 424, from which 150 are tested in the super-humid region (Belle Rive and Union Park) 130 in the dry irrigated areas (Pamplemousses) and 140 at Réduit.

Thirty three selections from first selections trials were made at Réduit and Pamplemousses. These varieties will be observed during the year and promissing ones will be planted in trials on estates towards the end of 1961. In these multiplication plots, two varieties from the 1957 series selected at Union Park in 1959 have been included because they showed many desirable features.

5. PRE-RELEASE AND VARIETY TRIALS

Because of the lack of planting material, only four variety trials with four replicates and 2 pre-release trials with 6 replicates could be planted. At the end of the year 103 varieties, planted in 9 pre-release trials and 27 variety trials were undergoing testing (table 10).

Promissing varieties in these trials are: M.253/4 M.305/49, M.19/51, M.423/51, M.272/52, Ebène 50/47 and the imported varieties B.41227 and R.397.

Unfortunately the results of the 1960 harvest were completely unreliable, so that no further information can be given.

It should be noted that the promissing variety M.81/52 showed leaf scald infection in 2 trials in different regions. More information has to be collected before the merits of this variety can be determined.

Although no results were obtained with regard to the usual behaviour of new varieties, valuable information about cyclone resistance has been compiled.

Table 10. Distribution of variety and pre-release trials over the island.

Year of planting	Region				
	Sub-humid	Humid	Super-Humid	Irrigated	Total
1956	2	—	—	1	3
1957	1	3	2	—	6
1958	1	6	1	2	10
1959	1	3	5	2	11
1960	—	2	2	2	6
Total	5	14	10	7	36

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NUTRITION & SOILS

1. SUGAR CANE AS A SOURCE OF ANIMAL FOOD.

D. H. PARISH & C. FIGON

A cane field at harvest is divided into three component parts: the cane, which is sent to the factory for crushing; the green tops which may be removed for livestock feeding and the dead leaf litter which is left in the field.

The cane tops which remain after harvest are by tradition considered to be there for the taking, and as the cane crushing season occurs in winter when supplies of cattle fodder are scarce, cane tops have become a vital item in the peasant cow-keeper's fodder supplies.

The months of May and June may also be months of fodder scarcity and the Department of Agriculture is therefore encouraging the ensiling of surplus cane tops for use during this or any other difficult period, and it thus seems probable that the entire yield of green tops will be removed from estates and large planters lands.

Cane tops left in the field would decompose rapidly and the potash and phosphate they contained would add to the general fertility of the field. The nitrogen content would also to some extent become available but in costing the nutrient value of cane tops it is probably better to exclude nitrogen altogether.

Fairly accurate data on the quantities of nutrients removed in cane tops (Halais, Parish & Feillafé (1960), are available and are given below:

Table 11. Average Estate Crop of 30 tons of Cane.

Weight of Tops	Equivalent to kilos of P_2O_5	Equivalent to kilos of K_2O
9 tons	9	34

Taking the value of one kilo of potash as Rs. 0.55 and one kilo of phosphate as Rs. 0.80, then one acre of average land, as a result of permitting the removal of tops, looses nutrients equivalent to about Rs. 25 per acre, or conversely, the cane tops have a value of about Rs. 3 per ton.

The value of the green tops to the peasant cow-keeper is very high as, although nutritionally they are of low value, due to the scarcity of fodder at the time the tops become available they enable many more animals to be kept than would otherwise be possible.

Sornay (1921) and Laval (1924) have published data on the nutritive composition of cane tops but the work was carried out some forty years ago and it was felt that more up-to-date analyses would provide useful information for the local livestock industry. For nitrogen and phosphorus much data is available in the Annual Reports of the Sugarcane Research Station although even this work is out-dated due to varietal changes.

Samples of the cane tops of several varieties were therefore collected throughout 1959 and the average of all the analytical data obtained are presented in table 12.

The two components of particular importance to the nutrition of farm animals are crude protein ($N \times 6.25$) and phosphorus, and analyses of tops for these materials have therefore been given in greater detail (tables 12 & 13).

The phosphorus levels for these cane tops can be considered as the maximum likely to occur in Mauritius as all the canes were from estate lands which were known to be well supplied with phosphatic fertilizers.

Table 12. Mean Composition of Cane Tops(%D.M.)

Protein (N × 6.25)	5.4
Fibre	34.5
Waxes	1.0
Ash	5.9
Nitrogen-free extract	53.2

The average moisture content of fresh tops is 75 - 80 %

Table 13. Protein and Phosphorus contents of cane tops for different varieties and time of harvest (% D.M.)

	Protein			Phosphorus		
Varieties	*Early*	*Mid*	*Late*	*Early*	*Mid*	*Late*
E.1/37	5.75	5.19	5.94	0.18	0.21	0.19
M.134/32	7.06	5.06	4.69	0.17	0.23	0.19
B.37172	6.00	4.75	5.25	0.20	0.18	0.14
M.147/44	5.50	4.63	5.19	0.21	0.18	0.18
Average	6.06	4.94	5.38	0.19	0.20	0.18

Cane tops from land deficient in phosphate could give figures about fifty per cent lower than those obtained in this work and this fact should be borne in mind when evaluating the dietary value of tops.

Sugar cane itself can be fed to ruminants directly, but this would only occur if over production led to a cane surplus, as has happened in Australia. Under normal conditions, cane will be crushed and become divided into sugar, molasses, scums and bagasse.

Sugar is a valuable food material as is molasses, but the scums and bagasse are useless. The scums however, contain all the protein which was extracted from the cane with the juice. The quantity of protein in cane juice is extremely low but nevertheless the amount involved during the crushing season is high. Locally, with the production of sugar at about one half million tons, 100,000 tons of scums containing 6% cane juice protein, are produced. In other words 6,000 tons of protein material are returned to the fields as a fertilizer in a country where not only farm animals suffer from dietary protein deficiency but also a large percentage of the population.

If this protein could be recovered in a form suitable for feeding to livestock or even to human beings then the effect on the Mauritian economy would be very marked.

Leaf protein extraction has been suggested as a means of producing protein for human feeding, but commercial developments have as yet been of limited scope. Sugar cane tops could be used as a material for extracting protein, but as they are already fully utilized in Mauritius for livestock feeding this is impossible.

Work carried out by the Technology Division of this Institute has shown that impure heat coagulated protein can be recovered from juice on a factory scale.

The analyses of one of these precipitates has been made and is given below.

Table 14. Composition of heat coagulate from cane juice.

Protein (N × 6.25)	15.7
Ash	14.5
Wax (Benzene extract)	14.9
Wax & resins (Benzene Alcohol extract) ...	21.0
Cellulose Fibre	33.0
Sugars	12.0

The amino acid analyses (Moore & Stein) of the hydrolysed protein is given in fig. 20.

The amino-acid analysis shows that the protein is a typical plant protein, and, provided that nothing toxic is present in the material, then it could well be utilizable as a feed-stuff. The quantity of fibre present however will be important as, if it is too high, then bulk will limit intake.

The total protein content is low but there is no doubt that a better figure could be obtained by better preparation of the juice which will remove more fibre and some soil. The fat soluble materials could also be removed, and the protein content thereby improved and a potentially useful cane-wax recovered at the same time.

The original aim of the sponsors of leaf protein was to enable plant protein associated with a high fibre content to be made directly available for human nutrition as the efficiency of conversion of plant protein into animal protein is low. With heat coagulates however, the principle is one of recovering a potentially useful material from a waste by-product.

Even if the cane juice coagulated proves useful only for ruminants, then, provided that costs are reasonable a locally produced cattlefood could well enable the livestock industry of Mauritius to flourish more vigorously.

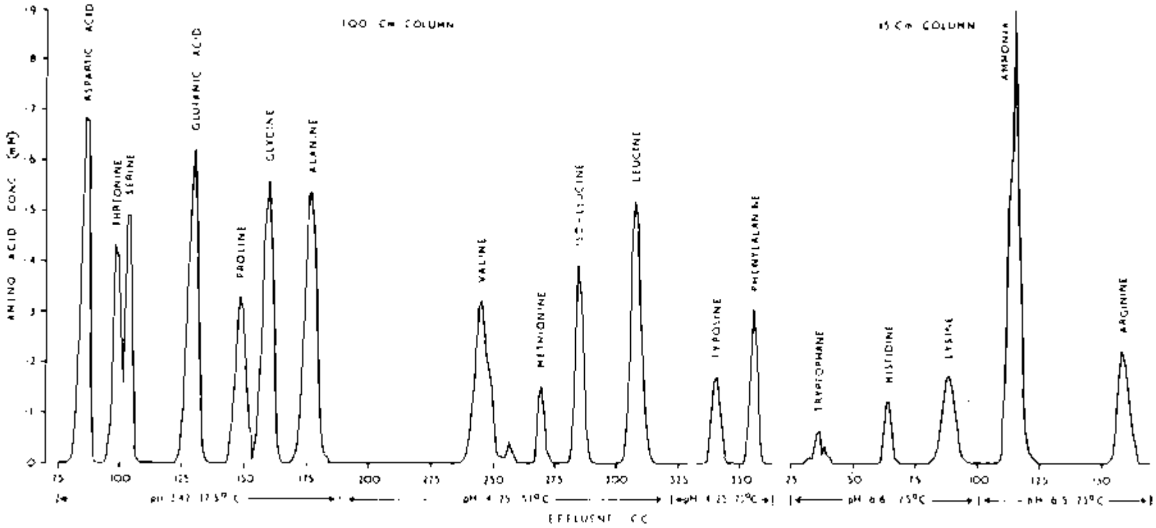

Fig. 20. Amino acid composition of hydrolysed heat coagulate from cane juice.

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2. FERTILIZERS AND THE SUGAR INDUSTRY

D. H. PARISH

Each year the sugar industry of Mauritius spends around Rs. 17,000,000 on imported fertilizers, a level of imports which places Mauritius at seventh place in the world list of countries with the highest fertilizer consumption per acre.

This high level of imports, however, does not in itself imply that these fertilizers are necessary nor that they are correctly used throughout Mauritius, but it does demonstrate the fact that the local sugar industry is extremely fertilizer conscious.

In view of the undoubted importance of fertilizers to the national economy and to the influences of past fertilizer practices on those current today, it was felt that a detailed examination of all the data available on fertilizer consumption during the century would prove interesting, not only in an historical sense but in demonstrating how in the past, practices fell short of the ideal.

Pierre de Sornay gives in great detail information on fertilizer imports and practices up to about 1920, and Parish and Feillafé discussed the influence of improving technical knowledge on these practices up to 1956.

This article brings together all the data available on fertilizers and the sugar industry since 1900. Most of the information up to 1953 has been taken from the Livre d'Or of the Chamber of Agriculture.

It is very difficult to say exactly what are fertilizer practices as they vary according to the degree of enlightenment of the grower. A general idea of the national average is obtained however, by taking five yearly averages for the period 1900-1959. It will be seen that this national average is fairly accurate particularly for the nutrients per ton of commercial sugar, as on a percentage basis, the estates and larger planters produce proportionally more cane than the average small planter.

In the case of nitrogen, moreover, the figures are probably almost correct, as even the worst of cane growers are not averse to using large quantities of nitrogen although their canes may be stunted through phosphate and potash deficiency.

For phosphate and potash the national average falls short of estate practice because of the small planter effect, and this should be borne in mind.

Fertilizer practices may vary quantitatively and qualitatively, and both these aspects will be discussed.

Fig. 21 shows the level of importation of nitrogen, phosphate and potash, whilst fig. 22 shows the total nutrients used by the local sugar industry; in other words the phosphate figures have been corrected for scums and the potash figures for molasses returned to the fields.

The correction of phosphate for scums used could be challenged on the grounds that scums have no commercial value and therefore must be disposed of anyway by returning to the fields, whilst molasses may be sold or used, as prices dictate.

Fig. 23 shows the fate of locally produced molasses and was used to estimate total fertilizer potash utilization. The nitrogen contents of both the scums and molasses have not been allowed for, as the quantities are small and cannot in any case be taken as being equivalent to inorganic nitrogen.

The most striking feature of fig. 21 is the close relationship between sugar production and imports of nitrogen, the two curves being almost superimposed. The potash curve also parallels quite closely the sugar produced, but at a lower level than nitrogen. Phosphate imports are the least well correlated with sugar production, until after 1954 when imports began to rise sharply and to run parallel with the sugar curve.

Taking the cost of nitrogen at approximately Rs. 1,500 a ton, potash at about Rs. 550 and phosphate at Rs. 800, it is clear that the bulk of the money spent by the local sugar industry on fertilizer imports has always gone on nitrogen.

When total nutrients imported are corrected for potash in molasses and phosphate in scums, (fig. 22) the most striking change from fig. 21 is the

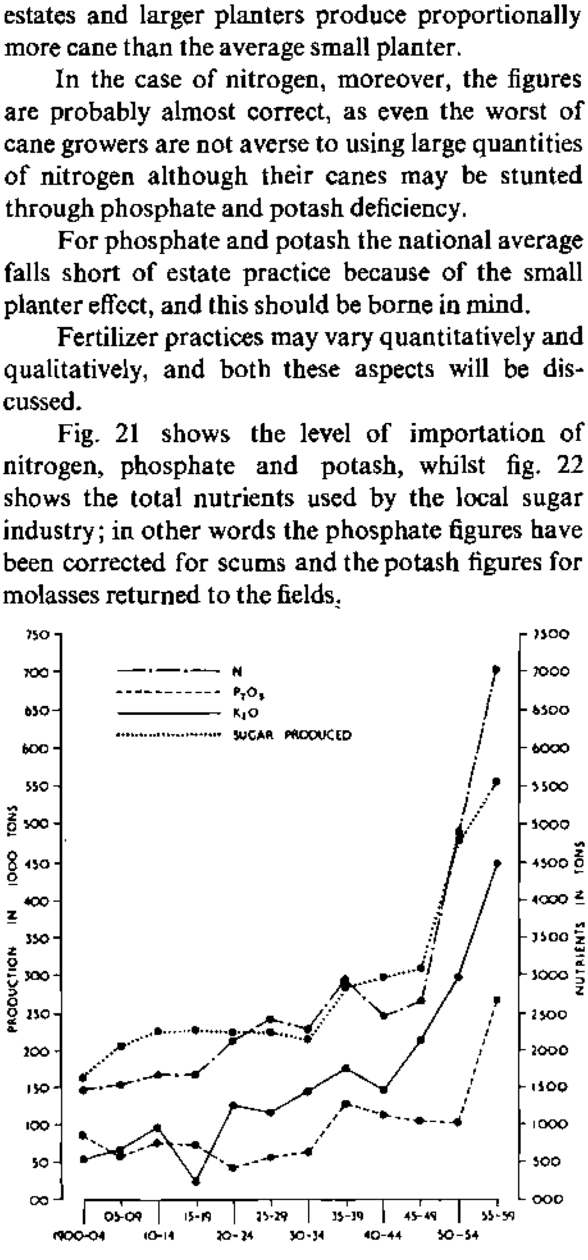

Fig. 21. Imported nutrients and sugar production, 1900 - 1959.

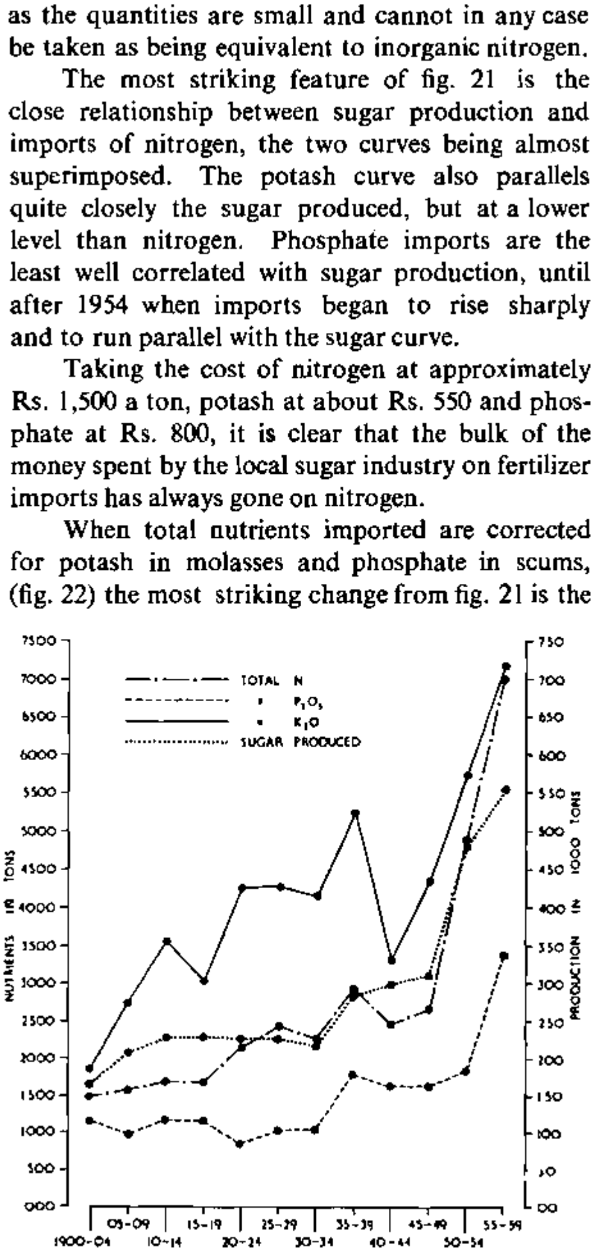

Fig. 22. Total nutrients and sugar production 1900 - 1959.

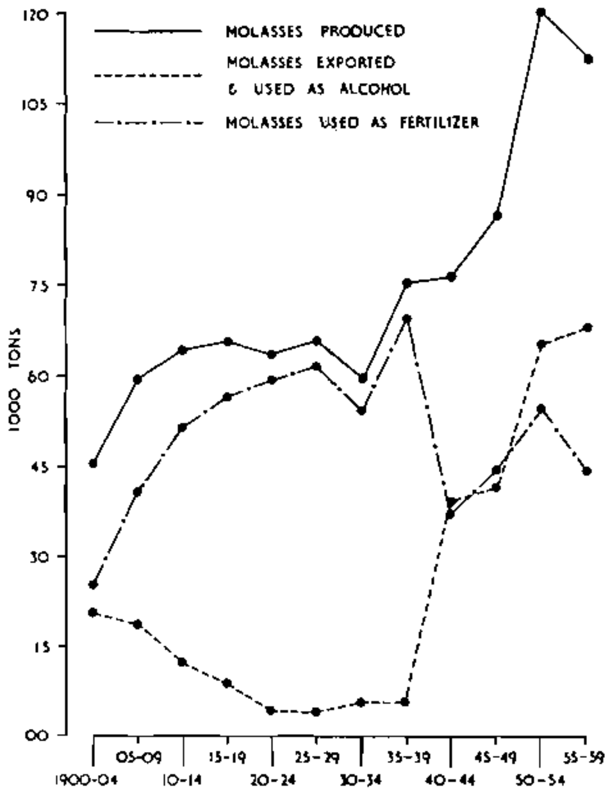

Fig. 23. Molasses production and disposal 1900 - 1959.

potash curve which now loses all relationship with sugar production.

Fig. 24 shows the nutrients imported per ton of sugar produced. This graph is the most interesting as it clearly demonstrates that the most important factor governing fertilizer imports is tons of sugar, in other words it appears that a fixed amount of money per ton of sugar produced is allocated for fertilizers.

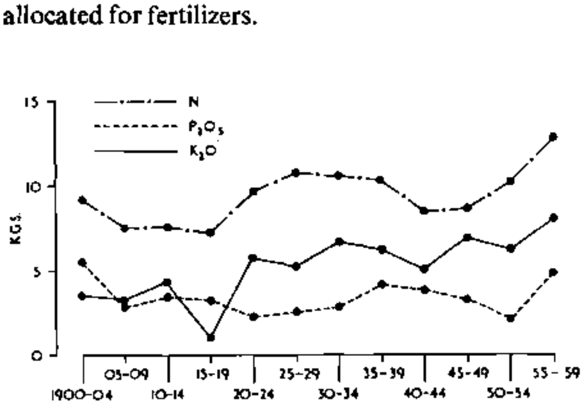

Fig. 24. Imported nutrients applied (kgs) per ton of sugar produced 1900 - 1959.

The way in which this money is distributed between nitrogen, phosphate and potash should be governed by crop requirements, but this has not been and still is not always the case.

Bonâme, after attempting to rationalize fertilizer practices by using scientific principles, in his report of 1895 speaks of the apparent disinterest of many planters in his recommendations. He points out that planters are fertilizer conscious but that «chacun croit n'avoir rien à apprendre au sujet de l'action des engrais, et qu'il est impossible de faire mieux que ce qu'il a fait jusqu'à présent».

More than half a century later with more scientific knowledge and practical know-how than was available then the picture has changed considerably. Most planters now readily accept scientific guidance, in the form of soil and plant analyses and experimental data, when drawing up their fertilizer programme. It is still evident however, that those who have the most to learn are the poorest pupils. Small planters present a pitiable picture, but it is not uncommon even amongst large planters and estates, to find violent switches being made in a fertilizer programme with little more reason than personal whim.

By and large, the potash status of our cane lands is good, whilst the phosphate status is poor. When the total nutrients utilized per ton of sugar produced (fig. 25) are calculated, it is obvious that the potash curve is completely irrational. For the period up to the second world war, potash imports should have been lower and phosphate imports higher than they were.

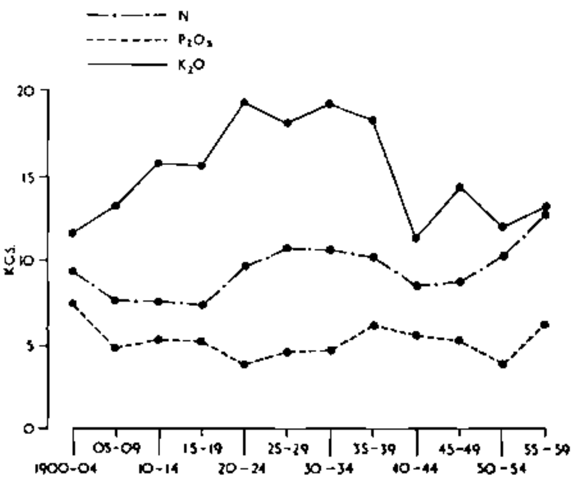

Fig. 25. Total nutrients applied (kgs) per ton of sugar produced 1900 - 1959.

The reason for this state of affairs is twofold: firstly the use of large dressings of Peruvian guano in the late nineteenth century had increased the phosphate status of our cane lands, whilst potash, to quote de Sornay, «paraissait être un élément dont on ne se souciait guère».

Bonâme, as a result of his work, recommended greatly increased dressings of potash with the result that potash imports increased whilst phosphate imports unfortunately declined.

The second factor which aggravated the already poor phosphate status of our soils was the introduction of heavy mechanical equipment for derocking and ripping.

The sub-soils of all our lands are extremely deficient in phosphate and the large amount of subsoil mixed with the top soil during mechanical preparation of the land reduces the soil phosphate levels to below the critical level for optimal cane growth.

At the time of foundation of the Sugar Industry Research Institute the nutrient status of our soils had completely reversed from Bonâme's day, and the first fertilizer work of the new Institute was aimed at obtaining full information on phosphate which was a factor limiting cane growth over a large area.

Fig. 26 shows the area under sugar cane. The acreage under cane in 1922 was not reached again until 1952.

The annual rate of increase in acreage is about 2000 arpents a year, much of this being potentially good land, some however being marginal or even sub-marginal land which will never produce a decent cane crop.

Imported nutrients applied in kilos per arpent is given in fig. 27 and serves to illustrate the low position allocated to phosphate fertilizers up to 1954.

Fertilizer salesmen will point to the graph showing the close correlation between imported fertilizers and sugar production and claim that production has improved because of the improvement in the degree of fertilization.

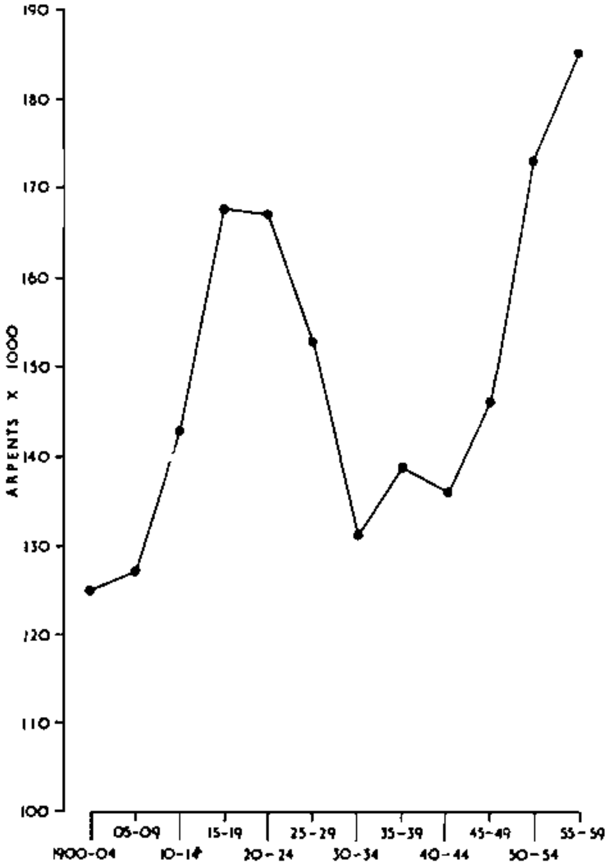

Fig. 26. Area under sugarcane 1900 - 1959.

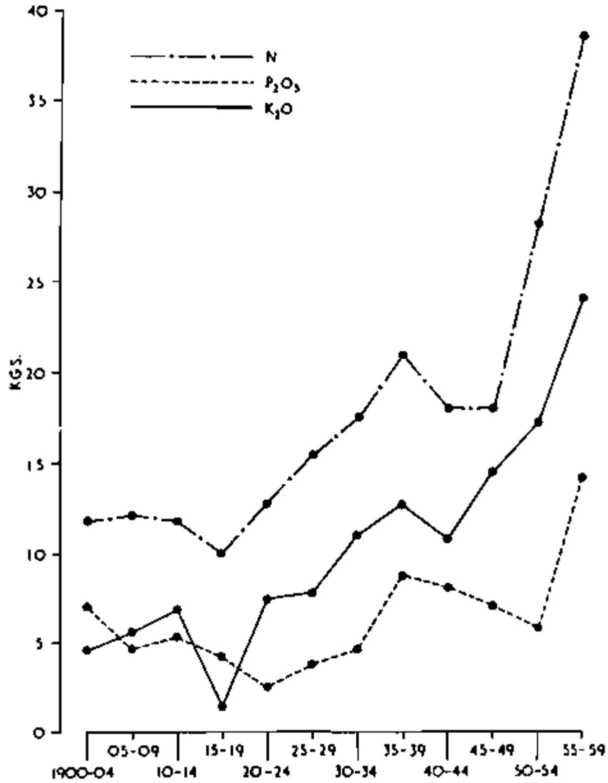

Fig. 27. Imported nutrients applied, kgs per arpent 1900 - 1959.

This would be a misinterpretation of the graphs. There is not doubt, however, that without imported fertilizers the local sugar industry would collapse and any move which could reduce the price of fertilizers would have a beneficial effect on local economy far greater than the apparent saving in import costs.

Qualitative changes in the fertilizers purchased by the sugar industry have occured, the moving principle being usually price per unit of nutrient although personal choice has also had a large effect.

Up to around the 1870s Peruvian guano was the only fertilizer imported on a large scale.

The material originally was very rich in nitrogen and phosphate but as the sources of supply were depleted the quality fell off and the price rose.

Guano phosphate was imported only from the end of the nineteenth century and proved extremely unpopular at first as it was compared with the Peruvian guano which experience had shown «était d'autant meilleur qu'il asphyxiait l'acheteur par le dégagement de l'ammoniaque» (de Sornay, 1921).

Scums were apparently not used as a fertilizer until the beginning of the twentieth century. Before the general acceptance of scums and guano phosphate as phosphatic fertilizers considerable quantities of super-phosphate were imported.

Modern practice is a combination of both guano phosphate and soluble phosphates.

The changes in nitrogen fertilizers concern only the decline in popularity of sodium nitrate due to the cheapness of synthetic sulphate of ammonia and the temporary attraction of urea in the years 1958 and 1959.

Imported potash was originally purchased as salpeter then as sulphate of potash but now is entirely utilized as muriate of potash. Molasses also have since the mid nineteenth century played an important role in building up the potash status of our soils.

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3. VOLATILIZATION LOSSES OF AMMONIA FROM UREA AND SULPHATE OF AMMONIA.

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

It has been appreciated for some time that if a nitrogen balance for a field is drawn up, income and outgo seldom balance.

On the credit side of the nitrogen balance, in the case of a non-leguminous crop, is the nitrogen added by the rainfall and as fertilizers and manure and the soil nitrogen, all quantities which can be accurately measured.

On the debit side accurate values for the amount of nitrogen used by the crop are available. Leaching losses are more difficult to assess as large scale lysimeters are expensive, even so, much data on the losses of nitrogen occurring in drainage water is available.

When the balance sheet has been drawn up it is usually found that a fairly large percentage of the nitrogen added to the soil is not recovered and has therefore presumably been lost to the atmosphere.

Allison (1955) has reviewed the literature up to 1955 and the main point to be made is that volatilization losses may be large under certain field conditions but that they may be kept to a minimum provided that certain simple precautions, such as avoiding surface applications of ammonium sulphate to alkaline soil, be taken.

Since 1955 urea has been produced on a large scale and become a competitor to sulphate of ammonia as a nitrogen source. Little work on the susceptibility of this material to volatilization losses was however carried out until the results of field experiments began to show that surface dressed urea was in many cases inferior to sulphate of ammonia in providing nitrogen to a growing crop.

When the results of the urea trials carried out by the Research Institute were published, volatilization losses of ammonia from the decomposed urea were suggested as one of the possible reasons for the poor performance of urea.

The results of Parish and Feillafé (*loc.cit*) showed that under field conditions the efficacy of urea compared to sulphate of ammonia as a nitrogen supplier to sugar cane was about 80%. Examination of the data however showed an efficacy varying from 50 to 100%. In other words, assuming that the entire shortfall of urea is due to volatilization losses, then losses may vary between almost one half of the applied nitrogen to negligible amounts.

Volk (1959), then showed, by means of a static ammonia absorber, that volatilization losses of ammonia from surface applied urea could be very high indeed and that the losses of nitrogen occurring in this way probably accounted for the poor preformance of surface applied urea.

Ernst and Massay (1960), studied the effects of several environmental factors on the volatilization of ammonia from surface applications of urea.

They found that increasing temperatures and/or soil pH markedly increase ammonia volatilization.

The same authors also demonstrated that losses of ammonia were greater when drying of the soil occurred, but that if the soil dried beyond a certain point, decomposition of urea ceased.

Wahab, Khan and Ishaq (1960), showed that more than half the total volatilization losses of ammonia from urea occurred during the first drying of the soil and that losses increased with increases in soil moisture and temperature but decreased with increasing soil acidity and increasing depth of placement.

In view of these results, it was felt that a study of the degree of nitrogen loss occurring with surface applied urea and factors affecting this loss would be well worthwhile.

Material and methods

For the first experiments the static ammonia absorbers designed by Volk (*loc. cit*) were used, but, although the results were interesting it is not possible, using this method, to vary the conditions of wetting and drying and therefore resource was made to laboratory experiments.

It is impossible in the laboratory to reproduce field conditions of temperature, wetting and drying accurately, but nevertheless data obtained in the laboratory can serve as a useful guide.

In this series of experiments the urea was applied to varying depths of soil and the wetting and drying cycles were varied.

The laboratory set up used is a normal aspirator train. The entering air is dried by passing through a calcium chloride tower, then scrubbed in concentrated sulphuric acid and passed over the soil, drying it and carrying over any unabsorbed ammonia present.

The ammonia was absorbed in standard sulphuric acid and the amount determined by titration.

Results and discussion

Urea is a stable neutral organic compound, which on adding to the soil is changed by the enzyme urease into the salt ammonium carbonate. This salt is extremely unstable and decomposes readily into ammonia and carbon-dioxide.

The change from urea to ammonium carbonate being catalysed by an enzyme can occur only under moist conditions and the rate of decomposition of the urea will increase with increasing temperature.

The ammonium carbonate formed splits into ammonia and carbon-dioxide and the ammonia may then be absorbed by the soil or lost to the atmosphere.

The losses of ammonia to the atmosphere will depend on the capacity of the soil to absorb ammonia. The ammonia absorbing capacity of a soil, apart from being affected by the type of soil, will also obviously vary with the volume of soil in contact with or overlying the decomposing urea.

The work using Volk's static ammonia absorbers showed that in a closed system, surface applied urea was fairly rapidly decomposed and that most of the ammonia liberated could escape to the atmosphere. The pH of the top layer of the soil rose from 6.5 to above 8.5 and the whole of the area covered by the application reeked of ammonia.

These experiments therefore showed that with surface applied urea, dressed as is current estate practice at the rate of 45 kg of nitrogen/arpent the dressing being banded along the cane row, losses of ammonia are potentially very high. This method however, as already pointed out, gives no indication of the losses which may be experienced under conditions of wetting and drying.

Several experiments were therefore carried out in the laboratory in which some of the factors which could effect the degree of loss of ammonia by volatilization were varied.

In the first experiment, the effect of degree wetting followed by a drying cycle was examined.

The soil used was a Réduit type low humic latosol with a pH of 6.5, the depth of soil used was one inch. Two treatments were given: the (a) series received water equivalent to a rain of 6mms. whilst the (b) series received 3 mms. showers on the days marked. The 6mms. addition of water brought the 1" of soil to about field capacity. the urea was applied on the surface at a concentration which could be expected to occur in normal field practice.

The results presented in fig. 28 show that after 7 days the (a) series had reached their maximum loss with 85% of the applied nitrogen volatilized, whilst at the same time the samples receiving 3mms. showers had lost only about 15% of applied nitrogen.

After the seventh day, all samples received 6mms. wettings and as can be seen from the graph an immediate evolution of ammonia occurred from

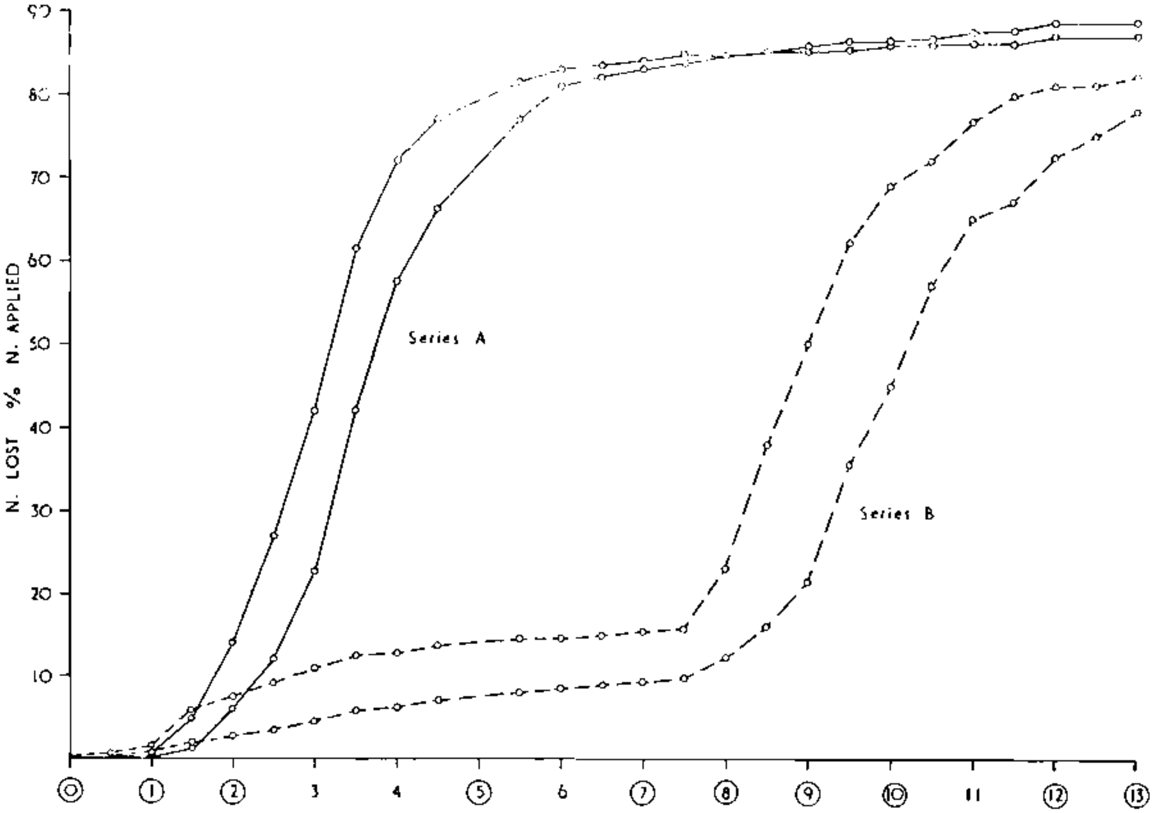

Fig. 28. Losses of nitrogen under different conditions of wetness. Series A received the equivalent of 6 mm. of rain on days indicated by circles. Series B received 3 mm. until the 7th day when applications equivalent to 6 mm. were made.

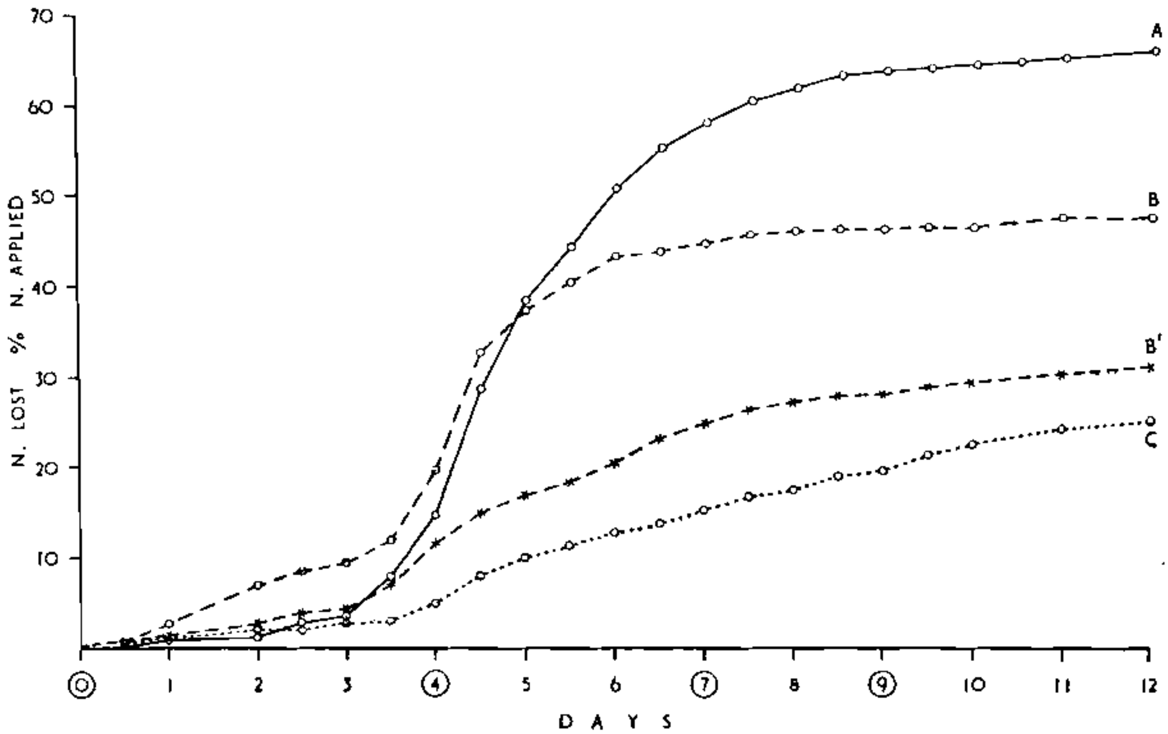

Fig. 29. Volatilization losses of nitrogen at different soil depths. Water equivalent to 10 mm. rain added at the origin and on the 4th day, on the 7th and 9th day applications equivalent to 5 mm. rain were made.
A. Urea applied over 1" of soil
B. " " " 2" of soil after wetting
B i. " " " 2" of soil before wetting
C. " " " 3" of soil.

the (b) series and losses continued until they approached those of the (a) series.

The results of the second experiment are shown in fig. 29. This experiment was made to study the effect of the depth of soil and the rainfall treatment was an attempt to simulate conditions which could occur during September, October and November, the months in which nitrogenous fertilizers are applied to cane locally. The additions of water are marked on the graph. Three depths of soil were used: 1", 2" and 3" and in the case of the 2" depth urea was added after the equivalent of a 10 mms. shower (B) and before the shower (B[1]).

This series of results show clearly, as is to be expected, that the soil volume, assuming that the urea is dispersed throughout the depth of wetting following the shower, governs the degree of loss. They also demonstrate, as would be expected, that the losses when urea is applied just after a heavy shower are higher than if the urea application is followed by rain.

Heavy showers following urea application will distribute the urea throughout the depth of wetting and losses of ammonia will be smaller therefore with infrequent heavy rains than with frequent light rains. There is a danger however, with heavy rains, that the urea may be washed out of the rooting zone, but this is merely another limitation of urea as a fertilizer in the tropics and will not be discussed here.

Tables 15 and 16 reproduced by kind permission of the Director of the Observatory, shows that conditions in Mauritius in the months of September October and November may be ideal for causing maximum ammonia loss, in that a sequence of light showers followed by drying conditions with very bright sunlight and consequently elevated soil surface temperature can occur quite often in this season.

Table 15. Frequency of daily rainfall amount, Vacoas. Nine year average (1951-59) of number of days of rain amounts millimetres of rain in 24 hours.

Months	0.1-0.9	1.0-4.9	5.0-9.9	10.0-24.9	25 mms & over	Total No. of rain days	Absolute highest mms.
August	4.4	12.2	3.6	3.8	0.7	24.7	35.5
September	6.2	10.6	3.4	1.6	0.0	21.8	23.4
October	5.7	8.3	2.2	1.3	0.3	17.8	67.6
November	5.4	5.9	2.0	2.4	0.7	16.4	75.8
December	6.1	5.8	2.3	2.7	2.8	19.7	135.5

Table 16. Frequency of daily rainfall amount, Pamplemousses — Thirty year average (1930-59) of number of days of rain amounts millimetres of rain in 24 hours.

Months	0.1-0.9	1.0-4.9	5.0-9.9	10.0-24.9	25 mms & over	Total No. of rain days	Absolute highest mms.
August	7.5	8.7	2.1	0.9	0.1	19.3	26.7
September	8.2	8.1	1.4	0.5	0.2	18.4	42.9
October	7.4	5.4	0.9	0.5	0.2	14.4	58.3
November	6.7	4.9	1.5	0.9	0.7	14.7	256.3
December	7.1	5.8	1.9	1.3	1.2	17.3	173.7

Taking all the results available, it is obvious that surface application of urea is a most unsuitable method of applying this fertilizer under our conditions.

If the urea were buried to a depth of about 6'', a physical impossibility on more than half our cane acreage, then presumably volatilization losses would be minimal.

A third series of experiments were made to demonstrate the effect of high soil pH's on ammonia losses from sulphate of ammonia; urea was also used for compariosn. The soil used was a coral sand, a soil with a pH of 8.7 and very low base exchange capacity.

Fig. 30 shows that rapid loss of ammonia from sulphate of ammonia occurs and that the total losses can be very high. The urea curve, after an initially slow rate of loss, due to the absence of unchanged urea, give losses of the same order as sulphate of ammonia.

When the pH of a soil rises much above seven it is essential to bury the sulphate of ammonia, and this method of application should be general practice on mcst of the dark magnesium clays, coral sands and fields around factories with high pHs.

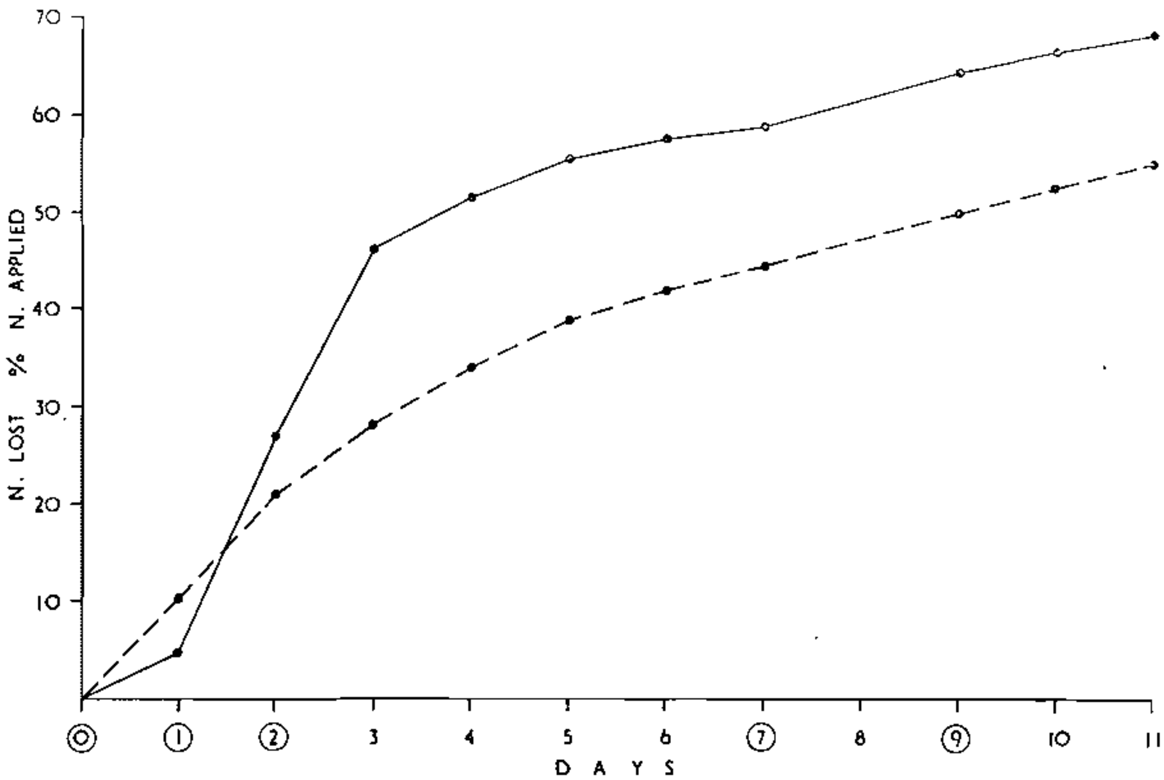

Fig. 30. Volatilization of nitrogen on coral sand. Plain line : urea; broken line: sulphate of ammonia. Water added at following rates : 2.5 mm. at origin, 2nd, 7th and 9th day. 5.0 mm. on the first day.

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CANE DISEASES

ROBERT ANTOINE

1. GENERAL CONSIDERATIONS.

THE two cyclones which struck the island at the beginning of the year have seriously damaged sugar cane fields, reduced the vitality of the plants and favoured the spread of pathogenic organisms. Thus, two major diseases, gummosis and leaf scald were once more in evidence in 1960.

(a) **Gumming Disease** (*Xanthomonas vasculorum*). Several susceptible varieties of old were severely infected with gumming disease in the variety collections, with a large number of dead stalks, even at Pamplemousses Experiment Station, in the sub-humid area, where gummosis is seldom encountered. The variety 55-1182, planted as infection cane in the gumming trial, contracted the disease naturally and so did the red cane 51NG142 introduced to serve as marker in field experiments. *Thysanolaena maxima*, an alternate host commonly planted as hedges throughout the island, was heavily infected and several cases of top rot were observed on palms. It is therefore beleived that were it not for the policy of cultivating only varieties highly resistant or immune to the disease a major epidemic would have prevailed. There was an excellent opportunity to assess once more the reactions of varieties under such conditions of stress. A special survey of varieties known to be susceptible in Réunion Island and resistant in Mauritius was made and no contradictory evidence was obtained. Thus M.147/44, highly susceptible in Réunion and now grown on a large scale in Mauritius, showed complete immunity to the strain of the pathogen present in the island. The leading Réunion variety, R397, which is fast succumbing to gummosis in that island again showed insusceptibility in Mauritius.

(b) **Leaf Scald** (*Xanthomonas albilineans*) A few varieties showed acute symptoms of leaf scald, including the commercial variety M.112/34 grown on a limited scale in the sub-humid area, the promising variety M.81/52, the seedling M.216/55 in a first selection trial and the breeding cane H.37-1933. It is interesting to note that M.112/34, susceptible in British Guiana, had been considered resistant in Mauritius. No signs of the disease were observed on the Barbados canes including B.34104, a variety highly susceptible in British Guiana and Madagascar.

Three resistance trials have been established at Belle Rive, Union Park and Pamplemousses. Varieties included are : M.112/34, M.147/44, M.31/45, M.202/46, M.93/48, M.253/48, M.423/51, M.81/52, Ebène 1/37, Ebène 50/47, R.397, B.3337, B.37172, B.34104. Controls are the susceptible White Tana and the resistant M.134/32. Infectious material is being provided by the following varieties : Sealy's seedling, White Tana, M.112/34 and M.81/52.

(c) **Ratoon Stunting Disease (virus).** Serious damage was sustained in the ratoon stunting trials and no significance was attributed to differences in experimental plot results due to the large reductions in yield brought about by the cyclones. Two trials on the reactions of commercial varieties were so badly damaged that they had to be replanted and so had the experiment in which more than 150 varieties are being studied as to their behaviour to infection. Planting material was derived from a nursery established with heat-treated cuttings.

(d) **Red Rot** (*Physalospora tucumanensis*). The incidence of red rot, as was to be expected, was much higher during the year, chiefly in virgins of M.134/32 and M. 112/34. A few fields showed severe infection after the second cyclone, the fungus having gained entry through the damaged rind at the junction between the prostrate and upright portions of the stem.

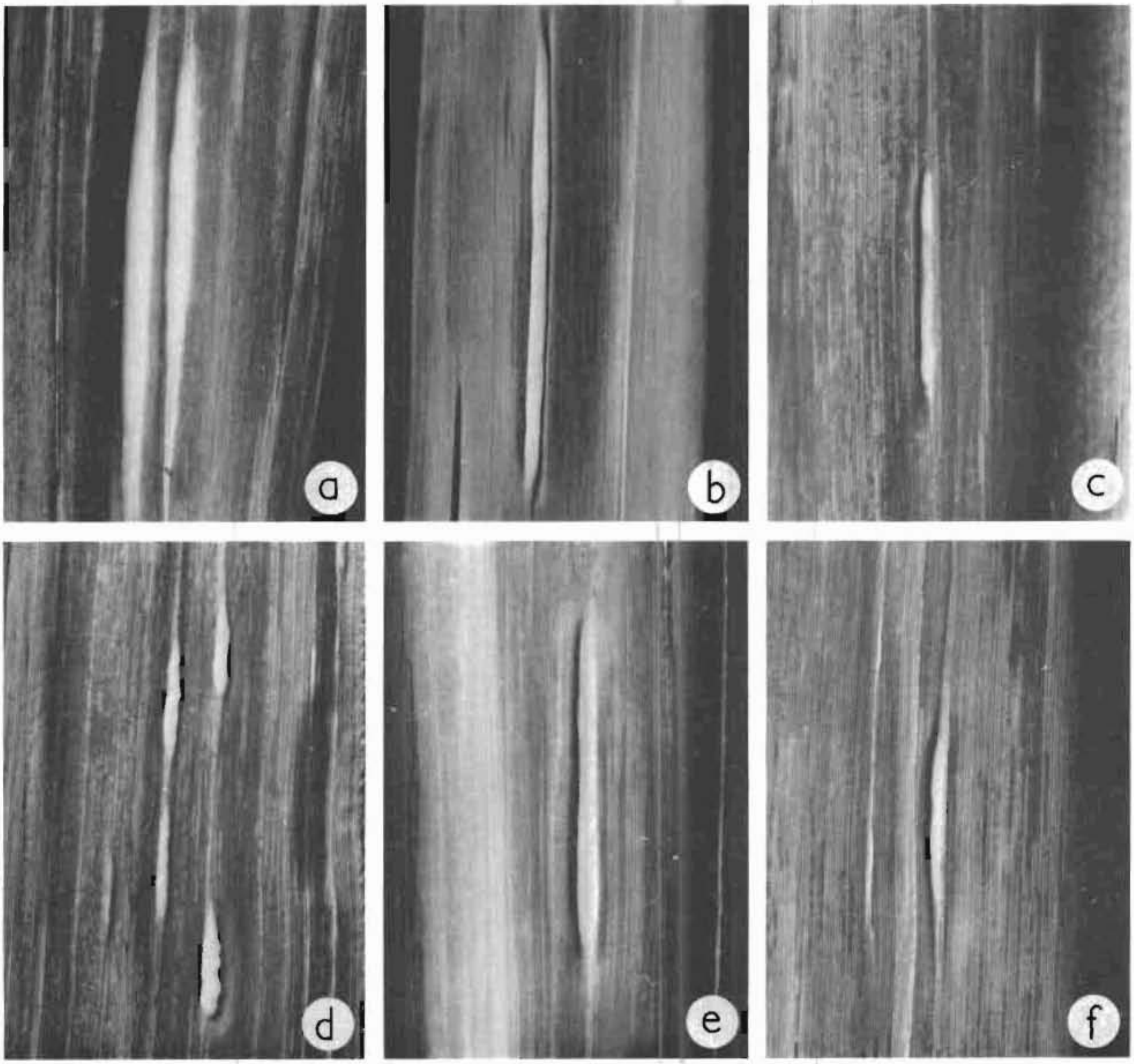

Fig. 32. Types of Fiji disease galls : (a) M. 134/32 (on mid rib), (b) B. 34104, (c) M. 147/44, (d) M. 134/32 (on blade), (e) N : Co. 310, (f) Q. 42.

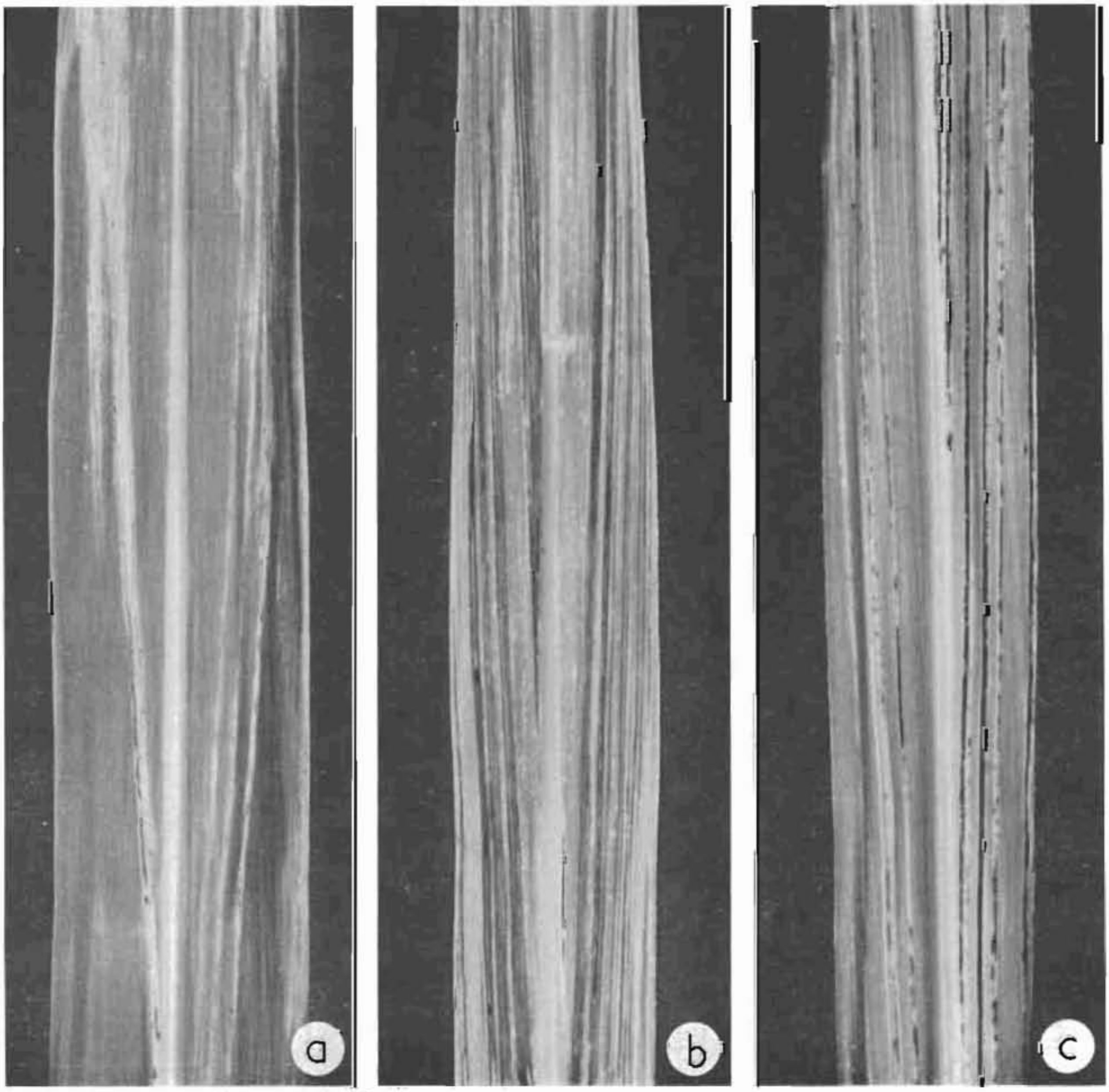

Fig. 31. Leaf symptoms of three bacterial cane diseases. (a) gumming disease, classical stripes, on 55 1182. (b) gumming disease, red stripe symptom on Louzier (Madagascar), (c) Red stripe/mottled stripe on B 37161

(e) **Chlorotic streak (probably virus).** The variety M.253/48 having shown high susceptibility to chlorotic streak, it has been recommended to planters to ensure, although the variety is cultivated in the sub-humid irrigated area, that cuttings are obtained from healthy fields, failing which the short hot water treatment should be given to all planting material.

It has been reported that plants derived from infected cuttings, growing in a locality where the disease does not prevail, will lose disease symptoms after a time and that the causal agent will disappear from the stalks. Investigations have shown that the pathogen may still be harboured in the underground portion of the plant. Thus, the rhizomatous parts derived from plants originally infected, but having apparently recovered in a dry locality, and from healthy plants were planted in containers, in the super-humid zone, in soil from a contaminated area. The results obtained on the expression of disease symptoms, given in table 17, tend to indicate that the pathogen may be harboured in a latent form, under certain environmental conditions, in the underground portion of the plant.

Table 17. Latency of chlorotic streak disease.

Stools derived from:	Plants showing leaf symptoms %
Plants having apparently recovered	20
Healthy plants ...	0

Experimentation on the transmission of chlorotic streak disease is progressing.

(f) **Pokkah-boeng** (*Fusarium moniliforme*). Several cases of pokkah-boeng were again observed this year during the period of active growth and although no appreciable damage was done to the cane several cases of top rot were seen on Ebène 1/37.

(g) **Pineapple disease** (*Ceratocystis paradoxa*). Three new fungicides were compared to the standard organo-mercurial preparation in the control of pineapple disease of cuttings. None proved superior to the standard at the three concentrations employed.

An interesting finding is that the protective effect of the fungicide is considerably more marked on bottom and middle cuttings or that there is a stimulating effect on the older dormant buds.

(h) **Soil fungi.** A screening of pathogenic soil fungi has been started with the assistance of the Commonwealth Mycological Institute and over 200 isolates obtained. The population levels are being studied under different environmental conditions, in association with the rotation of cane variety, the effects of various levels of organic amendments and the burning of cane before harvest.

In addition, isolates are being obtained from the rhizosphere of plants suspected of suffering from root disease.

2. HEAT TREATMENT OF CUTTINGS

(a) Hot water treatment programme against ratoon stunting disease.

Since the beginning of the campaign against ratoon stunting disease, in June 1958, to the end of 1959, the weight of cuttings treated at the central hot water treatment plant for estates amounted to 3,515 tons. The total area of nurseries established after recruiting was 800 arpents. The treatment target for 1960 had been set at 2,700 tons of cuttings. As a result of the cyclones there was an acute shortage of planting material; the cuttings available, with damaged or sprouted eyes, were unsuitable for heat treatment. It was therefore decided to close down temporarily the central plant at Belle Rive and carry out treatments, whenever necessary, in the small tank of the Institute at Réduit. As a result only 125 tons of cuttings were treated in 1960. However, as a compensating measure, it was recommended to planters to establish a second set of nurseries with material derived from existing nurseries.

(b) **Studies on germination of heat-treated setts.** Studies were continued on the germination of cuttings after the long hot water treatment. In view of the promising results obtained, particular emphasis was put on the addition of urea to the hot water bath in order to improve the germination of treated setts.

An experiment was conducted over two arpents and the reactions of four commercial varieties, M.147/44, Ebène 1/37, B.37172 and B.3337, were studied. Cuttings were taken at three levels on cane stalks obtained from stools 10 to 12 months old, after elimination of the top immature portion and the root-bearing bases. Such top, middle and bottom cuttings were planted after treatment in hot water at 50°C for 2 hours, with and without added urea at 0.25 % concentration.

Two blocks of one arpent each were planted with the treated cuttings at six weeks interval and, after three months' growth, each block was uprooted and immediately replanted, the number of germinated cuttings being recorded. Each plot consisted of 5 rows planted with 150 three-eyed cuttings in three replications. Experimental results obtained on 30,000 planted cuttings are given in table 18 and expressed graphically in fig. 33 and 34.

Table 18. Effect of the addition of urea to the hot water bath on the germination of top, middle & bottom cuttings of four commercial varieties.

	Germinated cuttings % (with and without urea)							
Variety	Top		Middle		Bottom		Total	
	—	+	—	+	—	+	—	+
Ebène 1/37	32	45	21	40	12	26	22	37
B.3337	57	62	51	49	31	39	46	50
M.147/44	50	59	33	42	18	25	33	42
B.37172	78	82	56	62	32	41	55	60
Total	55	61	41	48	24	33	40	47

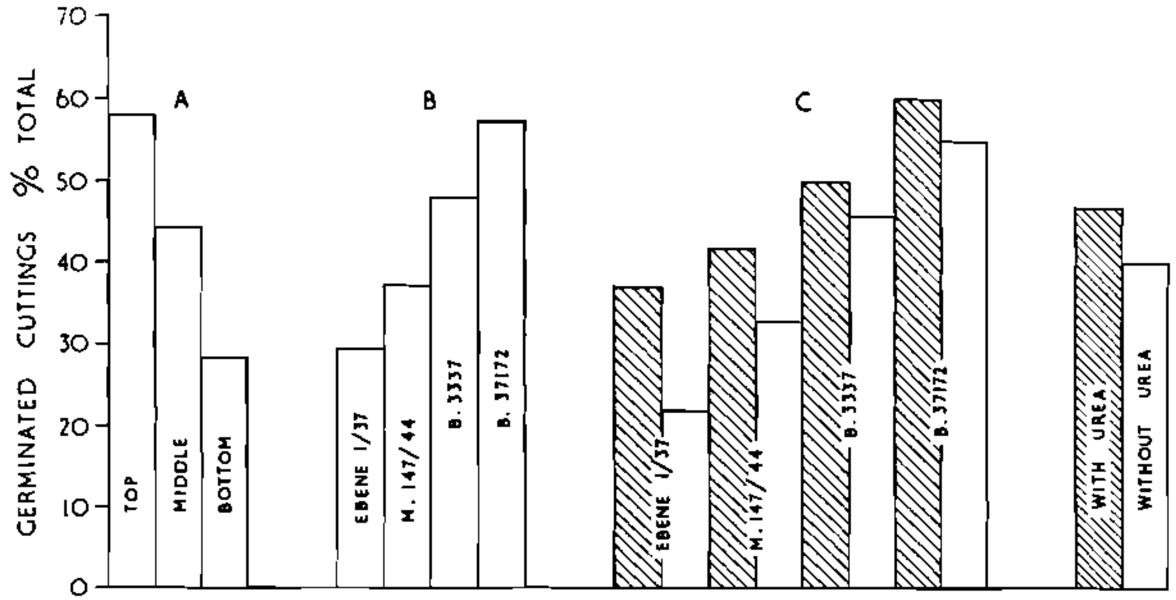

Fig. 33. Germination of heat treated canes. Effects of ; position of cuttings on stalk, A ; variety, B; urea treatment (shaded), C.

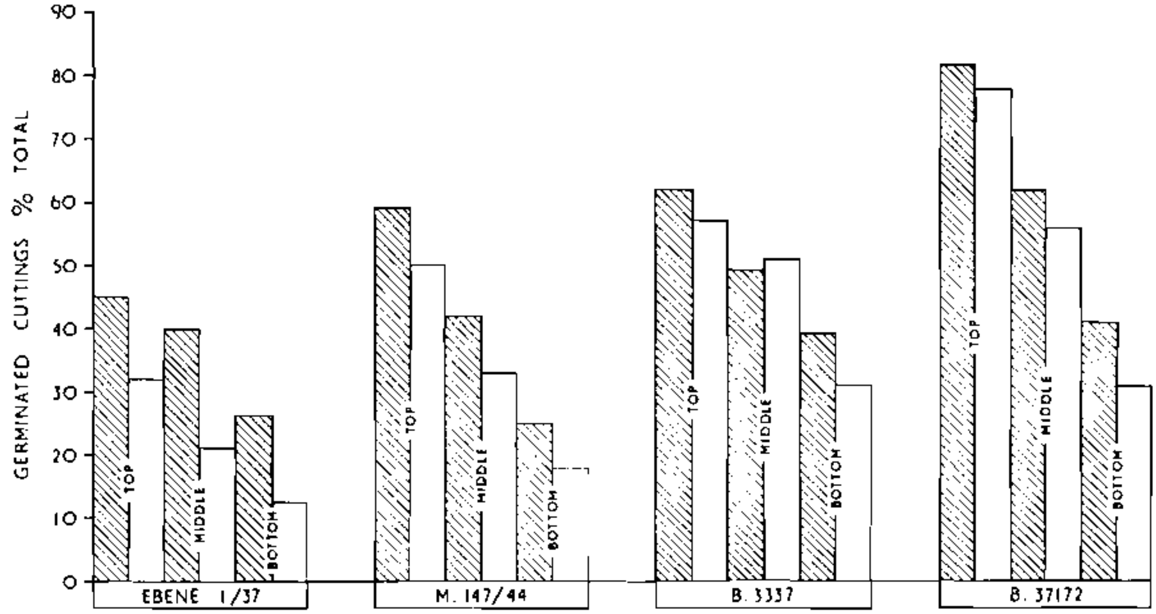

Fig. 34. Effect of urea (shaded) on germination of heat treated canes of four varieties.

The following conclusions can be drawn:

(i) The addition of urea to the hot water bath improved the germination of treated setts.

(ii) There is a different varietal response in germination after the heat treatment, Ebène 1/37 being the most affected and B.37172 the least.

(iii) The best germination after treatment is obtained with cuttings taken from the upper third of the cane stalk, after removal of the immature top.

(iv) Germination capacity decreases from top to bottom of the stalk.

The poor quality of cuttings, particularly those obtained after the cyclones and treated for the first plantings, should be taken into account. Thus, on an average, the germination of top cuttings of Ebène 1/37, the most affected variety, was 32% without urea and 45% with urea, the figures for the latest plantings were 58% and 71% respectively. Furthermore, owing to the severe shortage of planting material, cuttings had to be taken from plant as well as ratoon canes. It may be also that the germination of untreated setts would have been affected to some extent, as was shown by another trial.

Experiments were also conducted on the two newly released varieties, M.202/46 and M.93/48. The results obtained with and without the addition of urea to the hot water bath are given in table 19.

Table 19. Effect of the addition of urea to the hot water bath on the germination of M.93/48 and M.202/46.

Variety	No. of germinated shoots Without Urea	No. of germinated shoots With Urea	Increased germination %
M.93/48 ...	8,180	10,040	22
M.202/46 ...	12,430	15,880	28

Considering the results obtained it has been decided to add urea at a concentration of 0.3% to the hot water bath on a commercial scale. The cost of such addition is one rupee per ton of cane.

3. STUDIES ON BACTERIAL CANE DISEASES.

After the discovery of gummosis in Natal in 1956, followed by a severe epidemic of the disease in Réunion Island in 1958, attention was once more focussed on that major bacterial disease of the sugar cane inasmuch as varietal susceptibility seemed to differ in Mauritius, Réunion and Natal. Thus, M.147/44 very resistant in Mauritius showed high susceptibility in Réunion and N:Co.310 resistant in Mauritius and Réunion was severely affected in Natal. Although the influence of environmental conditions prevailing in the three countries cannot be ignored, it was decided to investigate the possible existence of different strains of the pathogen in the Western Indian Ocean area.

To that effect, three batches of cuttings of varieties D.109, N:Co.310 and M.147/44 were forwarded to the Commonwealth Mycological Institute as well as cultures of *X. vasculorum* from cane in Mauritius and Réunion and from an alternate host, *Thysanolaena maxima*, from Réuinon. Isolates of the bacterium were also obtained by the CMI from other sources. The preliminary results obtained in inoculation experiments carried out at Cambridge by Drs. Dowson and Hayward are given in table 20.

Table 20. Reactions of cane varieties inoculated in Cambridge to isolates of *X. vasculorum* obtained from different countries.

Variety	Réunion	Madagascar	Mauritius	S. Rhodesia*
D.109 ...	+	+ ?	+	+
M.147/44 ...	+	+ ?	—	+
N:Co.310 ...	+		+	+

* *The strain from Southern Rhodesia was assumed to be the same as the Natal one.*

It should be stressed that M.147/44 has consistently reacted as immune to the Mauritius strain whereas it has shown high susceptibility to the Réunion and S. Rhodesia ones. The reactions of N:Co.310 are also interesting : resistant under natural conditions to *X.vasculorum* in Mauritius and Réunion the variety has reacted as susceptible to artificial inoculation.

Varietal reactions assessed under natural field conditions, which are given in table 21, show the different response to *X. vasculorum* in the four territories.

Table 21. Reactions of cane varieties to gumming disease in four countries.

Variety	Réunion	Madagascar	Natal	Mauritius
D.109 ...	+			+
M.147/44 ...	+			—
N:Co.310 ...	—		+	—
Louzier ...	+	+		+
B.34104 ...	+			—
R.397 ...	+		+	—

In view of the interesting preliminary findings, it was thought that the scope of the research work should be enlarged. From the start it had been realized that such a research project involved the co-operation of scientists who would be responsible for carrying out the variety resistance trials in each territory and also that of an organization, existing in a country where the sugar cane is not grown, and capable of undertaking the work of screening the isolates from the various countries.

The cane diseases sub-committee of the «Comité de Collaboration Agricole Maurice-Réunion-Madagascar» having decided to initiate a co-operative study on bacterial cane pathogens and the assistance of the Experiment Station of the South African Sugar Association having been obtained, research was intensified. Furthermore the Commonwealth Mycological Institute agreed, at the request of the M.S.I.R.I., to send their bacteriologist, Dr. A. C. Hayward, on a visit of the four cane areas to obtain as many bacterial isolates as possible for cultural and physiological studies at the C.M.I. and inoculation experiments at Cambridge University.

Experimental work involves studies of:

(i) the field reactions to gummosis of as many varieties as possible common to the four territories in commercial plantations and in variety resistance trials,

(ii) the cultural and physiological properties of bacterial isolates from the various cane areas and,

(iii) the varietal reaction to inoculation experiments in the glasshouse using isolates of the pathogen from the different territories;

(ii) and (iii) being carried out at the Commonwealth Mycological Institute.

Dr. Hayward toured the four cane territories with the pathologists concerned and has taken to the C.M.I. more than sixty bacterial isolates for experimental work. Interesting observations have been made which positively point to the existence of different strains of *X. vasculorum*. Gumming disease resistance trials have also been established in the four territories and will help to throw more light on this important question.

Although the studies were concentrated mainly on gummosis, isolates were obtained from sugar cane affected by the other bacterial diseases: leaf scald, red and mottled stripes.

In Mauritius leaf scald is of sporadic occurrence in experimental plots and in variety collections. None of the commercial varieties grown at present are susceptible. Similarly, the disease is of little economic importance in Réunion and has not been recorded in Natal. The situation is more serious in Madagascar where the disease is widespread on B.34104, a variety highly susceptible in British Guiana and H.37-1933 on the West Coast and on the latter cane and Pindar on the East Coast. B.34104 and Pindar are resistant in Mauritius. The varietal reactions as shown in table 22 demonstrates once more the probable importance of pathogenic strains.

The problem therefore gravitates around the strain of the bacteria in relation to cane varieties. The foregoing evidence shows clearly that the concept of resistant varieties applies only to the one given territory and any generalization in that respect might lead to erroneous and dangerous conclusions. Similarly, studies on the inheritance of resistance must be qualified in relation to the strain of the pathogen concerned. Thus, the degree of immunity to *X.vasculorum* conferred to the nobilized progeny of *Saccharum spontaneum*, worked out for the strain occurring in Mauritius, does not seem to apply to Réunion Island and probably would not hold for many other parts of the world.

In Mauritius, all seedlings coming out of the first selection trial and imported canes, after the quarantine period, are included in a gumming resistance trial and all susceptible varieties are rejected. With such a policy in the breeding programme, a selection has been made for commercial planting of varieties immune or highly resistant to the strain of *X. vasculorum* present in the island. Should a mutation in that strain occur or another one be accidentally introduced serious consequences might result for the sugar industry; hence the importance of having rigid plant import and quarantine regulations.

As the taxonomy and nomenclature of some of the bacterial pathogens of the sugar cane are still rather obscure, isolates from plants affected by red and mottled stripe diseases are being studied at the C.M.I. and comparative inoculation experiments, to investigate the expression of disease symptoms, are being conducted in Mauritius with the local strains of the pathogens. The study is of special interest on account of the confusion which has arisen in the past between symptoms of gumming and those of red stripe and the difficulty experienced in differentiating with certainty between leaf markings caused by the red stripe and the mottled stripe organisms (fig. 31).

Table 22. Reactions of cane varieties to leaf scald disease in five countries.

Variety	Mauritius	Madagascar	British Guiana	Hawaii	Australia
B.34104	+	—	— —		
H.37-1933	—	— —		+	
Pindar	++	—			++

4. FIJI DISEASE IN MADAGASCAR

The Fiji resistance trial established at Brickaville in July 1959 in co-operation with the «Institut de la Recherche Agronomique de Madagascar» was visited during the year.

The twenty-one varieties included in the trial are: B.34104, B.3337, B.37161, B.37172, M.147/44, M.31/45, Trojan, Ragnar, Atlas, Vesta, Q.42, Q.47, Q. 49, Q.57, R.366, R.397, P.R.1000, POJ.2878, Pepecuca, S.17 and Co.301. The controls are the susceptible M.134/32, the tolerant N:Co.310 and the resistant Pindar.

The trial was established in a highly contaminated field of M.134/32. The infection material is being provided by rows and strips of cane which were left standing between varietal plots. So far the distribution of the disease in the canes providing infection in the trial has been very homogeneous, the latest survey having revealed the presence of 1258 diseased stools scattered throughout the experimental plot. If, in places, infected stools of M.134/32 are severely stunted, a large number of diseased plants, although showing the characteristic galls and "witches' broom" effect on the stalks, are as tall as the plants under test thus providing easy physical access to the vectors.

A preliminary assessment of varietal reaction has been made in virgins. Twenty-three plants have contracted infection in the plots of varieties under test. These include: M.134/32, N:Co.310, M.147/44, B.34104 and Q.42. As it has been observed in Madagascar that expression of disease symptoms was more rapid in progeny derived vegetatively from stools carrying latent infection than in ratoons from such plants, a proportion of the material obtained after ratooning the trial was planted to observe disease symptoms. These results will supplement the assessment to be made later in the trial in first ratoons.

A second trial was planted beside the existing one in July, 1960. The following varieties are included: Co.290, Co.421, R.397, CP.29-116, M.112/34, Pepecuca, B.4362, and Jason. The same three varieties are serving as controls : M.134/32, N:Co.310 and Pindar.

The three varieties recently released for commercial plantings M. 202/46, M.93/48 and M.253/48 and two promissing seedlings M.423/51 and Ebène 50/47 are in the quarantine greenhouse in Madagascar and will be included in a resistance trial in 1961.

In addition to the assessemnt of varietal reaction to the disease, observations made in variety plots and in commercial plantations have been recorded. Such observations compared to those given by Martin* are recorded in table 23. The symbol rating used is the one generally adopted, namely:

+ +	very highly resistant
+	highly resistant
= +	moderately resistant
=	average
= –	moderately susceptible
—	highly susceptible
— —	very highly susceptible

Table 23. Reactions of sugar cane varieties to Fiji disease in various countries.

Variety	In Madagascar	Symbol rating According to Wismer & Martin **
H.37-1933 ...	+	— + (Samoa) + (Fiji)
N:Co.310 ...	— or =—	= + (Australia)
Co.290 ...	+ +	+ + (Australia & Samoa)
Pindar ...	+ or = +	=— (Fiji) + (Australia)
B.34104 ...	—	
B.37161 ...	— or =—	
B.37172 ...	— or =—	
Q.42 ...	—	= or = + (Australia)
P.O.J.2878 ...	—	— (Samoa) — (Australia)
M.147/44 ...	—	
M.134/32 ...	— —	— (Fiji)
M.76/39 ...	— —	+ + (Fiji)
M.63/39 ...	— —	
Louzier ...	— —	
Batavia ...	—	
Port Mackay	—	
P.R.905 ...	=	
Co.419 ...	—	— — (Australia)

* *Martin, J. P. (1928). Field observations on the degree of resistance and susceptibility of seedlings to eye spot.* Hawaii. Plant. Rec., 23 : *275-279.*

** *Martin, J.P. and C.A. Wismer (1956). The resistance of sugar cane varieties to their major diseases.* I.S.S.C.T. Proc. 9th Cong. *India. 1030-1042.*

The typical Fiji disease symptom, the leaf gall, may vary in size and colour from minute yellowish-white to long thick glistening white protuberances as shown in fig. 32.

The eradication campaign agaisnt the disease in Madagascar is progressing satisfactorily and due credit should be paid to the Agricultural Authorities for their long and sustained efforts under difficult conditions.

Surveys of the cane lands in the whole province of Tamatave have now been completed. Rogueing and inspection gangs have been re-grouped and the main effort is concentrated on the cane zones of Brickaville and Tamatave. It is significant to note that surveys carried out over two months in the commercial plantations of the district of Tamatave have not revealed a single case of Fiji disease.

In addition, the scattered small plantations of sugar cane along the tracks leading from the contaminated region to the province of Majunga and the district of Maroantsetra have been inspected and found to be free from Fiji Disease.

CANE PESTS

J. R. WILLIAMS

1. THE STALK BORER

THE stalk borer (*Proceras sacchariphagus* Boj.) contributed substantially to the loss caused by the intense cyclones of 1960 owing to breakage of canes at weak points where borer galleries occurred. The insect is, however, responsible for considerable annual losses irrespective of cyclonic winds, which serve to emphasize its presence, and in the last ten years or so it has gained importance in the higher altitudes, probably due to the change in the varietal composition of the crop in these regions. The borer is undoubtedly the most important, as well as the most conspicuous, pest of cane in the island and research upon the various aspects of its biology and upon control methods is being intensified.

The stalk borer occurs in new plantations where in conjunction with the pink and white borers, it kills newly germinated shoots. It is not, however, particularly important at this stage and difficulty which may be encountered in establishing uniform stands of virgin cane, due to death of tillers and necessity of repeated recruiting, is chiefly due to the pink and white borers. Unlike these latter pests, the stalk borer is active in shoots of all ages and its importance does not diminish as the cane grows. On the contrary, it is in the older shoots that the stalk borer does most damage. The larvae tunnel in the stalk below the growing point where the stem tissues are soft and if several larvae are present the top of the stalk may die and side shoots sprout from the younger buds. Lesser mechanical injury causes constriction of the stalk, shortening of internodes, sprouting of buds near the point of attack and a final reduction in size and weight of stalks at harvest. There is also a decrease in the amount of juice in the stalks and an increase in the amount of non-sugars and gums while the borer galleries also permit the entry of bacteria and fungi which cause further undesirable effects. Finally, bored tops when included in planting material result in germinating failures.

Unfortunately, cultivation practices sometimes favour the abundance of the stalk borer. The water-shoots which are left at harvest in the higher altitudes, to promote early growth of ratoon cane, enable the insect to survive in numbers and quickly reinfect the succeeding crop. Cane tops left in the interlines also probably serve to carry over the insect to the next crop. Again, some important commercial canes are susceptible and not only is damage in them proportionately greater but they may permit the borer population to rise to a high level and affect surrounding fields.

The incidence and importance of the stalk borer in cane plantations is associated with the cane varieties under cultivation and an early assessment of the relative resistance of new, promising, varieties is obviously important. In variety trials, where several varieties are grown in small adjacent plots, the insect is not presented with the same conditions that exists in the uniform stands of varieties found on estates. The severity of borer attack on varieties in variety trials does not, therefore, necessarily reflect the resistance to borer which would be shown by the same varieties in commercial plantings. For this reason, a reliable assessment of the borer resistant qualities of a variety has been possible only by repeated observations in the field following its extensive propagation. It would obviously be an advantage if data from variety trials could be employed to determine, or at least to indicate reliably, the relative resistance of a new variety before it becomes widely cultivated.

For several years it has been the practice to determine at harvest the percentage of stalks and joints (internodes) bored in the different varieties included in trials where appreciable borer infestation occurred. The data so acquired was of doubt-

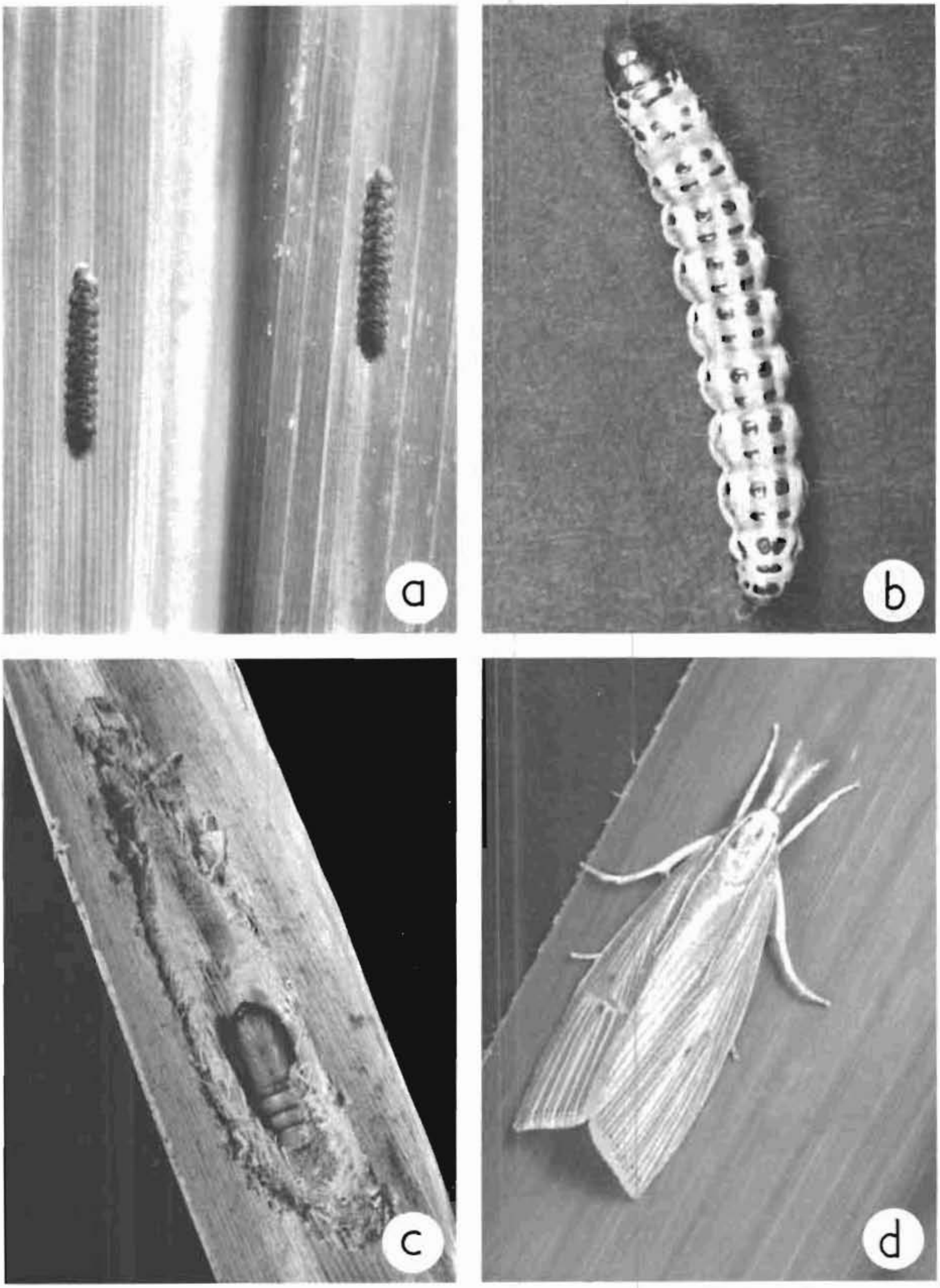

Fig. 35 Stages in the life-cycle of the stalk borer, *Proceras sacchariphagus* Boj. (a) Eggs (b) Larva (c) Pupa (d) Adult.

ful significance for assessing varietal resistance to borer. Agreement between conclusions drawn from variety trials and those obtained from field experience of the same varieties was necessary to establish the value of the former.

The method used to gauge the degree of borer attack in variety trials was to determine the percentage of stalks and joints bored in samples of 30 stalks taken at random from each plot at harvest. There were four replications of each variety so that 120 stalks of a variety were examined in each trial. Data was available from 27 trials and, including virgin and ratoon canes, comprised 65 sets of figures which compared borer damage of the varieties included in the respective trials. The results are expressed in table 24. In each section of the table, one variety has been taken as the standard and the borer "infestation" (% stalks and joints bored) of other varieties compared with it.

All the varieties included in table 24 are exten-

Table 24. Incidence of stalk borer in variety trials.

Variety	No. of Comparisons with standard	Infestation relative to standard: Higher	Lower	Same	Tentative rating relative to standard
Standard - M.31/45					
M.147/44	35	6	27	2	Resistant
M.134/32	21	5	15	1	Resistant
B.37172	14	2	11	1	Resistant
E.1/37	16	6	6	4	Same
Standard - E.1/37					
M.134/32	14	3	9	2	Resistant
B.37172	28	2	22	4	Resistant
B.3337	14	1	11	2	Resistant
M.31/45	16	6	6	4	Same
Standard - B.37172					
M.147/44	16	4	3	9	Same
B.3337	14	4	6	4	Same
M.134/32	14	5	4	5	Same
M.31/45	14	11	2	1	Susceptible
E.1/37	28	22	2	4	Susceptible
Standard - M.147/44					
B.37172	16	3	4	9	Same
M.31/45	35	27	6	2	Susceptible
Standard - M.134/32					
B.37172	14	4	5	5	Same
B.3337	14	4	7	3	Same
M.31/45	21	15	5	1	Susceptible
E.1/37	14	9	3	2	Susceptible
Standard - B.3337					
B.37172	14	6	4	4	Same
M.134/32	14	7	4	3	Same
E.1/37	14	11	1	2	Susceptible

sively cultivated commercial varieties and their resistance to borer, assessed by field experience, was discussed on pages 66-67 of the Annual Report for 1958. Study of the figures shows that the combined data from variety trials leads to conclusions which agree with those derived from field experience. Thus the varieties may be divided into two groups, the first containing the susceptible varieties M.31/45 and E.1/37, the second containing the more resistant M. 147/44, B. 37172 and M. 134/32. There is little difference between the varieties in each group.

As a result of this agreement between data from variety trials and field experience, it now seems permissible to attach greater significance to the former when they concern new, untried varieties. The data must still, however, be used with reserve for the percentage of bored stalks and bored joints is by no means a satisfactory criterion of the intensity of attack or of loss sustained. It is, however, the only definite data relating to borer attack which can be acquired in a routine manner when harvesting trials. Information of this nature concerning the new varieties M.202/46, M.93/48, and M.253/48 is still limited but suggests that all are more susceptible than M.147/44.

Introduction of foreign parasites for trial, chiefly against the stalk borer, was continued. A total of 122 consignments of parasitic insects were received by air from India through the cooperation of the Commonwealth Institute of Biological Control and, although many of them were failures because of mortality in transit, the following species were released — *Goniosus* sp., *Melcha ornatipennis* Cam., *Stenobracon deesae* Cam., *Stenobracon nicevillei* Bingh., *Iphiaulax* sp., *Sturmiopsis inferens* Tns., and *Apanteles* sp. In this connection, figure 36 shows the parasites of cane moth borers which exist in Mauritius at present. The stalk borer, the pink borer, and the white borer are considered together since some parasites attack more than one kind of borer. The parasites introduced recently from India are also included but it is not known if any of them have become established.

Late in December, a larva of the stalk borer collected at Mon Trésor was found to be parasitised by *Agathis stigmatera* (Cress.), a Braconid parasite which had been introduced from Trinidad during the period 1949 - 1953. The actual number of female *A. stigmatera* released was 15 in 1949, 540 in 1951, and 70 in 1953. The recovery of this parasite in the field so many years after its introduction is of considerable interest. It is evidently firmly established and a search will now be made to determine its incidence in the island.

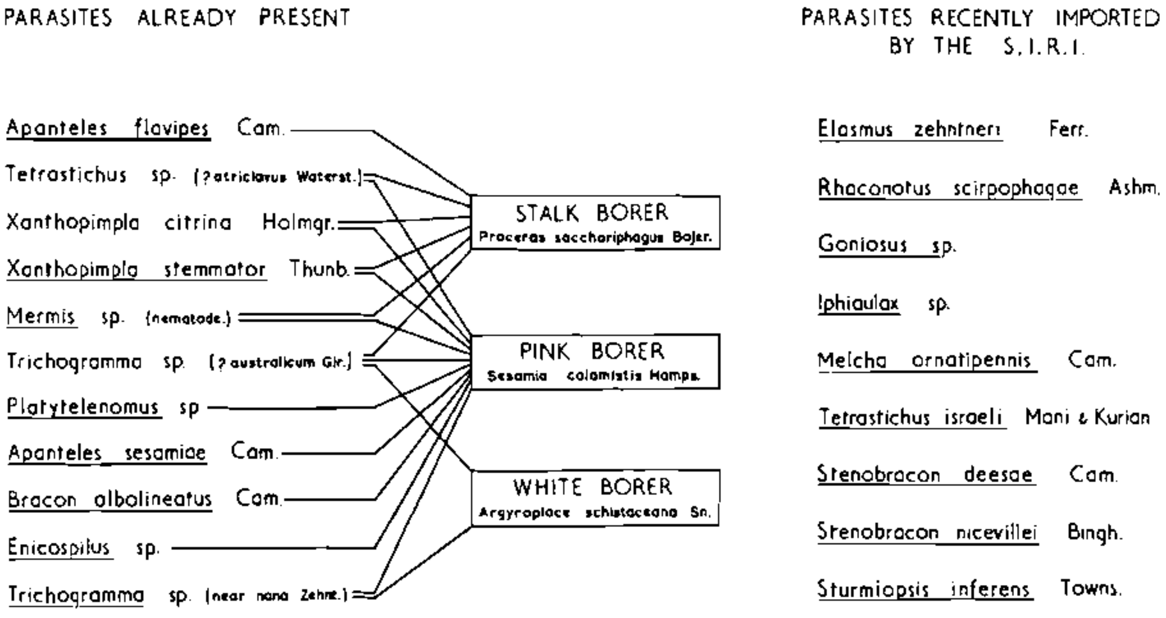

Fig. 36. Parasites of sugar cane moth borers in Mauritius.

2. NEMATODE INVESTIGATIONS

Soil and root samples taken in various parts of the island have revealed that the commonest nematode species associated with cane roots are *Pratylenchus zeae* and *Helicotylenchus nannus*. Other phytophagous species which have been found and identified, while not so ubiquitous, may on occasions occur in large numbers. These include species of *Trichodorus*, *Paratylenchus*, *Tylenchorhynchus*, *Radopholus*, *Hemicycliophora* and *Meloidogyne*. The effect of most of these nematodes upon cane growth is still obscure. It has been noticed that quite heavy infections of the burrowing nematode, *Radopholus similis*, may occur in roots of cane which appears healthy and vigorous.

Infectation by root-knot nematodes (*Meloidogyne* spp.) is often severe in sandy coastal soils but elsewhere seems to be uncommon and always slight. Infected roots are not conspicuously galled, as are the roots of many other plants when attacked by these nematodes, and microscopic examination of cane roots is always necessary to confirm a suspected attack. It is the finer roots which are mostly infected and the galls are few, small, and the most conspicuous of them are terminal. Owing to the absence of pronounced hypertrophy following infection and the small diameter of the roots concerned, the egg masses are found on the surface of the roots under the gelatinous exudate of the females. Removal of the egg masses reveals the females bulging through the ruptured tissues. Badly infected roots tend to be densely branched near the region of invasion so that a bunchy growth is evident. This feature seems of more value, as a gross diagnostic character, than the presence or absence of galls.

Many female *Meloidogyne* taken from cane roots in one locality contained an unidentified and previously unrecorded protozoan. An account of this organism, which appears to be a beneficial parasite, has been given elsewhere.*

Two soil fumigation experiments were destroyed by cyclones. It may be worth noting, however, that in two identical experiments on sandy soil, early growth of virgin cane was greatly stimulated in one and unaffected in the other by preplanting treatment with ethylene dibromide. The experiment showing growth stimulation had been laid down on land formerly growing cane but the other was on land newly cultivated.

3. OTHER INVESTIGATIONS

(a) Insecticides against white grubs

No further data could be obtained during the year from field trials owing to the destructive effect of the cyclones. It has, however, been decided not of pursue this work further in view of the disappointing results obtained. When this project was initiated, the use of aldrin or chlordane at planting appeared to offer a simple and cheap method of preventing white grub (*Clemora smithi*) infestation for a prolonged period while reports indicated also that growth improvements might result from suppression of other soil arthropods. Sufficient is known to conclude that, at least under local conditions and with the varieties grown, insecticidal doses cannot be safely applied to the soil and further work along these lines is not at present desirable.

(b) Army worms

Several outbreaks of the army worm (*Leucania loreyi*) were again reported during the year, always on young ratoon shoots in fields which 20 - 30 days previously had been burnt before cropping. The outbreaks are believed to result from a migration of moths into burnt fields to feed upon the juices forced out of the cane stalks by heat. The eggs deposited by the moths give rise to larvae which defoliate the young shoots which subsequently emerge. To confirm this theory, several fields were visited at night after they had been burnt and searched for moths feeding upon the drops of juice on the cane stalks. *Leucania* moths were not found but as no attacks developed later in the fields visited, the absence of moths nevertheless supports the sequence of events presumed to result in attacks.

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* *See publications listed on p. 33*

An experiment was laid down to determine if complete defoliation of young ratoon shoots has any appreciable effect upon subsequent growth.

(c) Food-plants of the pink borer

The pink borer of sugarcane (*Sesamia calamistis*), mentioned in section 1 above, lives primarily in wild grasses and a start was made at the end of the year to search for and identify its various host-plants as a preliminary to a more exhaustive study of this pest.

(d) Dispatch of beneficial insects to Madagascar.

During the course of investigations upon the biology of the stalk moth borer, numerous specimens of the parasite *Apanteles flavipes* Cam. were obtained from field collected borer larvae. The parasite does not apparently exist in Madagascar and, as the authorities there wished to introduce it, nine consignments comprising 61 batches of cocoons were dispatched in December.

WEED CONTROL

E. ROCHECOUSTE

1. HERBICIDAL VALUE OF SUBSTITUTED UREAS AND TRIAZINE COMPOUNDS IN THE SUPERHUMID AREAS.

CHEMICAL weed control in the super-humid zone where it rains almost all the year round sets a very difficult problem. In fact herbicide application in that zone is so tied up with rainfall that it often happens that a herbicidal spray has to be delayed for weeks, thus bringing conditions unsuitable for chemical weeding with regard to cane growth; this occurs more particularly at planting time. Further, the success of a herbicidal application may be completely ruined owing to uninterrupted rains experienced for weeks after the herbicidal spray. It must also be emphasized that the practice after harvest of lining up the trash on an interline which does not receive a herbicidal spray has led to unsatisfactory results. In fact the fairly quick rotting of the trash owing to the moist conditions generally prevailing in that zone contributes to the establishment of permanent foci of weed infestation on that interline. Obviously therefore, the efficiency of a herbicide becomes impaired not because the treatment has been ineffective, but because weed growth soon resumes activity on the untreated interline once the trash begins to rot.

Investigations on that particular aspect of the problem were conducted along two lines:

(i) evaluation of herbicides of low solubility in comparison to standard formulations in use,

(ii) evolution of a technique that would solve the problem of weed infestation arising from the quick rotting of trash in the untreated interline.

In these experiments weed eradication under the conditions prevailing in the superhumid zone were carried out in plant canes and ratoon canes.

Plant canes. The substituted ureas DCMU (Karmex) CMU (Telvar) and the triazine compounds Simazine and Atrazine (5-8lb.) were used alone and in combination with sodium chlorate (10 lb.) and TCA (10lb.) and were compared to a standard formulation consisting of an MCPA or 2,4 - D derivative (4 lb a.e.) TCA (10 lb.) and sodium chlorate (10 lb.). The herbicides were applied in pre-emergence spray about a week after planting at the above rates of the commercial product per arpent. Weed assessment was made by the frequency-abundance method four months after herbicidal application.

Ratoon Canes. In ratoon canes the substituted ureas DCMU, CMU and the triazine compounds Simazine and Atrazine (4-6 lb.) were used in combination with sodium chlorate, TCA and dalapon (6 lb.) and were compared to a standard formulation consisting of an MCPA or 2,4-D derivative (4 lb a.e.), Sodium chlorate (6 lb) and TCA (6 lb). As in plant canes, rates of application were in pounds of the commercial product per arpent and weed assessment was made by the frequency-abundant method.

In an attempt to solve the problem of weed infestation from untreated interlines the following experimental layout was adopted:

(i) After harvest the trash was lined up on the interline where remnants of the trash of the preceding season still persisted.

(ii) one week after this operation the interline free of trash received a herbicidal spray.

(iii) the following week the trash was transferred to the interline which had been chemically treated.

(iv) a week later the interline now free of trash received a herbicidal treatment.

As it will be observed in this technique, the total amount of a herbicide to be sprayed on an arpent of ratoon canes, say 6 lb., instead of being applied in one operation is, in fact, applied in two, but at half the dosage each time, i.e. 3 lb. In this way the whole field received a herbicide treatment as compared to only part of it in usual parctice.

Results. In plant canes the best treatment was, as shown in table 25 and in fig. 38 a formulation consisting of DCMU (5 lb.) and sodium chlorate (10 lb.). When used alone CMU was found more effective than Simazine in some trials, but in others they were comparable. However, in treatments where these herbicides were applied in combination with sodium chlorate they proved of about equal effectiveness. Further Simazine at 8 lb. was not found more effective than Simazine at 5 lb. It must also be observed that greater efficacy was not obtained when the herbicides were formulated with TCA alone or with TCA and sodium chlorate as compared to combinations with sodium chlorate alone. Although Atrazine was included only in a few trials yet there are indications that it is comparable in its effect to CMU and Simazine but is less effective than DCMU.

In ratoon canes, as shown in table 26, the best treatments consisted of a combination DCMU (6 lb.) and sodium chlorate (6 lb.) or dalapon (6lb.). It must be observed, however, that the DCMU-sodium chlorate treatment should be preferred owing to the deleterious effect of the DCMU — dalapon treatment on cane growth as exemplified by malformations of young cane shoots. In general it would appear that for maximum efficacy a dosage lower than 5-6 lb. per arpent is not to be recommended.

Effects on weeds. In general perennial weeds were not affected but DCMU has an excellent suppressing effect on the growth of *Oxalis debilis* and *Oxalis latifolia*, as compared to CMU and the two triazines. Although all the herbicides gave a good control of annual weeds, yet, DCMU proved the more effective, both in showing longer persistence in the soil and affecting a wider range of weeds. In fact Simazine, CMU and Atrazine exercised their effects only during the first 2-3 months following the treatment, after which weed invasion began, whereas in DCMU treated plots weed growth was checked for a period varying from 4 to 6 months. In general the annuals that were better controlled by DCMU than the other herbicides were: *Digitaria timorensis* (Meinki), *Setaria pallidefusca* (Millet Sauvage), *Setaria barbata* (Herbe bassine, Herbe Bambou), *Pycreus ferrugineus*, *Oxalis repens* (Petit oseille, Petit trèfle), *Lobelia cliffortiana* (Brède mamzelle), *Ageratum conyzoides* (Herbe bouc), and *Crepis japonica*. The following annuals, however, were apparently resistant to all the herbicides experimented: *Argemone mexicana* (Chardon), *Plantago lanceolata* (Plantain) and to a lesser extent *Paspalum paniculatum* (Herbe duvet).

General Conclusions. From results of experiments carried out during the years 1959-1960 it can be concluded that DCMU has shown outstanding herbicidal properties in the superhumid zone. It has outclassed CMU and the triazine compounds both in its longer persistence in the soil and its effects on a broader weed spectrum. Although effective when used alone, it would appear that a greater efficacy is obtained when it is formulated with sodium chlorate. Its potency with regard to the eradication of the two most noxious annuals of the wet localities, «meinki» and «millet sauvage» gives to the planters a very useful tool against these weeds. The technique involving the transfer of trash from one interline to another in order to apply a herbicidal spray to the whole field has given excellent results and its adoption in general practice is highly recommended in the wet localities of the island.

Table 25. Comparative efficacy of substituted ureas and triazine-compounds in plant canes.

TREATMENTS (Rates in lb of the commercial product per arpent in 60 gallons of water).	WEED INFESTATION % STANDARD FORMULATION — Localities — 1959 Trials: Alma No. 1	New Grove No. 1	Rose Belle* No. 1	St. Félix No. 1	Localities — 1960 Trials: Riche en Eau No. 1	Alma No. 2	New Grove No. 2	Rose Belle* No. 2
CMU (5)	33	72	65	33	46	62	—	57
DCMU (5)	33	61	65	33	27	28	—	31
Simazine (5)	51	74	96	51	64	62	—	76
Atrazine (5)	—	—	—	—	—	53	—	55
Simazine (8)	53	80	88	53	—	—	—	—
CMU (5) + Sodium Chlorate (10) ...	32	—	—	—	52	64	65	61
DCMU (5) + Sodium Chlorate (10) ...	25	—	—	—	15	13	32	15
Simazine (5) + Sodium Chlorate (10) ...	30	—	—	—	51	62	84	74
Atrazine (5) + Sodium Chlorate (10) ...	—	—	—	—	—	60	—	61
Simazine (8) + Sodium Chlorate (10) ...	37	—	—	—	—	—	—	—
CMU (5) + TCA (10)	—	—	—	—	62	69	70	79
DCMU (5) + TCA (10)	—	—	—	—	34	30	51	17
Simazine (5) + TCA (10)	—	—	—	—	56	84	83	66
Atrazine (5) + TCA (10)	—	—	—	—	—	63	—	55
CMU (5) + TCA (10) + Sodium Chlorate (10)	—	—	—	—	60	—	65	60
DCMU (5) + TCA (10) + Sodium Chlorate (10)	—	—	—	—	20	—	47	32
Simazine (5) + TCA (10) + Sodium Chlorate (10)	—	—	—	—	84	—	74	67
Atrazine (5) + TCA (10) + Sodium Chlorate (10)	—	—	—	—	—	—	—	57
RAINFALL								
Total rainfall (inches) during experiment. ...	19.60	29.38	26.11	11.90	23.78	27.99	19.55	31.55
No. of rainy days.	60	77	94	44	84	82	68	90

* The assistance given by Mr. R. Ng, Agronomist for the laying down of these trials is gratefully acknowledged.

Table 26. Comparative efficacy of substituted ureas and triazine compounds in ratoon canes.

TREATMENTS (Rates in lb of the commercial product per arpent in 80 galls. of water).	WEED INFESTATION % STANDARD FORMULATION — Localities — 1959 Trials: Valetta No. 1	Valetta No. 2	Bonne Verne	Alma	Localities — 1960 Trials: St. Aubin No. 1	St. Aubin No. 2	Bel Etang	Britannia	Riche en Eau
CMU (6)	—	—	—	—	55	—	—	—	—
DCMU (6)	—	—	—	—	35	—	—	—	—
Simazine (6)	—	—	—	—	65	—	—	—	—
CMU (6) + Sodium Chlorate (6) ...	78	76	62	65	43	48	59	64	33
DCMU (6) + Sodium Chlorate (6) ...	38	32	33	29	12	16	26	45	11
Simazine (6) + Sodium Chlorate (6) ...	67	111	67	88	40	46	65	45	76
Atrazine (6) + Sodium Chlorate (6) ...	—	—	—	—	—	51	—	67	63
CMU (6) + dalapon (6) ...	56	64	47	48	52	—	—	—	—
DCMU (6) + dalapon (6) ...	22	40	25	27	31	—	—	—	—
Simazine (6) + dalapon (6) ...	71	64	64	64	48	—	—	—	—
CMU (4) + Sodium Chlorate (6) ...	—	—	—	—	62	—	69	—	—
DCMU (4) + Sodium Chlorate (6) ...	—	—	—	—	30	—	53	—	—
Simazine (4) + Sodium Cholrate (6) ...	—	—	—	—	46	—	71	—	—
CMU (6) + TCA (6)	—	—	—	—	—	28	—	—	41
DCMU (6) + TCA (6)	—	—	—	—	—	13	—	—	19
Simazine (6) + TCA (6)	—	—	—	—	—	31	—	—	78
Atrazine (6) + TCA (6)	—	—	—	—	—	30	—	—	71
CMU (4) + Sodium Chlorate (6) + TCA (6)	—	—	—	—	—	37	70	—	53
DCMU (4) + Sodium Chlorate (6) + TCA (6) ...	—	—	—	—	—	16	30	—	28
Simazine (4) + Sodium Chlorate (6) + TCA (6) ...	—	—	—	—	—	33	67	—	87
Atrazine (4) + Sodium Chlorate (6) + TCA (6) ...	-	—	—	—	—	36	—	—	77
RAINFALL									
Total rainfall (inches) during experiment	63.34	53.03	54.62	78.43	28.44	33.89	30.72	23.47	18.52
No. of rainy days.	82	52	47	83	79	64	96	68	76

2. EFECT OF SUBSTITUTED UREAS, TRIAZINE COMPOUNDS AND TCA ON CANE GROWTH.

In the chemical weeding of plant canes the first herbicidal spray is usually applied a few days after planting but before cane emergence. In practice, however, it often happens that this first spray has to be delayed, thus setting particular conditions, in regard to cane growth. In fact at the time the spraying is made the canes often are at different stages of their early growth and consequently more susceptible to herbicide treatment. Experiments were carried out during the year on that particular aspect of the problem as described hereunder.

Experimental. The substituted ureas, DCMU and CMU and the triazine compounds Simazine and Atrazine were applied at the rate of 5 lb. per arpent just after planting, 10 days and four weeks later, while TCA was used at the rate of 10 lb. per arpent after planting only. Plot size was 1/200 arpent and the treatments were randomized with fourfold replications. The cane cuttings of the variety Ebène 1/37 used in these trials were treated against chlorotic streak by the short hot water treatment. Observations on germination were made and cane growth measured 3 months after planting. Cane elongation 6 and 9 months later could not be carried out as originally planned owing to damage caused to experimental plots by cyclone Carol.

Results. No effect on germination was observed in all treatments and the chemicals did not affect cane growth and tiller production significantly (table 27). It must be observed here that climatic conditions were favourable to cane growth during the three months these experiments were running.

Table 27. Effect of herbicides on cane growth, 3 months after planting.

Treatments (Rates in lb. commercial product per arpent)	Mean shoot length in cms.		Mean No. of shoots per plot	
	Belle Rive	Union Park	Belle Rive	Union Park
DCMU — 5 lb just after planting ...	15.2	12.5	66	78
CMU — 5 lb „ „ „ ...	14.1	11.0	55	73
Simazine — 5 lb „ „ ...	15.3	11.0	58	72
Atrazine — 5 lb „ „ ...	16.3	11.2	55	73
Atrazine — 8 lb „ „ ...	16.6	10.5	52	66
TCA — 10 lb „ „ ...	14.4	10.1	55	75
DCMU — 5 lb 10 days after planting ...	18.5	11.2	57	67
CMU — 5 lb „ „ „ „ ...	16.6	12.0	60	74
Simazine — 5 lb „ „ „ „ ...	14.8	10.5	58	70
DCMU — 5 lb 4 weeks after planting ...	15.7	9.2	62	66
CMU — 5 lb „ „ „ „ ...	15.0	14.7	64	65
Simazine — 5 lb „ „ „ „ ...	14.2	11.9	59	70
Control	16.0	12.3	54	64

3. EFFECT OF TCA AND DALAPON ON CANE YIELD.

The most effective way controlling *Cynodon dactylon* in sugar plantations is to treat the grass with fairly high rates of TCA or dalapon, either before planting the field, or in plant canes at the time the canes close in. Experiments were carried out in order to determine the tolerance of sugar cane to these herbicides under these particular conditions.

Experimental. A trial was laid down at Réduit Experimental Station with the variety M.31/45. Plot size was 1/100 arpent and the lay-out was a randomized block with 4 replications. The cuttings were treated against chlorotic streak disease by the short hot water treatment. The experimental plots consisted of TCA and dalapon, applied at one month and at two months before planting and in plant canes which have just formed a canopy. Observations on germination and subsequent growth were made at intervals and experimental plots were harvested 14 months after planting.

Results. No significant difference in cane yield was recorded in any treatment (table 28), although there were indications that the 20 lb. dalapon and 200 lb. TCA treatments have affected cane growth adversely. Further, all dalapon treatments in plant canes caused malformations of young tillers, the effects being more severe in the 20 lb. treatment. On the other hand, no abnormal growth was experienced in the TCA treatments in plant canes.

Table 28. Effect of TCA and dalapon on cane yield.

Treatments Rates in lb./arpent			Yield in Tons/arpent
TCA	— 100 lb.	applied two months before planting	30.8
,,	— 150 lb.	,, ,, ...	28.2
,,	— 200 lb.	,, ,, ...	30.4
Dalapon	— 20 lb.	,, ,, ...	27.8
,,	— 40 lb.	,, ,, ...	32.0
,,	— 80 lb.	,, ,, ...	31.4
TCA	— 100 lb.	applied one month before planting	30.4
,,	— 150 lb.	,, ,, ...	27.7
,,	— 200 lb.	,, ,, ...	31.4
Dalapon	— 20 lb.	,, ,, ...	27.8
,,	— 40 lb.	,, ,, ...	31.2
,,	— 80 lb.	,, ,, ...	27.8
TCA	— 100 lb.	applied in plant canes 7 months old	29.2
,,	— 150 lb.	,, ,, ...	29.7
,,	— 200 lb.	,, ,, ...	26.1
Dalapon	— 10 lb.	,, ,, ...	27.2
,,	— 15 lb.	,, ,, ...	28.2
,,	— 20 lb.	,, ,, ...	25.6
Control ...		... ...	29.2

4. EVALUATING NEW HERBICIDES WITH THE CHESTERFORD LOGARITHMIC SPRAYER

The technique of variable dosage spraying also called «logarithmic spraying» was used this year for the evaluation of new herbicides. The principle of dilution in the Chesterford logarithmic sprayer used for such work as described by Hartley, Pfeiffer and Brunskill, is to pump liquid from an intermediate vessel filled with the chemical at a known concentration to the spray nozzles. As spray liquid is drawn from the intermediate vessel it is replaced by an equal quantity of the diluting liquid and the concentration therefore falls in an exponential manner. During the spraying procedure the machine moves at constant speed and consequently the volume sprayed is proportional both to time and distance. In this type of experiment the concentration is an exponential function of distance along the plot or in other words the distance is a logarithmic measure of the concentration. One important advantage of this technique is economy of time and labour. Further in using the logarithmic spraying for testing new herbicides one has the advantage of observing the effect of continuously decreasing dosage both on crop and on weeds. In an experimental plot sprayed with this machine one can also see a fairly sharp defined region on the dilute side of which the crop has been unharmed by the spray and another well defined region on the high concentration side of which the weeds are severely affected. The concentrations at which these effects are observed can be measured directly in terms of distance and by reference to a calibration graph in terms of dosage-ratio. A full description of the Chesterford Logarithmic Sprayer is given in «Variable Dosage Spraying for Experimental Work» by Hartley, Pfeiffer and Brunskill (Proc. 3rd British Weed Control Conference, 1956-p.571).

Experimental. Two logarithmic trials were laid down at the Belle Rive Experiment Station in order to assess the following new herbicides in pre-emergence application; Atrazine, Simazine, DCMU, Weedazol, Emid, Fenac, Benzac, TBA, Fisons 18/15, CMPP, T480, Promethone and Alipur. In each trial the treatment was duplicated. Ten weeks after planting each 15 yard of logarithmic plot was subdivided into 3 yard sub-plots. Effects on weeds and cane growth were assessed in the sub-plots by the frequency-abundance method and shoot length measurement respectively. In the second trial information on cane growth could not be obtained owing to erratic germination and development of the setts in all treatments.

Results and Conclusions. Data obtained in the logarithmic trials are presented in tables 29& 30. From the results obtained it will be observed that Fenac, Benzac and TBA gave satisfactory results from a herbicidal view point but on the other hand they affected cane growth even at the lowest rates of application. CMPP gave fairly good results in one trial but proved less effective in the other and at the highest concentration cane growth was slightly affected. No information on the effect of Promethone on cane growth was obtained but its effect on weeds proved quite satisfactory. On a pound active basis, DCMU proved the best herbicide.

The use of the logarithmic sprayer for testing new herbicides has this year facilitated experimental work in that field. In fact this technique has shown its usefulness in supplying in a relatively short time basic information on the herbicides under test both with regard to the weeds and to the crop. Compared to the orthodox method of assessing phytotoxicity where to obtain valid information on new herbicides means spraying a series of plots over a fairly wide range of dosages, the logarithmic spraying technique undoubtedly offers the advantage of economy and time.

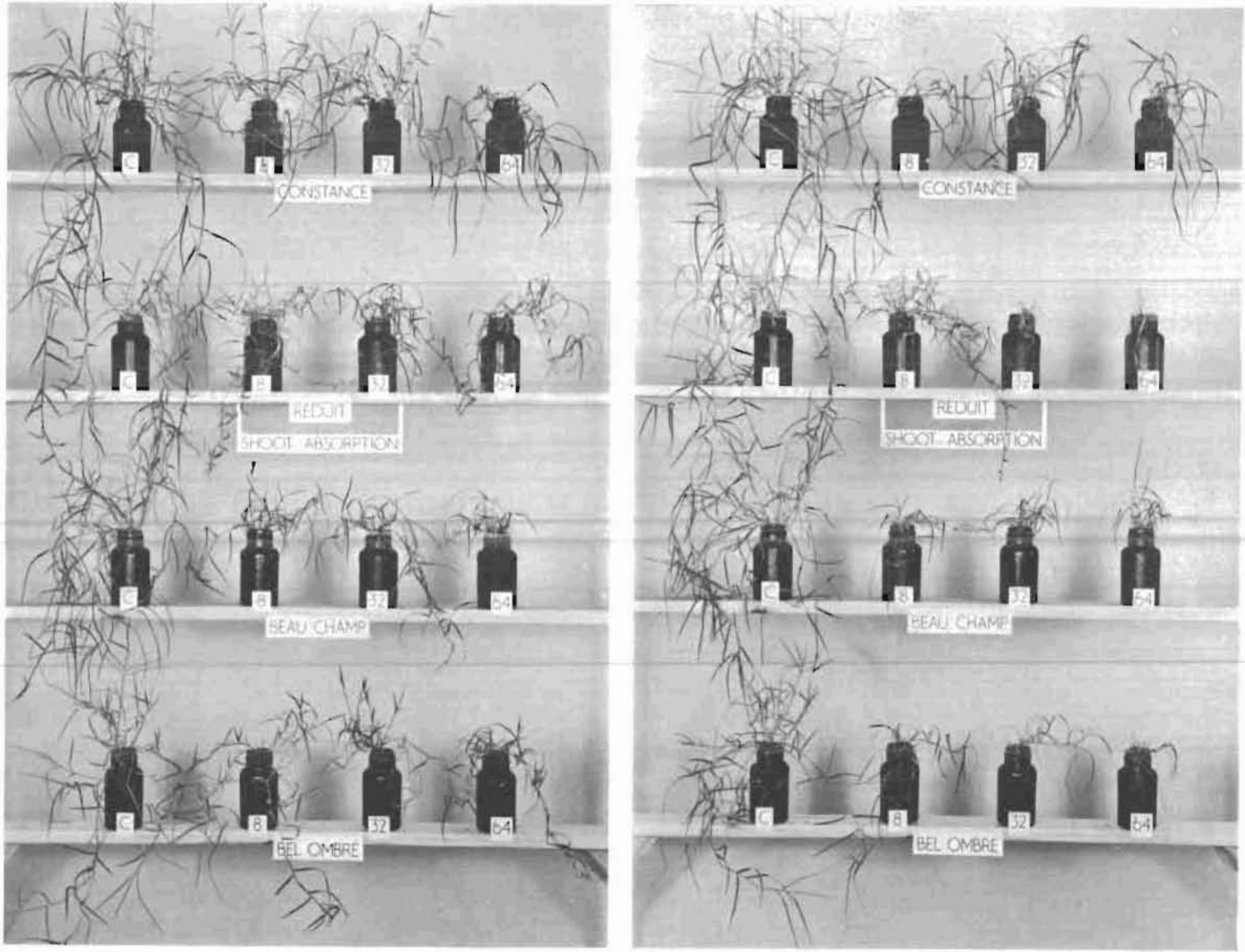

Fig. 37. Effects of TCA (left) and Dalapon (right) on *Cynodon dactylon* biotypes. Applications on shoots at rates of 8, 32 and 64 parts per thousand.

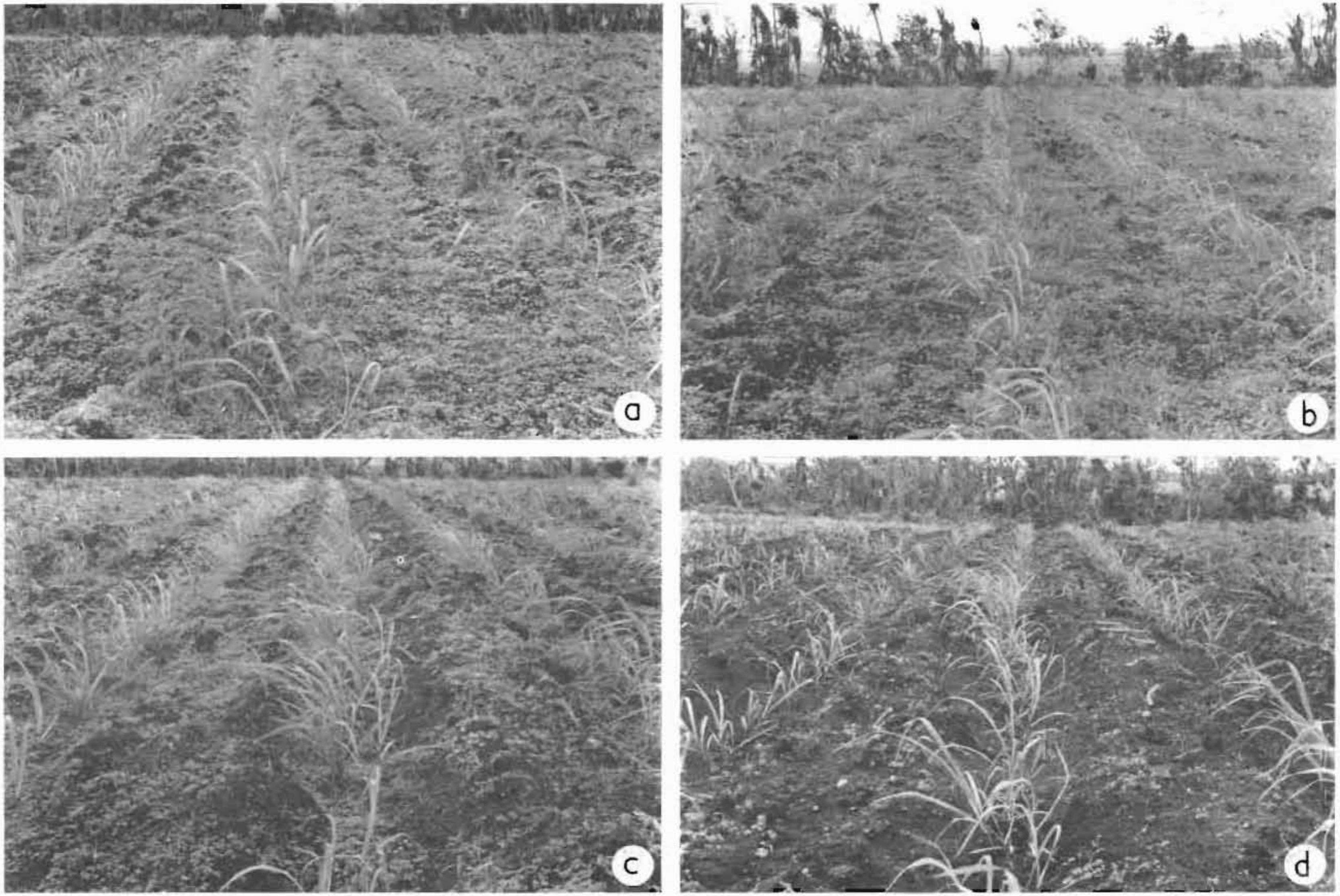

Fig 38 Effect of substituted ureas and triazine compounds (5 lb.) plus sodium chlorate (10 lb) in pre-emergence treatment in plant canes 4 months after application.
(a) Simazine (b) Control
(c) Primatol (d) DCMU

Table 29. Effects of new herbicides on weed infestation and cane growth 10 weeks after planting — Trial No. 1.

Treatments	Weed Infestation % Control — Dosage range per arpent (lb. active) per 3 yd. logarithmic strip						Mean Shoot Length % Control — Dosage range per arpent (lb. active) per 3 yd. logarithmic strip					
	7.0—5.2	5.2—3.9	3.9—3.0	3.0—2.2	2.2—1.7	1.7—1.3	7.0—5.2	5.2—3.9	3.9—3.0	3.0—2.2	2.2—1.7	1.7—1.3
Emid ...	27	41	43	58	64	—	89.9	101.7	106.5	103.1	110.7	—
Atrazine ...	27	34	34	32	42	—	109.4	104.9	103.9	112.7	114.4	—
Weedazol ...	41	46	43	63	72	—	103.0	102.9	107.3	106.9	109.8	—
Fenac ...	22	20	29	27	34	—	63.3	74.3	88.1	86.2	89.8	—
Benzac ...	30	34	41	40	54	—	67.3	69.2	72.2	75.3	77.3	—
Alipur ...	56	66	70	80	80	—	93.7	95.5	101.7	105.4	107.0	—
T.480 ...	40	49	51	60	61	—	73.4	84.5	96.2	101.2	104.5	—
TBA ...	—	36	34	36	43	45	—	67.5	71.2	72.7	78.4	101.3
Fisons 18/15	—	41	50	55	56	80	—	91.0	98.8	99.1	101.6	105.2
CMPP ...	—	56	57	57	66	74	—	82.7	83.0	88.8	99.0	109.3

Table 30. Effects of new herbicides on weed infestation 10 weeks after planting — Trial No. 2.

Treatments	Weed infestation % Control — Dosage range per arpent (lb. active) per 3 yard logarithmic strip						
	5.2—3.9	3.9—3.0	3.0—2.2	2.2—1.7	1.7—1.3	1.3—1.0	1.0—0.7
T.480	54	53	56	60	67	—	—
Benzac	31	43	46	46	61	—	—
Fenac	—	21	25	38	39	53	—
CMPP	33	33	38	42	45	—	—
Promethone	21	29	29	33	37	—	—
Fisons 18/15	39	43	46	49	59	—	—
Simazine	—	39	43	51	57	59	—
Atrazine	—	36	40	45	51	59	—
DCMU	—	16	24	28	42	51	—
TBA	—	—	33	38	43	45	52
Emid	—	40	53	67	69	71	—

5. FURTHER STUDIES ON *CYNODON DACTYLON* BIOTYPES.

Investigations on the biotypes of *Cynodon dactylon* locally known as «chiendent» were continued this year. It must be recalled here that previous work (M.S.I.R.I. Ann. Rep. 1959) has revealed that four clones of this grass exist in the island consisting both of tetraploid races, Constance and Réduit and triploid races, Beau Champ and Bel Ombre. Further these biotypes were found to differ in their epidermal structure and the importance of such differences in their identification when used in conjunction with other characters was emphasized.

Experimental work on the tolerance of the different biotypes to the trichloroacetic (TCA) and the 2,2 - dichloropropionic (dalapon) acids were carried out this year under greenhouse conditions using the water culture technique. Results obtained showed that in general the tetraploids were more resistant to these chemicals than the triploids as measured by morphogenetic effects and dry weight. Of the two tetraploids the Constance biotype was found to be more tolerant and of the two triploids the Bel Ombre biotype proved the more susceptible to these acids. It was also established that the Réduit strain although more tolerant than the Beau Champ and Bel Ombre strains showed at the higher concentrations of 32 and 64 parts per thousand of these acids a higher sensivity to scorching than the other two strains (fig. 37). Studies on the mode of entry of these chemicals into the plant also showed that absorption may occur through the shoots and/or roots, thus bringing evidence that TCA enters the plant not only through the roots, as is generally believed, but also through the leaf. (fig. 37).

CULTIVATION, IRRIGATION, CLIMATE

I. AN ANALYSIS OF METEOROLOGICAL ELEMENTS AND THE 1960 SUGAR CROP

PIERRE HALAIS

UNDER the conditions which prevail in Mauritius, three meteorological elements reckoned on a monthly basis, viz. rainfall, highest ~~monthly~~ hourly wind speed and mean daily range of temperature have been proved to exercise dominant influences on sugar production resulting from both the quantity and quality of the harvested cane crop.

The three graphs (figs. 39-41) represent data collected and averaged over the sugar area as a whole for the thirteen months, 1st October 1959 to 31st October 1960, and covering the normal vegetative (November-June) and maturation (July-October) periods.

Each graph features, apart from the normal values of the meteorological element concerned averaged over a large number of years, two contrasted crop years: 1956, the most productive (26.3 tons of cane per arpent harvested and 12.95 commercial sugar manufactured % cane) and 1960 the most disastrous (12.8 tons and 9.84%, respectively).

Rainfall (fig. 39).

The monthly values throughout the 1956 crop year may be considered as nearing optimal conditions for sugar production. They show monthly rainfall closely approaching the normal values for the November-June vegetative period, thus promoting continuous growth of the canes and for the July-October maturation period, monthly rainfall values well below the normals, thus ensuring high sugar content at harvest.

On the other hand great contrasts are found when comparing the disastrous crop year 1960 to the two others. Early rains, abnormally high for October and November followed by substantial amounts in December and January, had already brought the vegetation of the sugar cane to a very high and unusual climax when «Alix», the first strong cyclone of the year, hit the island. As could be expected the damage to the standing canes was considerable as proved by the number of broken stalks, the plants being specially vulnerable at this stage of their growth due to the large size and watery nature of the shoots and leaves.

The season continued to be wet when «Carol», the second cyclone of exceptional intensity and size, played havoc at the end of February on the already mutilated cane fields. Of course, further breakage of stalks resulted in an even higher proportion than in January.

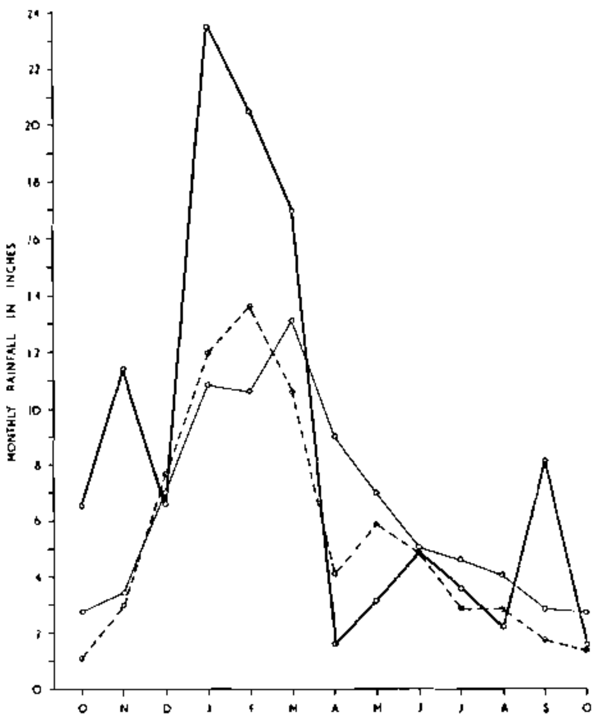

Fig. 39. Variations in monthly rainfall: thin line average 1875-1949; broken line 1956; thick line 1960.

The recovery of the canes that escaped destruction was hindered by the very dry conditions which prevailed at the end of the vegetative period notably in April and May.

To crown all, the month of September, at the peak of the normally dry maturation period, reached the highest value (8.05 inches) on record since organised collecting of meteorological data began in 1875.

Wind (fig. 40).

It is the general rule in Mauritius to account for the wind factor for agricultural purposes, by a single value featuring the highest speed recorded during one hour for the month. Median values for the period 1949-1960 were taken as the best normals available.

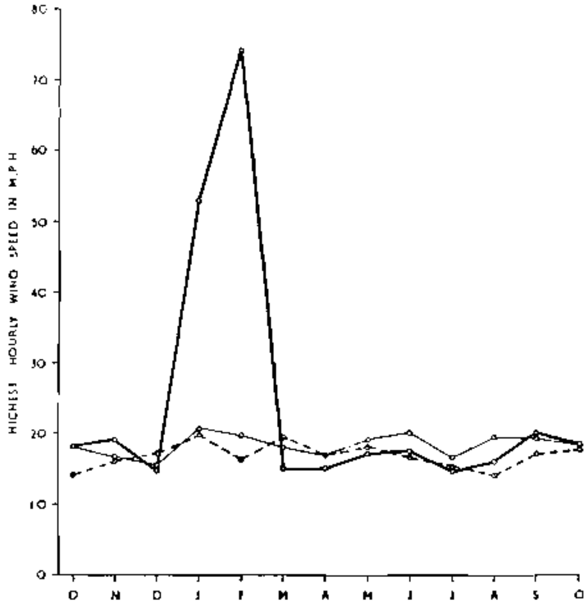

Fig. 40. Highest hourly wind speed, in m.p.h.: thin line, 1949 - 1960 ; broken line, 1956 ; thick line, 1960.

The wind values for the crop year 1956 can also be used as an optimal yardstick. They proved to be slightly above normals during the November-June vegetative period and well below normals during the July-October maturation period.

Concerning the crop year 1960, the highest hourly wind speed for cyclone «Alix» averages to 53 m.p.h., this figure being slighlty exceeded in the West and South sugar sectors of the island. For cyclone «Carol», the average reached the time record value of 74 m.p.h., the four sectors, West, North, East and South showing little differences whereas the Central Plateau (Vacoas Observatory) experienced somewhat lower speeds. To summarize, the five sugar sectors suffered in 1960 comparable cyclonic winds as far as strength, direction and duration are concerned.

The recrudescence of wind in September 1960, which moreover was exceptionally wet for that month is worth mentioning at a time of the year when calm and bright weather normally favours cane ripening.

Mean daily range of temperature (fig. 41).

This meteorological element is extremely useful under local climatic conditions as it integrates many other features of the weather.

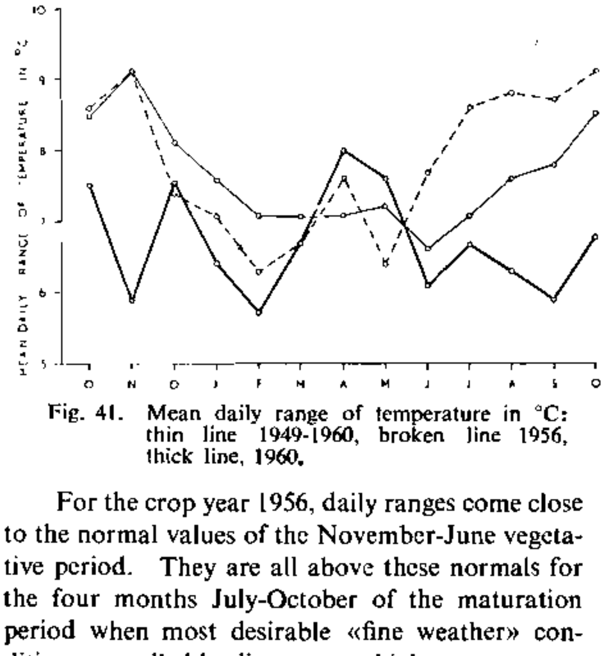

Fig. 41. Mean daily range of temperature in °C: thin line 1949-1960, broken line 1956, thick line, 1960.

For the crop year 1956, daily ranges come close to the normal values of the November-June vegetative period. They are all above these normals for the four months July-October of the maturation period when most desirable «fine weather» conditions prevailed leading to very high sugar content of the harvested canes.

The graph for the disastrous crop year 1960, illustrates too low daily ranges throughout for both vegetative and maturation periods. The divergence between the two contrasted crop years 1956 and 1960 is striking especially from June onwards. For the five consecutive months, June-October, the average daily range was 8.4 in 1956 against 6.4 with corresponding 12.95 sugar manufactured % cane against 9.84 %.

The 1960 sugar crop.

Table 31 summarizes sugar production for each of the five sugar sectors and for the island as a whole covering the reference period 1955-1959 on the one hand and 1960 on the other which suffered from the two destructive cyclones "Alix" and "Carol".

The sum of monthly rainfall deficits of the vegetative period November-June for the reference period 1955-59 averages to 11.5", whereas in 1960 a deficit of 12.0" was experienced which means that both vegetative periods were comparable as a whole as far as rainfall is concerned. However the sum of monthly excesses for the maturation period July-October for 1955-59 averages to 2.1" against 5.1" in 1960. This difference of 3.0" according to special equations worked out previously accounts for —0.9 for West and North, —0.7 for East and South, —0.5 for the Centre and —0.8 for Mauritius in the % of sugar manufactured % cane as a result of the better maturation period of 1960 compared to the drier period for the reference years 1955-59. This reduction expressed in % works to 7, 7, 6, 6, 4 and 6 for W, N, E, S, C and Island, respectively (table 32).

After applying the above corrections the % reduction in sugar production attributed to the cyclones «Alix» and «Carol» per se works out to the following figures:

	«Alix» & «Carol»	Comparative indices
West ...	44%	77
North ...	47	82
East ...	55	96
South ...	61	107
Centre ...	73	128
Island ...	57	100

Cyclones «Alix» and «Carol» have offered for the first time in recent years a most useful though dramatic opportunity, as a result of observations collected during a single yet appropriate season, of long range evaluation of cyclone damage to sugar production applicable to the various sectors of the island separately.

Table 31. Cane and sugar production, 1955-1960.

Sector	Ref. period 1955-1959			Cyclone year 1960		
	TCA	SM % C	TSMA	TCA	SM % C	TSMA
West	28.9	12.79	3.72	17.9	10.94	1.96
North	22.7	13.34	3.03	14.4	10.34	1.49
East	23.4	12.47	2.92	12.2	9.73	1.19
South	28.2	12.05	3.40	12.9	9.29	1.20
Centre	27.6	12.60	3.48	8.8	9.56	0.84
Island	25.6	12.57	3.22	12.8	9.84	1.26

Table 32. Wind speed and crop reduction, 1960.

Sector	Highest hourly wind speed in m.p.h.		% Reduction in 1960 compared to 1955-1959		
	«Alix»	«Carol»	Cane quantity	Cane quality	Sugar production
West	60	83	38	14	47
North	48	82	37	22	51
East	43	78	48	22	59
South	60	74	54	23	65
Centre	—	55	68	24	76
Island	53	74	50	22	61

Even though those sectors experienced in 1960, winds of comparable strenght, duration and direction, the reduction in sugar output went on increasing gradually with the geopgraphical sequence, West, North, East, South, and Centre. These reductions, expressed in terms of comparative indices Mauritius 100, are 77, 82, 96, 107 and 128, respectively.

It is now quite clear that natural climatic characteristics, rainfall, temperature (altitude), etc. as unavoidable human interference, concerning the choice of varieties and of certain cultural practices for the various sugar sectors provoke wide variations in the type of growth of the sugar cane plant with more or less heavy consequences when hit by comparable cyclonic winds.

It is worth adding that at present, this vulnerability of the various sectors increases with the proportion of Ebène 1/37 cultivated, as well as with the practice of selective harvesting which favours the formation of heterogeneous stools unable to resist cyclonic winds to any great extent.

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2. EFFECT OF CYCLONES ON CANE YIELD

GUY ROUILLARD

The occurrence of two severe cyclones during 1960 provided an excellent opportunity of studying the behaviour of cane varieties to high wind velocities and the relative effect on cane yields.

A few days after the passage of «Alix» and «Carol», measurements were made by all field officers of the Institute in cane fields representing the most important commercial varieties and in different sectors of the island . The large measure of cooperation received from the field staff of estates is gratefully acknowledged.

Fields of M.134/32, E.1/37, B.3337, B.34104, B.37172 and M.147/44 were studied in typical climatic zones where these varieties are best adapted. About 800 fields of the above varieties were selected to cover the following range of ages:

(a) Virgins planted during the first half of 1959.
(b) Virgins planted during the second half of 1959.
(c) Ratoons cut between 1st July and 15th August, 1959.
(d) Ratoons cut between 16th August and 15th October, 1959.
(e) Ratoons cut between 16th October and 30th November, 1959.

Ten plots, 10 feet long, were taken at ramdon in each selected field, and the following measurements were made:

(a) Total number of stalks, excluding shoots not showing a joint above ground.
(b) Number of broken or partly broken canes.

Table 33. Percentage of canes broken after Alix (A) and Carol (C) for each variety in different sectors and yield reduction.

	M.134/32		Ebène1/37		B.3337		B.34104		B.37172		M.147/44		Average	
	A	C	A	C	A	C	A	C	A	C	A	C	A	C
West	5	25	—	—	—	—	14	40	4	14	5	20	6	24
North	1	17	—	—	—	—	—	31	3	18	2	17	2	19
East	1	33	21	36	5	31	—	27	—	26	—	24	11	34
South	6	24	27	35	10	38	20	34	9	26	6	24	13	32
Centre	—	—	26	30	5	20	—	—	—	—	13	23	20	28
Island	3	23	25	33	6	30	22	33	4	20	3	22	11	29
% reduction in yield 1960/1959 ...	48		79		68		38		32		26		49.5	

Table 34. Percent broken canes in relation to virgins and ratoons in three sectors.

Sector	Virgins Long season	Virgins Short season	Ratoons Harvested beginning of crop	Ratoons Harvested middle of crop	Ratoons Harvested end of crop
North	19	8	18	18	17
South	31	25	40	37	34
Centre	27	18	43	40	32

From these data the percentage of broken canes was determined for each variety in different sectors. The results were compiled for the island as a whole and the percentage of broken canes correlated with the decrease in yield, as compared to 1959 which was a normal year.

An examination of the results given in table 33 shows that there were large varietal differences in number of broken canes, ranging on the average from 33% in Ebène 1/37 to 20% in M.147/44. It will be observed also that while certain varieties such as B.3337 showed little breakage after the first cyclone, a considerable number of canes were broken during the more intense second cyclone, suggesting a threshold value over which a variety becomes more vulnerable to wind damage.

On the basis of canes broken by wind the following ratings of susceptibility and resistance can be established:

(a) Very susceptible — Ebène 1/37, — B.34104
(b) Moderately susceptible — B.3337
(c) Tolerant — M.134/32, — B.37172 — M.147/44

When these results are examined in relation to yields obtained it will be seen that the same classification does not apply in every case and that there is no simple relationship between percentages of broken canes and yields obtained. The following combination is suggested to take both factors into account:

(a) Breakage above 50%
  (i) No recovery, low yield: Ebène 1/37. Very susceptible.
  (ii) Good recovery, fair yield: B.34104. Moderately susceptible.

(b) Breakage below 50%
  (i) No recovery, low yield: B.3337. Susceptible.
  (ii) Good recovery, high yield: M.147/44. B.37172. Tolerant.

Turning now to the effect of wind on virgins and ratoon canes of different ages, the results of the survey (table 34) showed that as expected, short season virgins sustained far less breakage than long season virgins. Similarly, younger ratoons were less affected.

For the island as a whole reductions in cane yields were progressively larger from virgins to older ratoons as the figures in table 35 indicate. (See also fig. 6).

Table 35. Yields of virgins and ratoons for 1960 expressed in % of the average for 1954-1959.

Yield in 1960	Average yield 1954-1959	% reduction in yield 1960/1954-1959
22.8	35.4	35.6%
18.0	33.2	45.8%
16.4	31.1	47.2%
13.2	29.7	53.1%
12.0	28.4	57.7%
12.3	28.5	56.8%

Removal of side shoots after cyclone. After the cyclones a great proliferation of side shoots could be observed, mostly on varieties M.147/44, B.34104 and M.31/45. Some planters believed that it would be beneficial to remove the lateral shoots several months before harvest. In order to assess the advantages of such a practice, two experiments were laid down to study the effect of side shoot removal on yield and sucrose content of the cane.

Ratoons of the variety M.147/44 were tried in the subhumid zone, one of the fields being irrigated. The Student's method was employed and the experiments consisted of 12 and 16 comparative pairs. The side shoots were removed in May and the experiments harvested in October, 1960. The results obtained are given in table 36.

On an experimental scale removal of sideshoots have produced no significant increase in yield, though a very small but systematic increase in sucrose content could be observed in 18 out of 28 cases. On a plantation scale it is possible that the quality of the cane would have been improved to a greater extent, because canes, free from side shoots are more likely to be properly trashed and cleaned before being sent to the mill.

Before adopting such a practice, it is important to point out that the removal of side shoots may favour the entry of the red rot organism into the cane. Varieties showing even slight susceptibility to this disease, should not be thus treated.

Table 36. Effect of removing side shoots on yield and sucrose content.

	Tons cane per arpent		Industrial recoverable sugar % cane		Tons sugar per arpent		
	Control	Sideshoots removed	Control	Sideshoots removed	Control	Sideshoots removed	S.D.
Irrigated field ...	32.0	31.2	10.2	10.5	3.26	3.28	±0.57
Non irrigated field ...	18.8	19.2	9.0	9.4	1.70	1.80	±0.26
	25.4	25.2	9.8	10.1	2.48	2.54	

3. FACTORY RESIDUES AND INORGANIC FERTILIZERS

GUY ROUILLARD & PIERRE HALAIS

In a review of organic and inorganic amendments Rouillard and Halais (1959) have shown that the application of factory residues in the form of scums (8 tons/arpent) and molasses (5 tons/arpent) added separately carried in both cases, small but significant increases in yields of 230 kgs. and 360 kgs of commercial sugar per arpent in virgin cane. No responses were obtained in the subsequent first ratoons. These trials were conducted in 21 different locations of Mauritius from 1947 to 1958. Nutrition was controlled systematically by means of foliar diagnosis and the beneficial effects of factory residues were observed even in soils which were well supplied with available phosphorus and potassium.

A new series of permanent experiments started in 1954 at the four stations of the Institute: Pamplemousses, Réduit, Belle Rive and Union Park, comprising a total of 128 individual plots, 64 provided with factory residues (4 tons of scums and 6 tons of molasses, added together, per arpent) and 64 comparative plots with straight inorganic fertilizers only, have been reaped successively in virgin canes, 1st, 2nd, 3rd and 4th ratoons. Fiolar diagnosis was used to control the nutritional status of the canes throughout this period. The results observed are summarized in table 37.

Table 37. Effect of scums and molasses on sugar yield.

	Inorganic fertilizers only					Scums and molasses in addition				
	TSA	Av. wt. of one 3rd leaf	Foliar diagnosis N	P_2O	K_2O	TSA	Av. wt. of one 3rd leaf	Foliar diagnosis N	P_2O_5	K_2O
Virgins ...	**4.00**	23.5	1.97	0.49	1.91	**4.72**	25.1	2.01	0.52	2.02
1st Ratoon ...	**5.14**	26.1	1.94	0.49	1.38	**5.21**	26.5	1.96	0.50	1.36
2nd ,, ...	**5.39**	24.0	1.90	0.48	1.43	**5.42**	24.3	1.90	0.48	1.49
3rd ,, ...	**4.46**	23.2	2.10	0.47	1.64	**4.37**	23.5	2.11	0.47	1.68
4th ,, ...	**4.54**	21.5	2.19	0.52	1.73	**4.64**	21.6	2.19	0.52	1.73

Only two differences emerge from the above table, both confined to virgin canes: (a) the yield of commercial sugar per arpent has increased from 4.00 to 4.72 tons, and (b) the weight of 3rd leaf at boom stage has passed from 23.5 grams to 25.1 grams. In both cases, these differences which are significant to 1:100 were in favour of the scums and molasses treatment.

Under optimal NPK nutritional conditions as proved by foliar diagnosis, a highly significant response to factory residues (16 positive cases out of 16 comparisons available) amounting to 720 kg. of commercial sugar per arpent, on the average, is shown for the virgin crop and no residual effect is observed in any of the subsequent ratoons harvested. This finding fully confirms previous observations.

It is now firmly established that scums and molasses, apart from their lasting nutritional value on soils deficient in phosphorus and potassium favour in a positive though transitory manner the establishement and growth of virgin canes under practically all conditions. The cause of this beneficial effect is as yet unidentified but may be related to early rooting of the young plant, this advantage extending up to the first harvest. Subsequently, no difference in yields are observed in ratoons, these being already provided with a well developed root system.

It is evident that full beneficial effect to be derived from the return of factory residues to cane lands, specially of molasses, only obtains when applications are restricted to virgin canes. This applies particularly to nurseries planted with disease free cuttings, the success of which should be assured at all costs. In assessing this advantage it is clear that the current market value of molasses has to be taken into account.

The four trials have been replanted at the end of 1960 and the same treatments applied. The full results obtained during the first rotation of this experiment will be published elsewhere.

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4. HIGHLIGHTS OF FINAL VARIETY TRIALS

PIERRE HALAIS

A. 1954 Series. A first series of highly replicated final variety trials started in 1954 has been carried out by the Institute with the help of the collaborating sugar estates in virgins, 1st, 2nd, 3rd and 4th ratoons. Five released varieties Ebène 1/37, B. 3337, B.34104, B.37161 and B.37172 were compared with the standard variety of that time: M.134/32.

Each trial consisted of a 6 × 6 latin square, the size of plots being 12 rows 50 ft. in length

(Halais and Rouillard, 1958). Each plot was divided into three subplots of four rows corresponding to three levels of nitrogen. Six similar trials were established covering the different climatic conditions of Mauritius. Each trial was harvested at three different dates, early (July), mid-season (September) and late (November). By this means all the ratoons had reached the regular age of 12 months when harvested.

The total number of replications available for each variety works out as follows:

6 trials × (2 replicates × 3 Nitrogen levels) × 3 dates of harvest = 108.

The data collected was grouped according to three climatic zones:

I. **Low elevation and rainfall**, at Beau Vallon and Bon Espoir (range of elevation 50-300 ft. and of mean annual rainfall of 60-75 inches).

II. **Medium elevation and rainfall**, at Mount and Fuel (400-525 ft and 60-90 inches.)

III. **High elevation and rainfall** at Eau Bleue and Bonne Veine (1000-1500 ft and 130-140 inches). According to usual local practice only average results obtained for the ratoons — the most profitable canes to grow in Mauritius — will be considered in this report. They cover the period 1955 to 1959 from 1st to 4th ratoons. This period of four years may be considered normal from a meteorological angle, although in 1958 a mild cyclone caused some damage particularly in zone III mentioned above.

For the better understanding of variety trials, it is most desirable, from the economic point of view, to penalize in the right proportion those varieties showing lower sucrose contents as proposed by Hugot (1958). Instead of calculating the final data in terms of tons of industrial recoverable sucrose per arpent obtained by multiplying the tonnage of cane harvested by the industrial recoverable sucrose % cane, the net or profitable sucrose per arpent is worked out from the tonnage of cane and the industrial recoverable sucrose % cane *minus* a constant: four.

All data presented in this report pertain to net or profitable sucrose as defined above, this change constitutes an improvement in the presentation of data over that published in previous annual reports of the Institute (Saint Antoine and Halais, 1961).

Table 38 summarises the data collected. The two varieties B.34104 and B.37161 have been omitted in this final compilation as they gave deceptive results from the start hence the regular weighing of the plots was discontinued before the 3rd and 4th ratoons.

This table in addition to the actual tons of net or profitable sucrose per arpent for the standard variety M.134/32 — bold type figures — gives the differences in favour of the three other varieties, Ebène 1/37, B.3337 and B.37172 for each of the three groups of climatic conditions.The following

Table 38. Final compilation of variety trials series 1954. Averages for 1st to 4th ratoons (1955 to 1959). Tons net or profitable sucrose per arpent.

Group	Location	Elevation ft.	Rainfall inches	M.134/32 (standard)	Ebène 1/37	B.3337	B.37172
I.	Beau Vallon Bon Espoir	50-300	60-75	**2.41**	+0.11	+0.40	+0.60
II.	Mount FUEL	400-525	60-90	**3.02**	+0.17	+0.24	+0.17
III.	Eau Bleue Bonne Veine	1000-1500	130-140	**1.80**	+0.66	+0.41	—0.09

broad conclusions may be drawn from those data:

M.134/32. This standard variety is outclassed everywhere by the three varieties in competition with the exception of B.37172 in Group III conditions: elevation above 1000 ft and annual rainfall superior to 130 inches. M.134/32, which occupied earlier some 90% of the cane area is planted nowadays on a very restricted scale.

Ebène 1/37. This variety when cultivated in localities near 500 ft elevation and 75 inches annual rainfall produces on the average a net or profitable sucrose return of at least 170 kg per arpent in excess of the standard variety M.134/32. This difference increases to 660 kg. when elevation of 1250 ft and rainfall of 135 inches are reached. Unfortunately, Ebène 1/37 shows very little resistance to cyclonic winds: even the mild cyclone which occurred in 1958 resulted in appreciable losses in cane tonnage and quality.

B.3337. Is a very hardy cane which possesses a wide range of adaptation to the various soil and climatic conditions met with in Mauritius. It outyields M.134/32 profitably by some 350 kg. of sucrose per arpent from 50 to 1500 ft. elevation and 60 to 140 inches of annual rainfall. Its main defect is a comparatively low sucrose content, but its special qualities, apart from hardiness, are: excellent response to high nitrogen fertilization without lowering of sucrose content and very good resistance to cyclonic winds (Sornay & Halais 1959) until a threshold of some 60 miles per hour is attained (Rouillard 1961). Stronger winds only occurred twice in the last 85 years in 1892 and 1960.

B.37172. It does particularly well at low elevation and rainfall where it outyields the standard cane M.134/32 by 600 kg. of net or profitable sucrose per arpent. This difference in favour of B.37172 decreases to 170 kg. at medium elevation and rainfall. When higher elevation and rainfall are reached — 1250 ft and 135 inches — its performance is very poor.

As a result of the 1954 series of variety trials described above, Ebène 1/37 and B.37172 have been considered in their elected climatic conditions, as standard varieties to supersede the once universal M.134/32. This change illustrated in table 39, shows the relative areas cultivated under these varieties and B. 3337 on sugar estates from 1954 to 1959.

Table 39. % of total area under four commercial varieties 1954-1959.

	M.134/32	Ebène 1/37	B.3337	B.37172
1954	83	9	1	< 1
1955	74	15	3	1
1956	66	17	4	2
1957	55	21	4	3
1958	43	25	5	5
1959	33	25	5	8
1960*	25	28	5	11

* *Estimated.*

B. 1957 Series. A second series of variety trials, run on similar lines was started in 1957. It has now been carried out in virgins, 1st and 2nd ratoons. Two varieties released at the end of 1955, M.147/44 and M.31/45, were compared with the standard varieties Ebène 1/37 and B.37172.

Eight trials were planted in the following three groups of climatic conditoins.

I. **Low elevation and rainfall**, at Clarence and St. André (range of elevation 150-200 ft and of annual rainfall 40-50 inches), both irrigated.

II. **Medium elevation and rainfall**, at Bon Espoir, Terracine and Etoile (150-450 ft and 60-110 inches).

III. **High elevation and rainfall**, at Henrietta, Union Park and Valetta (1100-1600 ft and 110-140 inches).

Owing to the highly contrasted climatic conditions which prevailed in 1959 — 1st ratoons — and in 1960 — 2nd ratoons — there is need this time to consider the results separately. The year 1959 may be considered normal for our purpose, whereas in 1960, Mauritius was visited by cyclones of exceptional violence.

Table 40 summarises the data collected in the same manner as those in table 38. For each climatic zone, the results for the standard varieties B.37172 or Ebène 1/37 are given in bold type as was done previously for M.134/32.

Table 40. Compilation of variety trials series 1957, for 1959 (1st ratoons) and 1960 — cyclone year — (2nd ratoons). Tons net or profitable sucrose per arpent.

Group	Location	Elevation ft.	Rainfall inches	B.37172 1959	B.37172 1960	Ebène 1/37 1959	Ebène 1/37 1960	M.147/44 1959	M.147/44 1960	M.31/45 1959	M.31/45 1960
I.	Clarence, St. André, irrigated	150-200	40-50	**3.27**	**1.71**	—0.14	—0.26	+0.10	+0.22	+0.16	—0.01
II.	Bon Espoir, Terracine, Etoile	150-450	60-110	**2.80**	**1.56**	—0.04	—0.28	+0.14	+0.18	+0.42	—0.18
III.	Henrietta, Union Park, Valetta	1100-1600	110-140	—0.80	—0.04	**2.47**	**0.34**	—0.42	+0.43	—0.43	+0.09

The following tentative conclusions are drawn for each variety for the years 1959 and 1960 separately:

B.37172. At elevations lower than 450 ft and rainfall lower than 110 inches the variety was outyielded in 1959 by both varieties M.147/44 and M.31/45 by amounts of 120 and 290 kg. of net or profitable sucrose per arpent, respectively. In 1960 the difference in favour of M.147/44 amounted to 200 kg., whereas B.37172 outyielded M.31/45 by 95 kg. of net or profitable sucrose per arpent.

Ebène 1/37. In the normal year 1959, this standard variety under conditions of higher elevation and rainfall gave considerably higher net or profitable sucrose yields than either M.147/44 or M.31/45. In 1960, the cyclone year, Ebène 1/37 showed derisory production especially in its normally elected climatic conditions and was outyielded by M.147/44 by a wide margin.

M.147/44. At elevations ~~higher~~ lower than 450 ft and rainfall inferior to 110 inches in 1959 as well as in 1960, M.147/44 outyielded the standard variety B.37172 by 120 and 200 kg. of net or profitable sucrose per arpent. For higher elevations and rainfall when compared to the standard variety Ebène 1/37 it gave totally different results in 1959 and 1960. Whereas in 1959 M.147/44 was outclassed by Ebène 1/37 by 420 kg. of net or profitable sucrose per arpent, in 1960 the reverse took place, M.147/44 outyielding Ebène 1/37 by 430 kg. This finding proves the remarkable resistance of M.147/44 to cyclonic winds.

The variety as a whole is poorer than B.37172 by — 0.7 industrial recoverable sucrose % cane, —0.44 for early, — 0.6 for mid-season and — 1.0 for late reapings as observed in 1959 and 1960. The average difference in net or profitable sucrose per arpent amounts to 160 kg. in favour of M.147/44 corresponding to 300 for early, 90 for mid-season and 110 kg. for late reapings. It follows that M.147/44 is an early maturing variety which should be cultivated in order to be harvested at the early start of the crushing season when the crop is particularly abundant.

M.31/45 has done well compared with the standard B.37172 in the normal year 1959 and at low or medium elevation and rainfall a net or profitable surplus of sucrose production of 290 kg. per arpent was observed. At higher elevation and rainfall it is easily beaten by the standard cane Ebène 1/37. As a whole, results obtained in 1960 — the cyclone year — were disappointing, M.31/45 showing little resistance to cyclonic winds. The main advantage of this variety is its high sucrose content. But one of its defects, as put forward by the entomological division of this Institute, is its susceptibility to the spotted borer. To conclude, M.31/45 needs to be further studied as a promising variety for low and medium elevation and rainfall in localities where this pest is not menacing.

Table 41. Recommended commercial varieties for different climatic conditions.

Elevation	Low<300	Medium Low 300-600	Medium high 600-1200	High>1200
Rainfall in inches	Low<60	Medium Low 60-80	Medium high 80-100	High>100
1st choice	M.147/44	M.147/44	M.147/44	Ebène 1/37
2nd ,,	B.37172	B.37172	Ebène 1/37	B.3337
3rd ,,		M.31/45		

Table 41 illustrates in *very broad terms*, the present recommendations of the Institute as far as the cultivation of commercial varieties is concerned.

The following qualities or defects should be taken into due consideration when contemplating the extension of these varieties:

M.147/44 should be harvested early in the crushing season;
B.37172 is a variety for medium and late harvestings;
M.31/45 is susceptible to the spotted borer;
Ebène 1/37 is susceptible to cyclonic winds;
B.3337 is low in sucrose content but responds well to extra nitrogen fertilization.

The precise choice of varieties for medium elevation and rainfall conditions is rendered more difficult as it will depend firstly on local combinations of the two dominant climatic factors responsible and secondly on local differences in soil fertility.

Table 42 shows the extent by which the new standard variety M.147/44 and the recommended variety M.31/45 have made the grade on the sugar estates.

Table 42. % of total area under two commercial varieties 1956-1960.

	M.147/44	M.31/45
1956	1	2
1957	6	3
1958	10	4
1959	15	5
1960*	20	6

* *Estimated.*

C. 1960 Series. Another series of ten final variety trials has been started on sugar estates in 1960 with M.147/44 and Ebène 1/37 as standard canes and comprising four new varieties: M.202/46, M.93/48, M.253/48 and Ebène 50/47.

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SUGAR MANUFACTURE

1. THE PERFORMANCE OF SUGAR FACTORIES IN 1960.

J. D. de R. de SAINT ANTOINE

PRIOR to the 1960 crop it was announced that Labourdonnais factory would be operating for the last season in Mauritius, the plant having been sold for reerection in Southern Rhodesia. It was also decided that Labourdonnais would crush part of the canes from Belle Vue factory area in order that the latter factory might enlarge its capacity and crush the canes from both factory areas in 1961.

Thus only 23 factories were in operation in 1960 and a synopsis of their chemical control figures is given in tables xvii (i-v) of the Appendix.

Cane and Sugar Production. Had it not been for the two cyclones Alix and Carol, the latter of an extreme violence that wrought havoc and desolation in the country, a normal crop would have been harvested instead of a mere 235,589* tons of sugar manufactured. The reduction would have been a little less drastic, however, had not drought conditions prevailed during the months of April and May. Further, as a result of heavy downpours in September, sucrose per cent cane which had been steadily increasing from the beginning of the crops through the end of August reached a plateau early in September and from that time onwards showed, on the average, little fluctuation until the end of the crop (vide fig. 4.)

Rainfall distribution for the periods April-May and September is given in tables 43 and 44.

Table 43. Rainfall distribution in April/May — inches.

		Island	West	North	East	South	Centre
1960	...	4.98	0.73	2.31	8.35	5.92	4.36
Normal	...	16.41	7.18	11.43	19.92	19.45	15.96
% Deficit	...	70	90	80	58	70	73

Table.44. Rainfall distribution in September — inches.

		Island	West	North	East	South	Centre
1960	...	8.05	3.30	5.68	8.89	8.12	10.59
Normal	...	2.90	0.64	1.64	3.61	3.39	3.31
% Excess	...	64	72	71	59	58	69

* *Provisional figure.*

Tonnages of cane crushed and sugar produced by sector are given in tables 45 and 46, in which the percentage reductions that prevailed in 1960 as compared to the normal period 1955 - 1959 are also indicated (vide fig. 7).

Table 45. Cane crushed, thousand metric tons.

	Island	West	North	East	South	Centre
Av. 1955-1959	4,413.0	259.3	1,102.9	877.7	1,552.7	620.4
1960 ...	2,393.5	165.1	725.1	514.4	777.4	211.5
% Reduction ...	45.8	36.3	34.2	41.4	49.9	65.9

Table 46. Sugar produced, thousand metric tons.

	Island	West	North	East	South	Centre
Av. 1955-1959 ...	554.4	33.1	147.0	109.3	187.0	78.1
1960 ...	235.6	18.1	75.0	50.1	72.2	20.2
% Reduction ...	57.5	45.3	49.0	54.2	61.4	74.1

As could be expected, the central plateau is the sector of the island that suffered most from the cyclones, its cane production being curtailed by 65.9 per cent and its sugar output by 74.1. Comparative figures for the whole island are 45.8 and 57.5 respectively.

Cane Quality. The quality of the raw material fed to the mills was very poor, as shown in tables 47 and 48.

Table 47. Sucrose per cent cane, 1956-1960.

	Island	West	North	East	South	Centre
1956	14.62	15.06	15.19	14.51	14.20	14.35
1957	14.59	14.87	15.53	14.33	14.16	14.33
1958	13.77	13.99	14.53	13.76	13.25	13.62
1959	13.76	14.09	14.67	13.66	13.23	13.66
1960	11.83	12.69	12.32	11.63	11.29	11.58

Table 48. Fibre per cent cane and mixed juice gravity purity 1956-1960.

	Fibre % cane	Mixed juice gravity purity
1956	11.67	87.5
1957	11.86	87.8
1958	12.21	87.2
1959	11.96	87.3
1960	14.38	83.5

The low sucrose content of the cane in 1960 may be attributed to the following causes in order of importance:

(a) Mechanical damage from cyclones
(b) Milling of immature shoots
(c) Exceptionally high rainfall in September
(d) Indirect cyclone effects.

Under item (d) above should be mentioned the greater susceptibility of the damaged cane to pests and diseases. Also, as a result of harvesting difficulties a considerable amount of trash found its way to the mills of most factories, along with a fair quantity of immature tops and young shoots.

Although it would be difficult to cast any blame for this state of things in 1960, yet it is felt that a few words of warning should be voiced for the future. Numerous articles have been published in sugar literature showing that it pays to cut clean canes, yet during the past few years — and very much so in 1960 — most factories of the island have been crushing cane containing fairly high percentages of trash and immature tops.

Sucrose losses resulting from the milling of cane containing trash may be expected mainly from the retention of sucrose by the trash in the bagasse. Further, more fibre in the raw material as a result of the trash present reduces the capacity of the milling train, increases power consumption and causes more wear and tear of the equipment.

Immature tops and young shoots however, are still worse offenders as they bring into the juice molassigenic non-sugars which decrease the juice purity, increase the yield of molasses per ton of cane, impede the exhaustibility of the molasses, increase the sucrose losses and reduce the capacity of the processing equipment.

It does not fall within the scope of this article to work out the economics of processing clean versus trashy and badly topped canes. Labour and climatic conditions, nature of the land, varietal position — to mention but a few of the governing factors — may vary so much from one factory area to another that such economics would have to be worked out for each factory. It is our firm belief, however, that collective action towards the obtention of a trash-free and well topped raw material would immediately pay dividends. A very few estates have already set the example, and the results have been so valuable that these estates are not prepared to slacken the reins now.

It would appear that the main reasons why the example has not been generally followed are:

(a) Labour difficulties which vary from estate to estate and which should be considered on their own merits in each individual case.

(b) Insufficient knowledge of the net profit that would result from the milling of clean, well topped canes; hence the necessity of working out the economics of the question at each factory.

The high fibre content of the cane in 1960, namely 14.36 as against a normal figure of about 12.00 may be attributed to the following causes:

(a) Low juice content of damaged and unhealthy canes

(b) Large amount of trash present with the raw material

(c) Better resistence to cyclones of high-fibre varieties M.147/44 and B.37172. Thus whereas in 1959 estate canes crushed included 28 per cent of Ebène 1/37 and 13 per cent of M.147/44, comparative figures for 1960 are 17.9 and 24.0 per cent respectively.

(d) Larger area under M.147/44 and B.37172 harvested in 1960.

As could be expected, the mixed juice purity was very low in 1960, averaging only 83.5. This poor juice quality resulted mainly from the crushing of a large proportion of damaged and unhealthy canes and of immature shoots.

Milling. A synopsis of crushing data and milling figures for the period 1956 to 1960 is given in table 49.

In spite of the fact that only 2,394 thousand tons of cane were harvested in 1960 as against 4,743 thousand tons in 1959, the mills crushed during an average of 89 days this crop as compared to 110 days last year. This may be attributed mainly to the difficulty of harvesting the cyclone-damaged canes, with the result that cane supply to the mills was inadequate and the number of net crushing hours per day amounted to only 14.92 as against 20.32 in 1959.

The high fibre and low sucrose content of the raw material was conducive to poor milling work on the whole. Thus whereas 87.7 tons of cane equivalent to 10.49 tons of fibre were crushed per hour in 1959, comparative figures for 1960 are 77.0 tons of cane and 11.07 tons of fibre. Not only did the tonnage of fibre ground per hour increase, but imbibition per cent fibre dropped from 230 to 209. As a result, extraction ratio increased from 34.1 to 39.6, and, whereas in 1959 only two factories had reduced mill extractions below 95, the number leaped to 11 in 1960.

A sixth factory, Medine, was equipped with a shredder this crop, and its milling work showed improvement. St. Antoine factory also improved its milling efficiency markedly and, with an extraction ratio of 32.5 has the third best milling performance of the island after Mon Loisir (30.6) and Beau Champ (31.9).

Table 49. Milling results — 1956-1960.

	1956	1957	1958	1959	1960
No. of factories	26	26	25	24	23
No of crushing days	109	105	108	110	89
No. of net crushing hours/day ...	20.87	20.89	19.50	20.32	14.92
Hours of stoppages/day* ...	0.97	0.80	0.89	0.82	0.57
Time efficiency	95.6	96.3	95.6	96.1	96.3
Tons cane/hour	74.7	76.1	82.5	87.7	77.0
Tons fibre/hour	8.72	9.03	10.07	10.49	11.07
Imbibition % fibre	222	231	217	230	209
Sucrose % bagasse	2.63	2.63	2.50	2.32	2.21
Moisture % bagasse	47.8	47.5	48.2	48.3	49.8
Reduced mill extraction ...	95.4	95.3	95.3	95.7	95.2
Extraction ratio	36.8	37.1	38.5	34.1	39.6

Clarification and Filtration. In spite of the fact that a few factories used a little Separan AP-30 during the crop, clarification of the damaged canes showed, on the whole, no difficulty. As a matter of fact, clarification was easier in 1960 than in 1959 when serious difficulties had been encountered in several factories (vide Ann. Rep. 1959, p. 79). However, with the low juice purities prevailing, appreciably more lime per ton of cane had to be used last crop. Thus whereas in 1959, 688 grams of hydrated lime of 63.7 per cent CaO was used comparative figures for 1960 are 871 grams at 63.4 per cent CaO. Consequently, more lime salts have doubtless found their way into the syrup and must have affected the viscosity of massecuites and molasses.

As could be expected with the low purity juices that prevailed this crop, the amount of filter cake produced per ton of cane increased from 24 kgs in 1959 to 30 kgs in 1960. Fortunately, however, sucrose per cent cake decreased from 3.57 to 2.69 so that sucrose losses in cake per cent cane were of the same value in both years.

Boiling House Work. The boiling house was the factory department which was most handicapped by the poor juice quality in 1960. Syrup purity was only 83.6 as compared to 87.5 in 1959. Corresponding A massecuite purities were 79.7 and 81.7, indicating less boiling back in 1960. Bel Ombre factory, with an average syrup purity of 82.6 followed a 2-massecuite system throughout the crop whereas all the other factories stuck to the 3-massecuite process.

Viscosities of boiling house products were generally very high. Thus a series of measurements made on spot samples on the 30th of August at Mon Desert Alma sugar factory which was then grinding severely damaged canes, yielded the following results (table 50). These results, however, are only approximate as no attempt was made to deaerate completely the products before measuring the viscosity. The latter was obtained with a Brookfield Synchro-letric Viscometer having a maximum range of 2,000,000 centipoises.

Table 50. Viscosities of boiling house products 1960 crop.

Product	Ref. Brix 20° C	Temp. of product, °C	Viscosity Centipoises
A massecuite	91.4+	52	22,400
B ,,	90.6+	50	60,000
C ,,	93.4+	27	> 2,000,000
Grain Strike	92.2+	35	1,100,000
A molasses	75.9	27	3,400
B ,,	79.5	34	5,350
Final ,,	85.6+	22	262,400

* *Exclusive of stoppages due to shortage of cane.*

\+ *1:1 dilution.*

As a result of the high viscosities prevailing during the crop, boiling time of C massecuites was considerably longer in many factories; nor was it possible to boil these massecuites as tight as during the previous crop, crystal per cent. Brix in C massecuite averaging 33.2 in 1960 as against 35.3 in 1959.

With low juice purities and high viscosities, exhaustion of final molasses was more difficult, as may be seen from table 51. Thus the gravity purity of these molasses averaged 37.2 as against 36.7 in 1959, in spite of the fact that heavy capital expenditure had been incurred in several factories to improve boiling house work. As could be expected, molasses % cane increased by about 22 per cent from 1959 to 1960, respective figures being 2.53 and 3.08 per cent at 95° Brix.

Keeping Quality of Raw Sugar. Towards the end of the 1959 crop the Mauritius Sugar Producers Association requested that the keeping qualities of the raw sugars be improved.

From that time onwards, and throughout the 1960 crop, the Chemist of the Sugar Syndicate exercised strict control on the dilution indicators of all raws, both at the time of arrival and at the time of shipment from Port Louis.

As a result of this action, of the 193,934 tons of sugar of the 1960 crop exported prior to the 1st of January 1961, only 2,594 tons showed Dilution Indicators in excess of 50*. Thus the important monetary losses that resulted from the shipment of raw sugars of poor keeping quality in previous years, have most probably been considerably curtailed in 1960.

Table 51. Final molasses, losses and recovery.

	1956	1957	1958	1959	1960
Final molasses, Gravity Purity ...	37.2	37.7	37.9	36.7	37.2
Red sugars % Brix	15.8	16.2	15.8	14.6	14.6
Total „ „	52.9	53.9	53.7	51.3	53.4
Wt. % cane @ 95% Brix ...	2.62	2.45	2.59	2.53	3.08
Sucrose in final molasses % sucrose in canes	6.29	6.17	6.75	6.40	9.21
Undetermined losses % sucrose in cane	1.30	1.58	1.23	1.16	2.26
Industrial losses % sucrose in cane	8.48	8.36	8.56	8.21	12.15
Reduced Boiling House recovery ...	89.0	89.0	89.3	89.6	88.5

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2. PROTEIN EXTRACTION FROM SUGAR CANE JUICE.

E. C. VIGNES & R. DE FROBERVILLE

Introduction. Like many other countries, Mauritius faces the problem of feeding an ever-increasing population. From a nutritional point of view it is important that an adequate proportion of protein should be included in the diet. Therefore growing attention is being paid today to the necessity of making use of the proteins in plants to supply increasing food requirements. For instance, the possibility of extracting protein and other foodstuffs from green algae had been explored. Also, largely through the efforts of Pirie (1953) attempts have been made to take advantage of the

* *Figures kindly submitted by the Sugar Syndicate.*

large reserves of protein present in green leaves which are potentially of great importance to man. As pointed out by Parish (1960) one obvious source of protein supply is sugar-cane juice, but as yet no investigation in this direction has been reported.

In the laboratory it is easy to separate albuminoid proteins from sugar-cane juice by simply heating the latter when the protein coagulates and can be removed by centrifugation. On a large scale, however, the isolation of protein becomes much more difficult. Although the actual amount of protein present in sugar-cane juice happens to be relatively small, the tonnage of sugar-cane ground annually is enormous. For Mauritius alone where the yearly crop totals about 4 3/4 million tons, it is reckoned that about 4000 tons of protein are lost in the filter muds. In the event of a satisfactory procedure being devised, it might be possible to turn most of this protein to profitable use by feeding animals like poultry, pigs and cattle. The search for such a process assumes acute importance especially in a country like Mauritius where unmistakable signs of protein deficiency are prevalent among the population.

Early last year the Sugar Technology division of this Institute started studying the possibility of extracting protein from sugar-cane juice. Laboratory experiments in the intercrop period having given encouraging results, it was decided to pursue the investigations on a pilot plant scale at Médine S.E. during the crushing season.

Quite apart from protein extraction, these studies have brought forward two other important aspects of centrifugation namely the removal of cane wax and partial juice clarification. Consequently, in order to assess fully the value of centrifuging cane juice, data collected went well beyond those necessary for the study of protein extraction.

Preliminary Experiments. Canes were passed through a cane chipper and the juice extracted in a hydraulic press. The juice was strained through a cloth, divided into three portions heated to 60°C, 80° C and boiling point respectively. Centrifuging the treated juice at 2500 revs/minute for 15 minutes removed the coagulable protein as a greenish curd which was dried at 80°C for 18 hours. Nitrogen on the samples of dry matter was determined by the Kjeldahl method. Crude protein ($N \times 6.25$) extracted per cent juice was 0.07, 0.08 and 0.09 while the dry matter contained 12.8, 19.1 and 21.0 per cent of crude protein respectively. The supernatent juice from the portion heated to 60°C remained cloudy while the other two were relatively clear.

Further experiments were made using a Lister Cream Separator. Juice obtained as described above was weighed, brought to the boil and passed through the centrifuge. Refractometric Brix and purity were determined on the juice, before and after centrifuging. At the end of each run, the apparatus was dismantled and the cake removed; its weight, moisture and nitrogen content determined. Results are shown in table 52.

The most important features emerging from this preliminary study are: the extraction of nearly a quarter of the protein present in the juice and the high percentage of crude protein in the dry cake (D.M.). The latter includes a considerable proportion of wax, fats and resins which can be extracted by acetone and benzene. Analysis revealed that the dry matter thus extracted contained up to 51.3% of crude protein.

Clarification tests carried out on the juice showed that after liming and settling the centrifuged juice yielded a clearer juice, although the size of the flocs was smaller. In addition the centrifuged juice needed less lime for clarification.

Description of Centrifuge. A small Westphalia KG 10006 discontinuous separator, the only centrifuge then available, was used at Médine. Basically it consists of a bowl of 2 ft. diameter rotating at 3800 revs/minute. The bowl is divided, by cylindrical sections of different diameters into six annular chambers through which the juice passes progressively. Immediately on entering the bowl through the centre, the raw juice is subjected to the centrifugal force which removes the largest and heaviest particles in the first chamber. The solids are gradually removed in each successive chamber according to their size and specific gravity; the smallest and lightest particles collecting in the outer chamber. Clarified juice is discharged under pressure by, what is termed, a stationary collector impeller and which acts as a pump. Located in the head of the bowl, this converts the rotational energy of the juice into pressure.

Prodecure. Raw juice from the mills was screened through vibrating screens, heated and fed to the separator at the rate of 750-1000 kgs/hr; the centrifuged juice being collected and weighed. In the various tests involved the temperature of the juice entering the separator varied between 48°Cand 100°C. Samples of mixed juice, centrifuged juice and juice from the clarifier were collected at 10 minute intervals; the composite samples were then analysed for pH, refractometric Brix, purity and reducing sugars. Turbidity of the centrifuged juice and defecated juice was measured by means of a Hellige Turbidimeter. The remainder of the juices were kept in deep-freeze and analysed later for CaO, MgO, SiO_2, wax and starch.

At the end of each run, the separator was dismantled, the cake removed and weighed; its moisture and sucrose content determined. It was difficult to obtain a truly representative sample of the cake for protein content. However, analytical, figures obtained on fairly representative samples varied between 13.3 and 22.2, with an average of 16.4%.

During the first two tests bagacillo present in the juice completely filled the bowl after only 2-3 hours. Therefore during subsequent tests the juice, after heating was further strained through a 100-mesh stationary screen before being sent to the separator. This procedure increased the length of the runs considerably; thus a run of 7 1/2 hours was possible before the machine was clogged up.

All the results obtained are collated in tables 53 to 55.

Discussion. (a) Protein Extraction. An examination of the figures obtained reveals that the percentage of protein extracted from the juice is as the same order as obtained in the laboratory. Broadly speaking, the higher the temperature the greater the amount of protein removed, within limits. However, it must be remembered that this will be affected by such factors as the rate of juice through the separator and the quality of the juice. Judging by the high average protein content of the cake isolated from the juice namely 16.4%, there is no doubt that further investigations on the same lines are called for. Nevertheless, it must be mentioned here that as a result of the cyclones, cane sucrose content was low last year and a fair percentage of immature shoots, relatively high in protein, were milled. This would not occur in a normal year.

It might be worth noting that the amount of cake removed from the juice, average 0.7% on dry basis, will be influenced by extraneous matter such as fine particles of clay, sand, soil etc., picked up by the canes in the fields which are not removed by the fine-mesh screen and find their way in the separator. Also from analytical figures obtained, it appears that 30% of the dry cake is made up of fine particles of fibre which have passed through the screen. A finer mesh would probably cut down this amount of fibre considerably, thus increasing the percentage of protein on the dry cake. Sucrose and moisture in the cake are of the same order as normally found in filter press cake.

As mentioned earlier, this series of tests have, unveiled two more promising fields of research: cane wax removal and partial juice clarification by centrifugation.

(b) Wax Removal. Whilst protein and other impurities collect on the inner surface of the cylinder in the separator bowl, cane wax tends to collect on the outer surface of the cylinders and to a greater extent on the surface of the inner cylinders. Consequently, it was possible during the tests to remove, part of the wax in a fairly pure state. Thus at the end of the 7 1/2 hour run during which 5670 kgs. of centrifuged juice and 56 kgs. of cake were collected, 2.4 kgs. of fairly pure wax was scraped off the outer surface of the cylinders.

Comparisons based on experimental work carried out in other industries seem to indicate that the isolation of protein and the commercial removal of cane wax cannot be accomplished in one operation. It would appear that a good combination would be: Protein extraction in a continuous desludger followed by removal of cane wax in a normal milk separator.

(c) Partial clarification. Comparing analytical figures for juice from the different sources, it will be observed that while the total (CaO + MgO) content in the mixed juice has not been affected, centrifuging has removed more than three quarters of the silica and wax and practically all the starch present in the mixed juice. Since centrifuged juice requires less lime for clarification than mixed juice, it is not unreasonable to assume that, if juice was centrifuged prior to liming, the amount of CaO found in the resulting clarified juice would be lower than is usually found in juice from the clarifier. Also there results a considerable reduction in silica, starch and wax, all of which affect the filterability of raw sugars adversely. Starch, in particular, is practically negligible in the juice from the centrifuge, thus eliminating one source of trouble in the refinery.

Centrifuging raw juice causes a rise in purity which can only be enhanced on further purification. Reducing sugars and pH are hardly affected. Although the centrifuged juice is more turbid than clarified juice, laboratory experiments have shown that centrifuged juice contains less solids in suspension than juice from the clarifier.

It must be emphasized here that while there is no question of centrifuges replacing clarifiers in sugar manufacture at the present time, preliminary centrifuging of even part of the mixed juice for protein extraction might at the same time prove a valuable adjunct to clarification.

Conclusion. Data collected, although not conclusive, demonstrate the need of further research in protein extraction by centrifugation. The subject is a complex one but worthy of intensive study in order to attempt to relieve the chronic lack of protein prevailing locally. From an economic point of view, it is evident that only a continuous centrifuge holds any promise of success under factory conditions. Quite likely such a separator could be satisfactorily adapted for protein isolation. Only future trials on these lines can provide a definite answer.

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Table 52. Results of Laboratory Experiments on Cane Juice Centrifugation.

Date	Raw juice Weight grams	Raw juice Purity	Centrifuged juice Purity	Cake Weight grams	Cake Moisture %	C.P. % juice (W/V)	C.P. % D.M.	Protein Recovery
27.6.60	5806	93.4	93.8	40.0	68.0	0.22	23.3	25.1
28.6.60	5000	93.1	93.7	28.0	67.1	0.15	21.3	28.1
29.6.60	5620	87.8	92.4	30.6	68.9	—	25.4	—
Average	5475	91.4	93.3	32.9	68.0	0.19	23.3	26.6

Table 53. Médine — Protein extraction from sugar cane juice.

Date	Crushing time Hours	Weight of of centrifuged juice Kgs	Temp. of juice feed °C	Cake Weight grams	Cake Pol.	Cake Moisture %	Protein ext. % juice	Protein ext. % Protein in juice	Dry cake % juice
8.9.60	2	1,740	59	37,000	—	—	0.06	—	—
9.9.60	2 1/2	1,900	71	35,110	—	—	0.09	36.0	—
14.9.60	2	960	55	9,600	—	—	0.07	27.3	—
19.9.60	2	3,000	48	26,200	4.7	53.5	0.04	14.4	0.4
20.9.60	7 1/2	5,670	87	58,400	5.1	51.5	0.07	26.6	0.5
21.9.60	2	3,580	82	44,200	7.1	56.0	0.07	26.6	0.5
22.9.60	1	750	90	10,200	8.9	60.5	0.07	28.8	0.6
23.9.60	1	870	90	18,200	8.2	60.5	0.07	34.4	0.8
30.9.60	1 1/2	1,500	100	19,000	8.3	57.0	0.05	28.0	0.5
3.10.60	1	840	92	17,600	7.9	65.5	—	—	0.7
4.10.60	1	1,050	100	21,200	9.3	59.0	0.06	25.8	0.8
5.10.60	1	790	100	15,200	6.9	54.0	0.05	27.3	0.9
6.10.60	1	860	100	15,100	7.2	42.5	0.07	31.6	1.0
Average	2	1,808	83	25,155	7.4	56.0	0.06	27.9	0.7

Table 54. Medine — Effect of centrifugation on juice purity.

Date	Mixed juice: Refractometric Brix	Purity	R.S.%	pH	Centrifuged juice: Refractometric Brix	Purity	R.S.%	pH	Turbidity	Defecated juice: Refractometric Brix	Purity	R.S.%	pH	Turbidity
9.9.60	13.99	90.0	0.43	—	13.89	91.9	0.48	—	—	—	—	—	—	—
19.9.60	14.55	87.2	—	—	14.05	87.9	—	—	—	—	—	—	—	—
20.9.60	14.58	86.8	0.48	—	14.58	86.5	0.49	—	—	—	—	—	—	—
21.9.60	14.58	86.5	0.37	—	14.58	86.1	0.38	—	—	14.58	85.9	0.43	—	—
22.9.60	14.27	84.9	0.38	5.3	13.97	87.3	0.42	5.3	700	14.07	86.7	0.45	6.7	350
23.9.60	13.79	87.7	0.44	5.3	13.69	88.9	0.44	5.3	520	13.69	87.5	0.47	7.0	330
30.9.60	13.47	86.7	0.45	5.1	13.47	89.3	0.49	5.1	520	13.57	90.8	0.51	6.9	400
3.10.60	13.99	85.3	0.48	5.1	13.99	85.3	0.50	5.1	520	13.89	85.4	0.54	7.2	310
4.10.60	15.34	86.5	0.49	5.1	15.14	87.7	0.49	5.1	620	14.44	85.5	0.54	7.2	450
5.10.60	13.94	84.2	0.47	5.0	13.64	86.4	0.50	5.2	—	14.04	83.9	0.53	7.0	—
6.10.60	14.14	87.7	0.47	5.2	14.14	87.2	0.51	5.1	—	13.44	86.4	0.51	6.9	—
Average	14.24	86.7	0.45	5.2	14.10	87.7	0.47	5.2	576	13.96	86.5	0.50	7.0	368

Table 55. Medine — Effect of centrifugation on non-sugars.

Date	Mixed Juice: CaO mg/l.	MgO mg/l.	SiO2 mg/l.	Starch ppm	Wax %	Centrifuged Juice: CaO mg/l.	MgO mg/l.	SiO2 mg/l.	Starch ppm	Wax %	Defecated Juice: CaO mg/l.	MgO mg/l.	SiO2 mg/l.	Starch ppm	Wax %
22.9.60	289	447	—	—	—	289	447	—	—	—	448	406	—	—	—
23.9.60	260	458	532	2	.093	267	458	108	1	.019	462	385	212	14	.023
30.9.60	303	478	428	31	.084	303	478	108	2	.016	477	406	180	31	.029
4.10.60	260	458	436	18	.080	260	458	112	1	.023	621	406	184	9	.028
5.10.60	282	442	368	45	.081	275	447	84	2	.016	462	385	164	9	.026
6.10.60	282	468	424	73	.117	260	452	104	2	.027	484	390	164	8	.029
Average	279	459	438	34	.091	276	457	103	2	.020	492	396	181	14	.027

3. THE USE OF CRYSTALLIZERS FOR THE COOLING OF HIGH GRADE STRIKES IN RAW SUGAR MANUFACTURE.

J. P. LAMUSSE & M. RANDABEL

Mauritius is one of the few sugar producing countries in which it is the normal practice to cool A and B massecuites in crystallizers before centrifugalling. Most of the studies made on this subject favour cooling of the massecuites but at least one author prefers boiling back to the use of crystallizers in order to achieve the same final massecuite purity.

Experiments were conducted during the 1960 grinding season in five raw sugar factories to assess the extent to which cooling of A and B massecuites affected the crystal content and purity drop between massecuite and molasses. All the experimental work was done using industrial equipment and factory massecuites.

The results obtained show that the purity drop between massecuite and molasses is higher by an average of 6.2 points for A massecuites and 4.4 points for B massecuites, when these massecuites are cooled in crystallizers. Similarly, the crystal content of the A massecuite increased by 7.4 points and that of the B massecuite by 5.3 points. Results of individual runs vary widely and it was not possible to establish a rate of increase in either purity drop or crystal content per degree of temperature.

The use of crystallizers to cool high grade massecuites is preferred to the alternate process which involves boiling back for the following reasons.

(1) Boiling back is objectionable from the standpoint of destruction of sucrose and increase in viscosity.
(2) Crystallization being more rapid with high purity products, the yield of a crystallizer will be higher on high grade massecuite.
(3) Assuming the same yield of sugar could be obtained by the two processes, boiling back would require an investment in additional equipment which would be larger than the cost of the crystallizers it would replace. Moreover, the steam requirements of the factory would be increased.

An attempt was made to calculate the volumes of massecuite involved in the two processes. It was round that, if the high grade massecuites are not cooled, 16.9% more A massecuites and 13.5% more B massecuites would have to be boiled to achieve the same molasses exhaustion. For a 100 T.C.H. factory, this would require 450 cubic feet of additional pan capacity plus one 42" × 24" centrifugal, and would bring about an increase in steam consumption of one ton per hour. On the other hand, if A and B massecuites are cooled, seven additional crystallizers of 1000 cubic feet each would be required.

It is intended to carry out, during the 1961 crop, further experiments on the cooling of A and B massecuites.

4. THE INFLUENCE OF MAGMA PURITY ON VOLUME OF C MASSECUITE AND ON RECYCLING OF FINAL MOLASSES

J. D. de R. de SAINT ANTOINE

The boiling system followed in the great majority of cases in Mauritius is the so-called magma system in which the C sugar is single-cured, mixed with syrup and used as footing for the A and B strikes. This system, however, may lead to poor results if the magma purity falls below certain limits. The lower this purtiy, the higher will be the volume of C massecuite to deal with, and, in particular, the more molasses will be recycled. Also, low purity magma footing may affect the refining properties of the raw sugar produced.

It has been observed that during the past few years the magma purity obtained on the average in many sugar factories of the island was dangeroulsy low. Table 56 shows these purities for the period 1957-1960. Figures for factories producing direct consumption white sugar have not been included, whereas purities of double-cured C sugars are marked with an asterisk and have not been taken into consideration when working out the averages.

Table 56. Apparent magma purities, 1957-1960.

Factory	1957	1958	1959	1960
1	81.0	98.5	81.2	80.5
2	81.6	—	82.6	84.1
3	81.5	81.0	79.8	78.5
4	85.0	—	81.9	81.4
5	—	—	85.0	80.8
6	82.3	81.4	82.5	80.4
7	—	82.0	82.0	80.9
8	—	79.1	81.7	83.0
9	80.3	81.9	78.5	—
10	77.2	85.5	84.2	83.5
11	83.7	—	82.4	84.3
12	—	73.1	76.4	78.1
13	83.7	82.6	84.6	80.5
14	83.7	83.7	83.6	82.3
15	83.0	—	81.0	80.0
16	—	85.7	80.9	77.7
17	90.7*	77.0	78.0	78.8
18	—	—	79.8	78.5
19	91.5*	91.3*	82.1	91.5*
20	—	89.1*	92.0*	90.3*
Average	82.1	81.0	81.5	80.8

* *Double-cured C sugars.*

As may be seen from the above table, magma purities during the past few years have amounted to about only 81-82 on the average, whilst in a few factories figures below 80 are recorded year after year. It would thus appear that all manufacturing superintendants do not fully realize what a considerable difference it makes in the amount of molasses recycled when magma purities are allowed to drop to such low levels. It is the purpose of the present paper to stress this point in particular.

The figures in the tables below have been calculated for a factory crushing 100 tons of cane per hour and in which the following average figures obtain:

Mixed juice per cent cane	... 100
Clarified „ „ „ „	... 97
Brix clarified juice	... 14.50
Brix syrup	... 61.30
Gravity purity syrup	... 87.5
„ „ final molasses	... 36.5
Apparent „ „ „	... 36.5
„ „ C massecuite	... 56.0
Pol raw sugar	... 98.65
Purity „ „	... 99.6

To calculate the effect of decreasing magma purities on the quantities of C massecuite and of recycled final molasses, the apparent purity of the C massecuite and that of the final molasses must be assumed to be the same in all cases. Also the calculations must be based on the purity of the C sugar instead of on that of the magma. However these purities are very close to each other, as shown in table 57 which is based on the following values:

Brix C sugar ...	... 100.0
Brix syrup ...	... 61.3
Brix magma ...	... 95.0
Purity syrup ...	... 87.5

Table 57. C sugar and corresponding magma purities.

Purity C sugar	Purity magma
94.0	93.5
90.0	89.8
86.0	86.1
82.0	82.4
78.0	78.8
74.0	75.1
70.0	71.4

The amounts of C massecuite produced per hour with different C sugar purities have been calculated for the chosen set of conditions and are reproduced below :

Table 58. Influence of C sugar purity on volume of C massecuite.

Purity C sugar	Cu. ft. C massecuite per hour	Per cent increase in vol. of. C massct. for C sugar purities below 90.
94.0	100.8	—
90.0	105.1	—
86.0	110.8	5.4
82.0	118.1	12.4
78.0	128.1	21.9
74.0	142.5	35.6
70.0	164.8	56.8

It is thus seen that with decreasing magma purities the volume of C massecuite that has to be boiled per hour increases markedly. But even more marked is the influence of decreasing magma purities on the amount of final molasses recycled, as shown in table 59, the figures of which have been calculated for the same set of conditions shown above.

Table 59. Influence of C sugar purity on recycling of molasses.

Purity C sugar	Kgs. solids recycled in final molasses/hour	% Increase in molasses solids recycling for C sugar purities below 90°
94	147	—
90	273	—
86	436	60
82	646	137
78	933	242
74	1348	394
70	1992	630

Thus by using magma produced from C sugar of say, 78° purity, 242 per cent more molasses solids are recycled per hour as compared to the amount recycled when the C sugar is of 90° purity. One need not stress numerous disadvantages of such heavy molasses recycling.

An interesting aspect of the figures appearing in table 59 is the fact that if the purity of the C sugar is plotted against the logarithm of the amount of solids recycled in molasses per hour, the part of the curve between C sugar purities of 90 and 70 is almost a straight line. Fig. 42 which, for convenience, has been plotted on semi-log paper, illustrates this point.

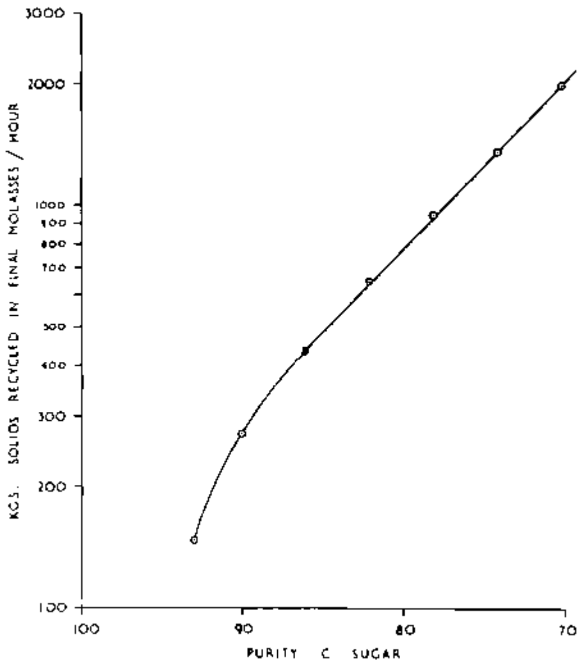

Fig. 42. Influence of purity of C sugar on amount of recycled molasses.

The equation of the straight line has been worked out and yields the following relationship:

$$\log M = \frac{150 - P}{24.25}$$

where M is the amount of molasses solids recycled per hour and P is the purity of C sugar.

This relationship may be used to calculate the amount of molasses solids recycled per hour in a 100 T.C.H. factory for any C sugar purity between 90 and 70, say. However, the equation will yield accurate results only if the average Brixes and purities prevailing are the same as those chosen for the present study. Yet, even for slightly different conditions the equation will be helpful to obtain an approximation of the amount of molasses solids recycled per hour without going into lengthy calculations. These calculations have been made for a new set of conditions, namely:

Gravity purity syrup ...	...	88.5
Gravity purity final molasses	...	38.5
Apparent gravity purity final molasses ...	...	35.5
Apparent purity C massecuite	...	58.0

other conditions being the same as in the previous example. The amounts of molasses solids recycled in this case are shown in table 60 which also includes for convenience the corresponding figures obtained previously.

Table 60. Influence of C sugar purity on molasses recycling for different sets of conditions.

Purity C Sugar	Kgs. solids recycled in final molasses per hour	
	New conditions	Original conditions
94	160	148
90	300	273
86	472	436
82	720	646
78	1054	933
74	1558	1348
70	2411	1992

It may thus be seen that for C sugar purities above about 80, the use of the equation given will yield a fairly close approximation of the amount of molasses solids recycled per hour if the Brixes and purities prevailing are not much different from those used for the purpose of this paper.

It is hoped that the figures given above, in particular those pertaining to low C sugar purities and corresponding amounts of molasses recycled, will impress manufacturing superintendents and that more caution will be paid in future to this most important aspect of boiling house work.

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5. CHEMICAL CONTROL NOTES

J. P. LAMUSSE

PRELIMINARY STUDIES ON THE USE OF THE REFRACTOMETER FOR ROUTINE CHEMICAL CONTROL.

It is well known that the refractometric Brix of an impure sugar solution is nearer to the true solids (determined by drying) than the Brix measured with a hydrometer, although both hydrometer and refractometer usually read too high. Hydrometer readings are particularly high when the juice contains impurities in suspension, but these do not affect the refractometer.

Although most refractometers are not accurate enough to be used for routine chemical control of raw sugar factories, the Bausch and Lomb precision refractometer is capable of measuring Brix values accurate to the second decimal place. This instrument has replaced hydrometers for routine chemical control of all sugar factories in Hawaii since the early 1940's. The B. & L. refractometer is expensive and this is probably the main reason which has limited its adoption for routine control in other sugar producing countries.

During the 1960 crop a B. &. L. precision refractometer was used in parallel with hydrometers in an attempt to compare the results obtained with these instruments for the routine chemical control of sugar factories. Unfortunately, the refractometer was available only for the last days of the grinding season and comparisons could only be made for a few days in two factories: Mon Trésor and Constance.

At the time of the experiment, Mon Trésor was grinding mostly short season plant cane and it had been noticed that, every year, when the factory started grinding this category of cane the boiling house efficiency fell to an abnormally low value, although no change was brought to either factory process or chemical control procedure. For various reasons the comparison at Mon Trésor had to be limited to the Brix of juices.

At Constance parallel control using the refractometer and standardised hydrometers was carried out during one week on all juices and on final molasses. The recoveries and profit and loss account was calculated using the two sets of figures.

Results obtained at Mon Trésor are given in tables 61 and 62.

Table 61. Comparison of Brix and purity values obtained with the refractometer and with hydrometers at Mon Trésor S.E.

	Mixed juice				1st expressed juice		Last expressed juice	
Daily Average	Hydrometer Brix	Refractometer Brix	Hydrometer Pty.	Refractometer Pty.	Hydrometer Brix	Refractometer Brix	Hydrometer Brix	Refractometer Brix
Monday ...	15.18	15.66	85.8	83.0	19.89	20.24	5.18	5.92
Tuesday ...	14.63	15.15	87.0	84.0	19.52	19.92	5.02	5.74
Wednesday	14.44	14.95	87.3	84.3	19.69	19.96	4.89	5.64
Thursday ...	14.13	14.57	86.8	84.0	19.72	20.10	4.72	5.53
Friday ...	14.27	14.70	87.3	84.6	20.22	20.42	4.84	5.48
Saturday ...	14.48	14.92	87.3	84.6	20.61	20.46	4.57	4.97
Average ...	14.52	14.99	86.9	84.1	19.94	20.18	4.87	5.55

Molasses Purity*

	Hydrometer	Refractometer
Thursday ...	32.7	33.6
Friday ...	32.9	33.7
Saturday ...	31.9	35.0
Average ...	32.5	34.1

Table 62. S.J.M. Recovery

	Hydro-meter	Refracto-meter	Ratio of B.H.E. Refracto-meter to Hydrometer
Thursday ...	93.1	90.6	1.028
Friday ...	93.0	91.1	1.021
Saturday ...	93.5	91.7	1.020
Average ...	93.2	91.1	1.023

At Mon Trésor the refractometer Brix of all juices was higher than the hydrometer Brix and consequently purities of mixed juice calculated from the refractometer Brix were low. This is contrary to what was found at Constance and to what could be predicted from theoretical considerations, but is it interesting because it explains the abnormally low B.H.E. of the factory at the time. The recoverable sugar per cent. sucrose in mixed juice based on the two sets of mixed juice purities and on the average molasses purity for the three days on which molasses analyses are available is given in table 62. This table also shows the ratio of Boiling House Efficiencies calculated from these recovery figures. It will be noted that the B.H.E. calculated from figures obtained with the refractometer is, on the average, 1.023 times greater than the B.H.E. from hydrometer purities. Thus during week covered by the study, the B.H.E. according to the factory report (based on hydrometer purities) was 95.5. This is abnormally low for Mon Trésor factory. If this B.H.E. is multiplied by 1.023, the efficiency becomes 97.7, a more likely value in this case.

The results obtained at Constance are given in tables 63 & 64.

Table 63. Comparison of Brix and purity values obtained with hydrometers and the refractometer at Constance S.E.

	Mixed juice				Final molasses **	
Daily Average	Hydro-meter Brix	Refracto-meter Brix	Hydro-meter Purity	Refracto-meter Purity	Hydro-meter Purity	Refracto-meter Purity
			80.9	82.2	—	—
Monday ...	13.79	13.57	80.2	81.1	32.6	37.0
Tuesday ...	13.48	13.34	81.1	82.5	32.8	35.9
Wednesday ...	13.48	13.22	81.3	81.9	31.8	34.3
Thursday ...	13.39	13.15	81.0	81.8	31.2	34.8
Friday ...	13.62	13.46	82.2	83.4	32.0	35.7
Saturday ...	13.41	13.23	81.1	82.2	32.1	35.5
Average ...	13.53	13.33				

* *The molasses Brix was determined with hydrometers at 1:10 (wt/vol) dilution and with the refractometer at 1:6 (wt/wt) dilution.*

** *Determined at 1:10 (wt/vol) dilution.*

Table 64. Comparison of weekly report figures calculated from purity values based on refractometer and hydrometer Brix — Constance S. E.

Kilos recoverable sugar			Commercial sugar recoverable % cane			Estimated undetermined losses			Estimated Boiling House Efficiency	
Hydrometer	Refractometer	True Weight* Stock Taking	Hydrometer	Refractometer	Stock taking	Hydrometer	Refractometer	Stock taking	Hydrometer	Refractometer
1,090,760	1,079,204	1,057,104	9.99	9.88	9.68	0.10	0.21	0.41	98.0	96.9

At Constance interesting weekly report figures were calculated from purities based on hydrometer and refractometer Brixes. These are compared to the corresponding figures calculated from the weight of sugar obtained by weighing and stock taking which will hereafter be called the stock figures but which are based on a run of only one week.

Examination of the results tabulated show that the figures calculated from refractometer purities are intermediate in value between those calculated from hydrometer readings and the stock figures. It is interesting to note that the use of a refractometer instead of hydrometers for Brix determination can change not only figures used in the control of the factory such as estimated undetermined losses from 0.21 to 0.10, but that data of commercial interest such as the daily estimated commercial sugar extracted % cane can increase from 9.88 to 9.99.

The comparisons made this crop are of limited value because of the short duration of the tests, but they have shown that, apart from the greater accuracy of the Brix determinations, which help pinpoint losses in the factory, the use of the B. &. L. refractometer simplifies routine Brix determination and reduces the risks of experimental errors such as the presence of air and suspended matter in the juice which affect the hydrometer but not the refractometer reading. The instrument is simple to operate and can be used by semi-skilled laboratory assistants.

The preliminary results obtained this crop seem to justify a more thorough study in 1961 and it is hoped that it will be possible to carry out a number of comparisons in several factories for the whole of the next grinding season.

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6. CALCULATION OF RECOVERABLE SUGAR FROM SUCROSE CONTENT OF CANE IN EXPERIMENTAL PLOTS.

J. D. de R. de SAINT ANTOINE & PIERRE HALAIS

Every year during crop time representative cane samples from each individual experimental plot of field trials are analysed at this Institute for sucrose and fibre per cent cane. The sucrose values obtained in that way are on the average higher whilst the fibre values are somewhat lower than average industrial figures recorded in Mauritius factories. This mainly results from the fact that cane weighed at factories contains a certain proportion of trash, tops and extraneous matter where-

* Purities of product in stock based on hydrometer Brix.

as both the Queensland fibrator — used up to 1959 for the analysis of canes from experimental plots — and the cane-chipper which has replaced the former as from the 1960 crop (Saint Antoine and Leguen, 1959) can only deal with clean canes, free from trash and tops. Furthermore, the assumption made that juice extracted by the press following the Queensland fibrator method is equivalent to the absolute juice of the cane inflates the sucrose per cent cane values by about 4%. This incorrect assumption does not create any bias in the conclusions for agronomy at least, as only differences in sucrose content and not absolute values are looked for and usually published.

For several years it had been observed that, in addition to the 4% deduction mentioned above, a further deduction of about 10% should be made to sucrose per cent cane values obtained at the laboratory of this Institute to bring them in line with industrial figures. To check on the magnitude of the deduction to be adopted the results of the 1959 final variety trials for the standard varieties Ebène 1/37, M. 134/32, M. 147/44 and B. 37172 were averaged for sucrose % cane and weighed averages based on the percentages of those varieties harvested in 1959 were calculated. The results, which represent the aggregate of 756 analyses, are shown in table 65.

Table 65. Sucrose per cent cane of 1959 final variety trials.

	Per cent harvested on estate lands	Sucrose % cane
Ebéne 1/37 ...	28.0	16.41
M.134/32 ...	33.8	16.07
M.147/44 ...	13.0	14.70
B.37172 ...	6.6	15.66
Average ...		15.95

The above results were obtained with the Queensland fibrator and for the calculations it had been assumed that juice obtained by pressing the fibrated material was equivalent to the absolute juice of the cane, as already pointed out. Such is not the case in practice when heavy pressures cannot be applied in the press and when the shredded material still contains many unbroken cells. It is thus necessary to reduce the sucrose per cent cane values obtained above, the correction factor adopted being 0.96. This figure was arrived at in 1959 when 55 comparative determinations of sucrose per cent cane were made on duplicate samples with the help of the cane chipper and of the Queensland fibrator. Respective values obtained were 14.70 and 15.34 (Saint Antoine & Leguen, 1959) the ratio of which is 0.958.

Thus the average sucrose per cent cane corrected for the reason explained above is:

$$15.95 \times 0.96 = 15.31$$

In 1959, however, average sucrose per cent cane for the whole island amounted to 13.76. The ratio of this figure to 15.31 being 0.90, it is only necessary to deduct 10 per cent from the sucrose per cent cane figure arrived at in the laboratory when using the cane chipper method to obtain industrial sucrose per cent cane.

Now, should it be necessary to calculate the amount of industrial recoverable sucrose, the simplest way is to deduct 1.8 from the industrial sucrose per cent cane value. The figure 1.8 represents total sucrose losses in the factories averaged over the period 1956 to 1959, both years inclusive. Furthermore, the differences between sucrose per cent cane and sucrose recovered per cent cane worked out at weekly intervals for each sector of the island for the period 1956 to 1959 are summarized below table 66.

Table 66. Weekly total sucrose losses of factories, 1956-1959.

Sucrose per cent cane	No. of values within range	Total sucrose losses
16.0	7	1.95
15.0 — 16.0	54	1.87
14.0 — 15.0	141	1.75
13.0 — 14.0	89	1.76
12.0 — 13.0	8	1.78

The above table shows that for a wide range of sucrose per cent cane total sucrose losses in factories amount on an average to 1.8 irrespective of juice purity and fibre content.

Summarizing the above statements, it is henceforth proposed to use the following formulae at this Institute whenever necessary for agronomic or other studies:

Sucrose per cent cane	=	SC
Industrial sucrose per cent cane (ISC)	=	0.9 SC
Industrial recoverable sucrose per cent cane (IRSC)	=	0.9 SC — 1.8

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APPENDIX*

I. Description of cane sectors.

II. Area under sugarcane.

III. Sugar production.

IV. Yield of Cane.

V. Sugar manufactured % cane.

VI. Sugar manufactured per arpent.

VII. Rainfall excesses and deficits.

VIII. Wind velocity.

IX. Wind velocity. Cyclone years.

X. Variety trend 1950 — 1960.

XI. Composition of 1960 plantations.

XII. Relative production of virgin and ratoon canes.

XIII. Yield of virgin and ratoon canes.

XIV. Evolution of 1960 sugar crop.

XV. Evolution of cane quality, 1960.

XVI. Duration of harvest and weekly crushing rates, 1947 - 1960.

XVII. Summary of chemical control data, 1960 crop.

(i) Cane crushing and sugar produced.

(ii) Cane, bagasse and juice.

(iii) Filter cake, syrup, pH, final molasses and sugar.

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(v) Milling work, sucrose losses and balance, recoveries.

XVIII. Molasses production.

XIX. Importation of fertilizers.

XX. Sales of herbicides.

XXI. List of crosses made in 1960.

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* *Grateful acknowledgment is made to the Secretary, Mauritius Chamber of Agriculture, for providing the necessary data to compile Tables II to VI.*

Table I. General description of sugarcane sectors of Mauritius.

SECTORS		WEST	NORTH	EAST	SOUTH	CENTRE
DISTRICT		Black River	Pamplemousses & Rivière du Rempart	Flacq	Grand Port & Savanne	Plaines Wilhems & Moka
ORIENTATION		Leeward	—	Windward	Windward	—
PHYSIOGRAPHY		Lowlands and Slopes	Lowlands	Slopes	Slopes	Plateau
GEOLOGY		Late lava — Pleistocene.				
11 PETROLOGY		Compact or vesicular doleritic basalts and subordinate tuffs.				
ALTITUDE		Sea level—900 ft.	Sea level—600 ft.	Sea level—1,200 ft.	Sea level—1,200 ft.	900—1,800 ft.
HUMIDITY PROVINCE		Sub-humid	Sub-humid to humid	Humid to super-humid		
ANNUAL RAINFALL, inches. Range and mean		(30—60) 44	(40—75) 55	(60—125) 94	(60—125) 90	(60—150) 90
MONTHS RECEIVING LESS THAN TWO INCHES RAIN		June to October	September to October	None		
AVERAGE TEMPERA-TURE °C	JAN.	27.0°	26.5°	25.5°	25.0°	23.5°
	JUL.	21.0°	20.5°	19.5°	19.0°	17.5°
CYCLONIC WINDS, greater than 30m p.h. during 1 hour		December to May				
11 PETROLOGY		Compact or vesicular doleritic basalts and subordinate tuffs.				
ALTITUDE		Sea level—900 ft.	Sea level—600 ft.	Sea level—1,200 ft.	Sea level—1,200 ft.	900—1,800 ft.
HUMIDITY PROVINCE		Sub-humid	Sub-humid to humid	Humid to super-humid		
ANNUAL RAINFALL, inches. Range and mean		(30—60) 44	(40—75) 55	(60—125) 94	(60—125) 90	(60—150) 90
MONTHS RECEIVING LESS THAN TWO INCHES RAIN		June to October	September to October	None		
AVERAGE TEMPERA-TURE °C	JAN.	27.0°	26.5°	25.5°	25.0°	23.5°
	JUL.	21.0°	20.5°	19.5°	19.0°	17.5°
CYCLONIC WINDS, greater than 30m p.h. during 1 hour		December to May				
PEDOLOGY Soil Groups: (*) A. Low Humic Latosol		« Richelieu » bouldery clay (13,000 arpents)		—		
B. Humic Latosol		—	« Réduit » bouldery clay (60,000 arpents)			
			—	« Sans Souci » bouldery clay (21,000 arpents)		
C. Lithosol		« Mapou » stony and gravelly clay (19,000 arpents)		—		
(*) Other unclassified groups occur chiefly in the West and North (2000 arpents)			« Plaisance » stony and gravelly clay (55,000 arpents)			
			—	« Rose Belle » stony and gravelly clay (29,000 arpents)		
IRRIGATION		Common	Some	Rare		
APPROXIMATE AREA 1000 arpents	Sector	56	91	72	160	63
	Cane	11	53	44	63	26
CANE PRODUCTION 1000 metric tons Average 1957 - 59		272	1,053	899	1,608	638
SUGAR PRODUCTION 1000 metirc tons Average 1957 - 59		34	141	111	192	79
SUAGR FACTORIES Production in 1000 metric tons Average 1957 - 59		Médine 34	Mon Loisir 28 St. Antoine 20 Solitude 21 The Mount 21 Beau Plan 19 Labourdonnais 17 Belle Vue 15	Union Flacq 60 Beau Champ 29 Constance 22	Savinia 30 Mon Trésor 25 Riche en Eau 23 Union 22 Britannia 20 Rose Belle 20 Benarès 15 Bel Ombre 14 Ferney 12 St. Félix 11	Mon Désert 35 Highlands 23 Réunion 21

Table II. Area under sugar cane in thousand arpents(1), 1955 - 1960.

Year	Area under cane Island	Area reaped					
		Island	West	North	East	South	Centre
1955	180.05	168.59	8.82	47.80	36.90	52.78	21.86
1956	181.21	167.90	8.74	48.16	35.95	53.17	21.88
1957	182.67	169.58	8.95	48.27	35.72	54.25	22.29
1958	189.22	176.69	9.20	49.14	38.78	56.62	22.95
1959	195.31	183.12	9.62	50.37	40.93	58.77	23.43
1960(2)	197.00	186.05	9.21	50.41	42.06	60.30	24.07

NOTE: (1) *To convert into acres multiply by 1.043*

„ „ „ hectares „ „ 0.422

(2) *Provisional figures.*

Table III. Sugar production in thousand metric tons(1), 1955 - 1960.

Crop Year	No. of factories operating	Av. Pol.	Island	West	North	East	South	Centre
1955	26	98.6	533.3	31.52	148.39	103.40	173.96	76.07
1956	26	98.6	572.5	31.06	167.14	110.22	187.60	76.47
1957	26	98.5	562.0	36.05	141.28	103.31	198.86	82.50
1958	25	98.5	525.8	31.80	137.17	106.07	178.80	72.01
1959	24	98.6	580.4	35.22	141.95	123.76	195.86	83.59
1960(2)	23	98.0	235.6	18.06	74.99	50.07	72.23	20.23

NOTE: (1) *To convert into long tons multiply by 0.984*

„ „ „ short „ „ „ 1.102

(2) *Provisional figures*

Table IV. Yield of cane metric tons per arpent(1), 1955 - 1960.

	1956	1957	1958	1959	1960(2)
ISLAND					
Millers	32.0	32.2	30.5	32.5	15.3
Planters	21.0	19.1	19.1	19.7	10.4
Average	26.3	25.6	24.5	25.9	12.8
WEST					
Millers	32.2	35.9	32.4	34.4	21.4
Planters	24.1	27.8	25.2	26.4	15.8
Average	27.0	30.8	28.0	29.3	17.9
NORTH					
Millers	32.2	29.0	29.5	30.0	19.2
Planters	22.2	16.9	17.5	17.1	11.8
Average	25.5	21.1	21.6	21.5	14.4
EAST					
Millers	31.6	31.5	31.5	33.0	16.3
Planters	19.2	17.2	16.8	19.2	9.4
Average	23.9	22.9	22.4	24.8	12.2
SOUTH					
Millers	31.7	32.8	30.3	32.3	14.6
Planters	20.9	22.0	22.5	21.4	9.4
Average	28.3	29.3	27.4	28.6	12.9
CENTRE					
Millers	32.7	34.1	30.6	34.9	9.7
Planters	19.0	20.4	19.9	22.0	7.6
Average	27.1	28.6	25.9	29.1	8.8

NOTE: (1) *To convert in metric tons/acre multiply by 0.959*
" " " long tons/acre " " 0.945
" " " short tons/acre " " 1.058
" " " metric tons/hectare " " 2.370

(2) *Provisional figures.*

Table V. Average sugar manufactured % cane(1), 1955 - 1960.

Crop Year	Island	West	North	East	South	Centre
1955	12.61	12.85	13.22	12.43	12.11	12.83
1956	12.95	13.17	13.59	12.84	12.47	12.89
1957	12.94	13.07	13.86	12.64	12.49	12.88
1958	12.14	12.36	12.95	12.22	11.53	12.12
1959	12.24	12.48	13.08	12.22	11.64	12.27
1960(2)	9.84	10.94	10.34	9.73	9.29	9.56

NOTE: (*1*) *To convert into tons cane per ton sugar manufactured: divide 100 by above percentage.*

(*2*) *Provisional figures.*

Table VI. Tons sugar manufactured per arpent reaped, 1955 - 1960.

	Island	West	North	East	South	Centre
1955	3.17	3.57	3.10	2.80	3.30	3.48
1956	3.41	3.56	3.47	3.07	3.53	3.49
1957	3.31	4.02	2.92	2.89	3.66	3.68
1958	2.98	3.46	2.79	2.74	3.16	3.14
1959	3.17	3.66	2.81	3.03	3.33	3.57
1960 (1)	1.26	1.96	1.49	1.19	1.20	0.84

NOTE: (*1*) *Provisional figures.*

Table VII. Monthly rainfall in inches. Average over whole sugarcane area of Mauritius.

	GROWTH PERIOD (deficient months in italics)								NOV.-JUNE (sum of monthly deficits)	MATURATION PERIOD (excess months in italics)				JULY-OCT. (sum of monthly excesses)
Crop year	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE		JULY	AUG.	SEPT.	OCT.	
Normals 1875-1949	3.77	7.09	11.04	11.06	12.09	9.50	6.91	4.96	15.00	4.59	4.15	2.90	2.81	2.50
Extremes	0.52 13.18	1.74 39.92	2.69 32.46	3.07 36.04	3.35 38.98	1.45 27.60	1.62 21.41	0.97 16.49	2.20 29.20	1.62 10.23	0.60 12.52	0.69 6.41	0.76 9.83	0.00 9.40
1947	10.36	*3.42*	*8.06*	*6.83*	*4.26*	9.69	*3.50*	5.66	22.57	2.76	3.91	2.20	1.24	0.00
1948	*2.52*	*6.83*	*8.23*	*5.10*	*8.04*	12.13	*2.61*	*1.80*	21.79	4.12	2.84	*3.34*	*2.98*	0.61
1949	4.01	*5.48*	*4.81*	16.71	*8.86*	*7.01*	*3.30*	10.09	17.17	4.11	1.91	1.39	1.39	0.00
1950	*3.34*	*3.42*	*10.20*	*5.21*	23.18	11.39	*2.98*	*7.02*	14.72	4.47	*5.02*	2.80	2.35	0.87
1951	*3.15*	*5.86*	11.65	*8.20*	*10.89*	*7.98*	7.00	7.26	7.43	*4.91*	*5.41*	*4.16*	*3.84*	3.87
1952	4.08	*2.22*	*5.26*	11.17	16.88	10.11	*5.69*	*4.86*	12.31	*8.22*	*5.20*	*3.47*	*3.13*	5.61
1953	6.06	18.05	11.65	*6.59*	*10.57*	*8.35*	11.95	12.75	7.14	*10.10*	*4.72*	*3.07*	2.68	6.25
1954	*3.76*	11.47	*5.00*	*7.96*	14.89	*6.20*	*6.49*	6.06	12.88	*6.44*	*5.04*	*4.11*	1.53	3.76
1955	4.81	*5.19*	*4.50*	23.28	19.60	10.97	8.83	7.73	8.44	*4.66*	3.85	3.68	1.12	0.85
1956	*3.03*	7.70	12.02	13.59	*10.60*	*4.14*	*5.93*	*4.90*	8.63	2.94	2.82	1.68	1.40	0.00
1957	*2.08*	8.11	*7.80*	*6.98*	*8.93*	10.66	*6.14*	*3.66*	14.24	3.55	2.54	*3.32*	0.96	0.42
1958	*2.09*	10.26	13.49	13.28	29.54	13.29	*4.95*	*2.20*	6.40	*8.22*	*4.51*	1.50	2.47	3.99
1959	*1.18*	*3.06*	13.64	*9.48*	13.93	*4.81*	*3.04*	*1.80*	19.91	3.07	*6.01*	2.67	*6.53*	5.59
1960	11.43	*6.58*	23.46	18.29	16.97	*1.73*	*3.23*	5.06	11.96	3.57	2.29	*8.06*	1.49	5.16

NOTE: To convert into millimetres multiply by 25.4.

Table VIII. Highest wind speed during one hour in miles(1). Average over Mauritius.

Crop Year	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
November	—	21	17	24	18	18	14	16	12	13	13	19
December	18	16	24	21	15	16	15	17	13	13	14	15
January	27	26	21	22	18	28	13	20	20	14	17	*53*(2)
February	20	24	20	25	15	15	*34*(2)	16	19	18	17	*74*(2)
March	20	17	18	25	15	15	29	19	18	*33*(2)	18	15
April	18	21	17	22	20	16	16	17	16	28	17	15
May	20	19	20	24	22	22	19	18	15	14	16	17
June	24	20	23	25	23	20	22	17	13	14	17	17
July	21	23	21	20	24	16	17	15	12	11	16	15
August	18	19	24	25	24	23	20	14	17	20	18	16
September	20	21	21	21	20	19	19	17	17	17	17	20
October	18	19	20	20	19	20	14	18	15	17	18	18

NOTE: (*1*) *To convert into: knots multiply by 0.87.*
kilometres/hr. multiply by 1.61.
metres/sec. multiply by 0.45.

(2) *Cyclonic wind above 30 miles per hour.*

Table IX. Highest wind speed during one hour in miles in different sectors. Cyclone years.

		West	North	East	South	Centre
February	1955	—	30	—	37	35
March	1958	34	29	22	35	31
January	1960 *Alix*	60	48	43	60	—
February	1960 *Carol*	83	82	78	74	55

Table X. Variety trend in Mauritius, 1950 - 1959.

% Area cultivated (Estate lands).

	M. 134/32	M. 112/34	M. 147/44	M. 31/45	Other M. seedlings	Ebène 1/37	B. 3337	B. 34104	B. 37161	B. 37172	Others
1950	91	2	—	—	5	1	—	—	—	—	1
1951	92	2	—	—	4	2	—	—	—	—	—
1952	90	2	—	—	3	4	—	—	—	—	1
1953	86	2	—	—	3	8	—	—	—	—	1
1954	83	2	—	—	3	9	1	—	1	—	1
1955	74	2	—	—	2	15	3	—	2	1	1
1956	66	2	1	1	3	17	4	—	3	2	1
1957	55	2	6	3	1	21	4	1	3	3	1
1958	43	2	10	4	2	24	5	1	3	5	1
1959	33	2	15	5	1	25	5	2	3	8	1

Table XI. Percentage annual plantations under different cane varieties on sugar estates, 1956 to 1960.

Years / Varieties	Island					West					North					East					South					Centre				
	1956	1957	1958	1959	1960	1956	1957	1958	1959	1960	1956	1957	1958	1959	1960	1956	1957	1958	1959	1960	1956	1957	1958	1959	1960	1956	1957	1958	1959	1960
M.134/32	20.6	7.5	3.0	1.2	2.8	20.6	23.8	6.2	—	—	5.28	17.8	8.1	2.7	11.3	17.0	1.7	0.5	0.2	0.4	17.2	7.9	3.0	1.5	1.2	1.7	—	0.4	0.4	0.3
M.147/44	14.0	35.6	28.9	32.7	30.0	40.8	46.4	25.2	20.5	17.8	6.8	47.3	35.3	50.4	49.4	16.6	32.1	34.8	39.0	27.8	11.5	39.6	25.1	31.2	27.9	16.1	13.5	22.0	8.0	16.4
M.31/45	9.0	9.1	8.0	3.8	2.6	—	6.9	13.1	4.8	7.4	1.4	5.8	4.8	4.9	6.7	8.4	10.1	15.7	5.7	3.8	13.6	12.6	7.3	2.4	0.3	8.0	1.0	2.8	3.3	—
M.202/46	—	—	—	—	7.7	—	—	—	—	9.2	—	—	—	—	6.2	—	—	—	—	4.9	—	—	—	—	10.4	—	—	—	—	5.0
M.93/48	—	—	—	—	2.9	—	—	—	—	1.5	—	—	—	—	0.9	—	—	—	—	1.8	—	—	—	—	5.3	—	—	—	—	0.4
M.253/48	—	—	—	—	2.1	—	—	—	—	20.2	—	—	—	—	0.2	—	—	—	—	3.6	—	—	—	—	0.6	—	—	—	—	0.7
Ebène 1/37	28.5	33.2	28.9	24.3	14.5	7.6	—	—	—	—	8.6	6.6	5.2	7.2	3.2	35.4	43.1	27.5	25.2	17.8	22.0	24.7	30.5	30.2	14.5	61.4	81.2	57.5	35.2	31.7
B.3337	7.4	1.8	4.8	6.9	10.3	—	—	—	—	—	0.6	—	—	—	—	2.9	1.0	1.7	6.4	10.2	12.2	—	7.6	8.3	15.2	8.6	1.8	8.4	14.7	16.0
B.34104	2.9	2.2	2.9	2.8	2.5	11.5	7.8	32.0	29.6	15.9	0.8	1.6	5.6	2.9	2.1	0.5	0.5	0.1	—	0.3	4.7	3.3	3.2	2.1	2.9	—	0.3	2.7	1.2	—
B.37161	8.4	2.1	0.9	—	—	16.6	1.1	1.1	—	—	14.7	4.6	4.4	—	—	7.6	2.7	—	—	—	8.6	1.6	—	—	—	0.8	—	—	—	—
B.37172	6.4	5.7	20.6	21.0	16.5	2.4	3.9	13.3	30.9	26.4	8.4	11.6	32.3	25.7	19.6	9.3	7.3	18.8	15.9	17.4	7.6	4.8	22.3	19.8	18.6	0.5	0.1	3.0	23.0	0.5
Other varieties	0.6	0.7	1.2	6.8	8.1	0.5	0.7	6.3	14.2	—	1.6	1.2	1.9	5.1	0.4	0.4	0.7	0.7	7.0	12.0	0.8	0.5	0.7	4.2	3.1	0.3	1.0	2.6	14.1	31.5
Total area arpents	12706	13948	13011	13203	14321	678	536	403	512	729+	2169	2105	2573	2579	2796	2029	3076	2964	2620	2834	5438	6224	5536	5565	6058	2392	2007	1939	1927	1905

Table XII. Percentage weight of ratoons in total cane production on estates.

Year	Island	West	North	East	South	Centre
1949	82.0	75.9	78.9	81.7	83.3	82.3
1950	83.0	79.1	82.3	83.5	87.3	83.9
1951	87.6	80.0	82.5	85.6	91.5	86.3
1952	88.6	85.0	83.4	87.9	90.2	86.7
1953	87.8	85.9	87.7	88.1	88.5	85.4
1954	88.0	83.8	86.8	89.6	89.4	85.3
1955	87.1	86.7	88.6	87.7	86.4	86.1
1956	84.5	87.5	86.4	84.9	83.8	82.9
1957	85.0	79.0	86.9	83.6	85.7	83.7
1958	82.9	77.9	86.3	77.5	83.1	85.5
1959	86.1	87.8	85.9	82.1	87.2	87.8
1960	81.9	82.2	82.7	78.3	75.2	84.8

NOTE: *The weight of cane produced on estates in 1959 was: virgins 396,765 tons; ratoons 2,456,195 tons.*

Table XIII. Average yields of virgin and ratoon canes on estates.

Tons per arpent. A: 1947 - 1959 B: 1960.

	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
Virgin	35.4	22.8	41.5	31.0	34.4	26.3	39.1	27.9	34.0	21.3	34.7	12.3
1st Ratoon	33.2	18.0	35.5	24.2	33.1	23.6	34.4	19.9	32.5	16.6	33.1	9.9
2nd ,,	31.1	16.4	33.2	22.7	30.1	21.9	33.2	16.8	30.8	16.3	30.8	8.5
3rd ,,	29.7	13.2	31.9	17.9	29.1	18.3	31.1	13.3	29.1	12.5	29.7	8.9
4th ,,	29.1	12.0	30.7	18.5	28.0	17.0	30.0	11.8	29.4	11.0	28.9	8.8
5th ,,	28.4	12.3	30.6	21.2	27.6	17.4	27.8	12.3	28.9	11.5	28.5	7.4
6th ,,	28.5	12.4	30.3	19.7	27.2	18.0	28.3	12.0	29.0	11.5	29.0	8.4

Table XIV. Evolution of 1960 sugar crop. Production data at weekly intervals

	Island	West	North	East	South	Centre	*Island*	West	North	East	South	Centre	*Island*	West	North	East	South	Centre
	30th July						*6th August*						*13th August*					
Cane crushed (1000 m. tons)	186	12	45	23	72	34	317	22	83	45	110	57	466	33	132	70	152	79
Sugar Manufactured % cane	9.40	10.03	9.79	9.35	9.21	9.16	9.57	10.23	9.84	9.58	9.30	9.38	9.67	10.35	9.99	9.71	9.33	9.49
Sugar Manufactured (1000 m. tons)	17.4	1.2	4.4	2.0	6.6	3.2	30.4	2.2	8.2	4.3	10.3	5.4	45	3.4	13.2	6.9	14.1	7.4
	20th August						*27th August*						*3rd September*					
Cane crushed (1000 m. tons)	593	42	174	92	189	96	761	53	226	125	239	118	906	63	272	154	280	137
Sugar manufactured % cane	9.77	10.51	10.13	9.83	9.38	9.56	9.87	10.72	10.24	9.96	9.41	9.58	9.95	10.84	10.37	10.05	9.43	9.59
Sugar manufactured (1000 m. tons)	57.9	4.4	17.7	9.0	17.7	9.1	75.2	5.7	23.2	12.4	22.4	11.3	90.2	6.8	28.2	15.5	26.5	13.2
	10th September						*17th September*						*24th September*					
Cane crushed (1000 m. tons)	1064	74	323	185	327	155	1208	85	369	214	374	166	1359	96	419	247	418	179
Sugar manufactured % cane	9.98	10.86	10.46	10.05	9.46	9.59	10.00	10.86	10.50	10.0	9.46	9.60	10.00	10.87	10.50	10.01	9.47	9.62
Sugar manufactured (1000 m. tons)	106.2	8.0	33.8	18.6	31.0	14.8	120.8	9.1	38.8	21.5	35.4	16.0	135.9	10.4	44.0	24.7	39.6	17.2
	1st October						*8th October*						*15th October*					
Cane crushed (1000 m. tons)	1509	107	468	279	467	188	1657	119	516	310	515	197	1797	131	562	341	560	203
Sugar manufactured % cane	9.98	10.85	10.49	9.95	9.43	9.64	9.95	10.86	10.46	9.92	9.39	9.63	9.92	10.90	10.41	9.85	9.35	9.62
Sugar manufactured (1000 m. tons)	150.6	11.6	49.1	27.7	44.0	18.2	164.9	12.9	53.9	30.8	48.3	19.0	178.3	14.3	58.5	33.6	52.3	19.6
	22nd October						*29th October*						*5th November*					
Cane crushed (1000 m. tons)	1921	142	605	369	598	207	2054	155	651	398	639	211	2153	165	679	422	675	212
Sugar manufactured % cane	9.90	10.92	10.40	9.79	9.34	9.59	9.89	10.93	10.33	9.75	9.32	9.56	9.85	10.93	10.30	9.71	9.29	9.56
Sugar manufactured (1000 m. tons)	190.2	15.6	62.9	36.0	55.9	19.8	202.8	17.0	67.3	38.9	59.4	20.2	212.0	18.0	70.1	41.0	62.7	20.2
	12th November						*19th November*						*Total Crop Production (Preliminary figs.)*					
Cane crushed (1000 m. tons)	2256	165	708	456	715	212	2339	165	724	488	750	212	2393	165	725	514	777	212
Sugar manufactured % cane	9.84	10.93	10.30	9.70	9.30	9.56	9.84	10.93	10.34	9.69	9.30	9.56	9.84	10.94	10.34	9.73	9.29	9.56
Sugar manufactured (1000 m. tons)	222.0	18.0	73.0	44.2	66.6	2.02	230.2	18.0	74.9	47.3	69.8	20.2	235.6	18.1	75.0	50.1	72.2	20.2

Table XV. Evolution of cane quality during 1960 sugar crop.

Week Ending	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
30th July	11.53	9.54	12.26	9.99	11.68	9.73	11.23	9.42	11.36	9.35	11.15	9.19
6th August	11.87	9.81	12.63	10.46	11.98	9.89	11.77	9.90	11.65	9.51	11.75	9.72
13th ,,	11.95	9.92	12.73	10.57	12.20	10.24	11.78	9.89	11.64	9.42	11.78	9.83
20th ,,	12.15	10.11	13.13	11.12	12.50	10.49	12.07	10.17	11.73	9.58	11.84	9.90
27th ,,	12.21	10.21	13.09	11.48	12.79	10.76	12.20	10.35	11.69	9.56	11.66	9.69
3rd September	12.37	10.35	13.13	11.52	12.93	10.96	12.34	10.41	11.81	9.61	11.70	9.69
10th ,,	12.14	10.19	12.78	10.93	12.78	10.82	11.95	10.16	11.64	9.56	11.63	9.62
17th ,,	12.12	10.15	12.68	10.91	12.70	10.76	11.78	9.80	11.62	9.56	12.10	10.25
24th ,,	12.00	10.04	12.58	10.92	12.39	10.52	11.64	9.82	11.39	9.14	11.75	9.95
1st October	11.66	9.76	12.33	10.72	12.16	10.28	11.46	9.63	11.10	9.08	11.59	9.74
8th ,,	11.52	9.62	12.41	10.95	12.00	10.15	11.27	9.23	10.98	9.03	11.68	9.56
15th ,,	11.49	9.60	12.62	11.27	11.83	10.00	11.27	9.26	11.00	8.99	11.08	8.90
22nd ,,	11.50	9.47	12.28	11.14	11.90	9.87	11.17	9.09	11.06	8.93	10.73	8.56
28th ,,	11.55	9.44	12.67	11.03	11.80	9.70	11.30	9.24	11.16	8.94	11.00	8.54
5th November	11.53	9.36	—	—	12.20	9.95	11.16	9.13	11.26	9.07	—	—
12th ,,	11.87	9.78	—	—	12.51	10.40	11.65	9.53	11.62	9.30	—	—
19th ,,	11.84	9.80	—	—	12.60	10.87	11.46	9.50	11.90	9.58	—	—

NOTE: *A* = *Sucrose % cane.*

B = *Commercial Sugar manufactured % cane.*

Table XVI. Total duration of harvest in days (A) and weekly crushing rates of factories in 1000 metric tons (B) in different sectors of the island, 1948 - 1960.

YEARS	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
1948	132	167.6	140	7.3	122	42.1	136	33.6	140	60.0	125	24.6
1949	133	176.5	142	7.7	128	44.0	129	37.0	140	62.4	127	25.4
1950	141	184.6	130	10.1	140	47.9	145	35.1	144	65.0	135	26.5
1951	154	197.8	150	10.3	169	52.0	159	40.3	140	65.8	132	29.4
1952	149	192.4	151	9.9	149	50.5	155	40.2	154	63.4	131	28.4
1953	158	205.7	162	11.8	167	57.7	161	42.5	153	66.0	145	27.7
1954	140	214.1	142	11.7	137	60.5	138	42.9	147	68.7	134	30.3
1955	133	222.6	134	12.8	122	64.2	140	41.5	140	71.6	127	32.5
1956	136	227.3	129	12.7	137	62.7	138	43.4	138	76.2	128	32.3
1957	128	237.5	144	13.3	104	68.2	133	42.9	141	78.6	129	34.5
1958	130	233.0	128	14.3	106	69.9	137	44.4	141	77.0	133	31.3
1959	135	238.0	133	14.4	102	73.3	149	47.8	147	81.2	133	35.7
1960	107	156.5	108	10.7	118	43.0	121	29.8	118	46.1	83	17.8

Table XVII. Summary of chemical control data 1960.

(i) CANE CRUSHED AND SUGAR PRODUCED

		Médine	Solitude	Beau Plan	The Mount	Labourdonnais	St Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Tresor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
CRUSHING PERIOD	From	21/7	20/7	29/7	15/7	15/7	25/7	5/8	18/8	29/7	6/7	30/7	1/7	16/7	8/7	22/7	11/7	29/7	29/7	1/8	12/8	15/7	28/7	11/7	—
	To	5/11	15/11	31/10	7/11	22/11	2/11	17/11	2/12	24/11	24/11	16/11	13/10	24/11	23/11	21/10	12/10	28/11	16/11	24/11	3/12	29/10	10/10	12/9	—
	No. of crushing days	91	99	78	94	108	78	87	89	99	117	91	87	101	116	55	80	103	85	99	94	89	61	54	89
	No. of crushing hours per day	18.72	20.64	18.49	13.27	21.60	17.53	15.13	20.40	10.53	11.98	11.83	10.30	13.42	14.10	14.52	9.92	14.75	15.02	15.09	15.83	11.88	15.63	12.50	14.92
	Hours stoppage per day	1.02	0.47	0.74	0.97	0.39	0.33	0.56	0.57	0.97	0.28	0.14	0.25	0.52	0.08	1.34	0.57	0.33	1.13	0.67	0.66	0.63	0.39	0.21	0.57
	Overall time Efficiency	94.9	99.8	96.2	93.2	98.2	98.1	96.2	95.6	94.0	97.7	98.8	97.5	96.3	99.4	91.5	94.6	97.8	93.0	95.8	96.0	95.0	96.1	98.3	96.3
CANE CRUSHED (Metric Tons)	Factory	75,031	29,622	32,512	60,372	41,774	39,242	88,933	50,299	143,745	86,949	28,370	69,453	86,673	108,299	32,689	44,681	71,452	89,059	27,645	33,173	45,995	38,176	46,822	1,370,966
	Planters	90,066	113,659	73,920	30,703	80,923	78,563	54,874	93,190	96,941	43,262	24,904	9,368	18,227	29,790	14,515	7,352	881	119	38,767	42,034	31,965	26,195	22,357	1,022,575
	Total	165,097	143,281	106,432	91,075	122,697	117,805	143,807	143,489	240,686	130,211	53,274	78,821	104,900	138,089	47,204	52,033	72,333	89,178	66,412	75,207	77,960	64,371	69,179	2,393,541
	Factory % Total	45.4	20.7	30.5	66.3	34.1	33.3	61.8	35.1	59.7	66.8	53.2	88.1	82.6	78.4	69.3	85.9	98.8	99.9	41.6	44.1	59.0	59.3	67.7	57.3
	Per day	1,814	1,447	1,364	969	1,147	1,510	1,653	1,612	2,431	1,113	585	906	1,039	1,190	858	650	702	1,049	671	800	876	1,055	1,281	1,162
	Per hour actual crushing	97.0	70.1	73.8	73.0	53.1	87.9	109.3	78.1	156.5	92.9	49.5	87.9	77.4	84.4	59.1	65.6	47.6	70.0	44.4	50.5	73.8	67.5	102.5	77.0
VARIETIES CRUSHED (Factory)	M.134/32 per cent	42.2	42.6	54.5	29.9	58.7	41.8	47.0	23.1	18.9	34.8	11.1	13.3	27.4	45.3	9.4	19.5	14.8	36.6	13.1	44.4	10.5	0.6	6.9	29.1
	Ebène 1/37 per cent	2.5	0.6	3.2	9.1	—	0.6	3.8	5.9	19.8	19.2	14.4	29.2	37.4	13.9	38.4	16.9	8.3	17.2	14.6	3.6	44.8	55.1	52.6	17.9
	M.147/44 per cent	20.9	41.0	16.9	36.1	16.8	22.9	27.9	49.6	37.8	14.2	33.4	18.6	9.3	16.2	14.9	31.0	26.4	20.9	30.5	17.3	21.0	4.7	25.8	24.0
	M.31/45 per cent	3.3	1.9	0.6	3.3	3.7	3.5	1.9	7.2	6.3	4.0	8.5	8.4	2.5	5.0	5.5	9.8	6.1	5.5	9.4	7.0	2.9	—	2.1	4.7
	B.~~37172~~ 3337 per cent	—	—	—	—	—	—	—	—	3.5	2.6	5.1	8.0	2.7	14	26.5	20.2	2.3	5.2	4.6	3.0	9.6	1.92	11.4	4.5
	B.~~3337~~ 37172 per cent	6.9	10.1	5.7	8.8	6.1	27.9	11.8	13.2	8.3	14.3	13.0	15.8	11.2	10.5	2.1	1.1	25.7	7.6	18.7	11.6	3.2	—	0.4	10.4
	Other varieties	24.2	3.8	19.1	12.8	14.7	3.3	7.6	1.0	5.4	10.9	14.5	6.7	9.5	7.7	3.2	1.5	16.4	7.0	9.1	13.1	8.0	20.4	0.8	9.4
SUGAR PRODUCED (Metric tons)	Raw Sugar	18,062	14,146	11,378	9,324	12,998	5,310	15,721	14,200	23,450	12,415	84	7,259	11,287	13,643	4,167	4,869	64	7,720	6,160	6,747	7,375	6,650	6,200	219,229
	White Sugar	—	—	—	—	—	6,111	—	—	—	—	4,237	—	—	—	—	—	6,012	—	—	—	—	—	—	16,360
	Total	18,062	14,146	11,378	9,324	12,998	11,421	15,721	14,200	23,450	12,415	4,321	7,259	11,287	13,643	4,167	4,869	6,076	7,720	6,160	6,747	7,375	6,650	6,200	235.589
	Tons Sugar 96° Pol.	18,557	14,570	11,682	9,594	13,380	11,790	16,156	14,605	24,090	12,747	4,472	7,457	11.606	14,034	4,279	5,003	6,304	7,944	6,329	6,918	7,592	6,815	6,363	242,288
CANE/SUGAR RATIO	Tons cane per ton sugar made	9.1	10.1	9.4	9.9	9.4	10.3	9.2	10.1	10.3	10.5	12.3	10.9	9.3	10.1	11.3	10.7	11.9	11.6	10.8	11.2	10.6	9.7	11.2	10.2
	„ „ „ „ „ of 96° Pol.	8.9	9.8	9.1	9.5	9.2	10.0	8.9	9.8	10.0	10.1	11.9	10.6	9.0	9.8	11.0	10.4	11.5	11.2	10.5	10.9	10.3	9.5	10.9	9.9

Table XVII. Summary of chemical control data 1960.

(ii) CANE, BAGASSE AND JUICES.

		Médine	Solitude	Beau Plan	The Mount	Labourdonnais	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Benarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
CANE	Sucrose per cent	12.69	11.87	12.50	12.12	12.55	12.06	12.71	11.99	11.55	11.36	10.84	11.20	12.78	11.91	11.05	11.26	11.22	10.46	11.27	10.96	11.51	12.21	11.09	11.83
	Fibre per cent	14.46	16.21	13.53	13.58	15.04	16.30	14.25	15.07	12.85	14.77	15.21	13.55	13.83	15.28	13.09	13.33	15.71	13.04	15.48	15.99	14.01	11.52	13.47	14.38
BAGASSE	Sucrose per cent	2.12	2.34	2.23	1.99	2.51	1.84	1.87	2.35	2.00	1.80	2.24	1.85	2.67	2.70	2.97	2.07	2.45	1.88	2.28	2.13	2.29	2.66	2.27	2.21
	Moisture per cent	50.00	50.61	49.14	48.15	50.65	50.30	49.37	48.30	50.30	47.40	48.80	50.73	49.85	50.00	52.09	47.60	48.68	49.63	49.90	49.70	51.66	50.90	51.37	49.79
	Fibre per cent	46.75	46.14	47.47	48.85	45.90	47.09	48.05	48.32	46.80	49.78	47.89	46.69	46.46	46.40	44.00	49.31	47.87	47.40	46.86	47.30	45.00	45.51	45.56	47.07
	Weight per cent cane	30.9	35.1	28.5	27.8	32.8	34.6	29.7	31.2	27.5	29.7	31.8	29.0	29.8	32.9	29.7	27.0	32.8	27.5	33.0	33.8	31.1	25.3	29.6	30.6
1st EXPRESSED JUICE	Brix (B_1)	18.85	18.64	18.59	17.77	18.93	19.09	18.83	18.29	17.18	17.33	16.63	17.31	18.73	17.45	16.16	16.15	17.12	16.34	15.83	16.57	17.05	17.19	16.59	17.51
	Gravity Purity	85.8	86.1	85.3	86.6	87.8	86.9	87.2	85.7	85.2	84.2	82.9	85.4	87.2	87.0	85.5	87.4	84.8	83.5	85.0	85.8	85.6	87.9	86.4	85.9
	Reducing sugar/sucrose ratio	3.5	4.2	3.5	3.8	2.7	3.0	3.4	4.2	3.7	3.9	4.9	3.3	3.0	3.2	3.8	3.7	4.3	5.0	3.4	3.8	2.7	3.1	3.2	3.6
LAST EXPRESSED JUICE	Brix	3.50	4.10	3.05	2.10	3.96	4.15	2.56	3.62	3.28	3.16	3.72	5.85	4.47	4.18	4.87	3.33	3.73	2.61	3.06	4.03	3.23	2.77	4.21	3.63
	Apparent Purity	65.2	71.9	65.7	66.7	72.6	70.4	72.4	70.9	69.8	63.9	67.2	71.6	72.3	75.1	76.0	67.6	71.5	66.1	71.2	73.2	68.5	67.6	73.9	70.1
MIXED JUICE	Brix	14.28	14.31	14.10	13.50	14.05	14.58	13.21	13.53	13.55	13.13	12.19	13.78	14.00	12.97	12.71	12.13	13.63	12.22	12.67	11.84	13.27	13.18	13.14	13.43
	Gravity Purity	83.9	83.2	83.1	84.2	84.9	83.0	84.0	83.1	83.3	80.8	80.3	81.7	85.4	85.1	83.1	84.2	82.2	80.3	82.8	81.9	83.4	85.7	83.2	83.5
	Reducing sugar/sucrose ratio	3.9	4.3	3.8	4.4	3.3	3.7	4.0	4.7	3.8	4.6	5.6	4.1	3.5	4.3	4.5	3.9	4.5	7.1	4.3	4.4	3.2	3.3	3.6	4.2
	Gty Pty. drop from 1st expressed juice	1.9	2.9	2.2	2.4	2.9	3.9	3.2	2.6	1.9	3.4	2.6	3.7	1.8	1.9	2.4	3.2	2.5	3.2	2.2	3.9	2.2	2.2	3.2	2.4
ABSOLUTE JUICE	Brix (BA)	17.95	17.19	17.63	16.86	17.59	17.51	17.76	17.12	16.06	16.69	16.16	15.87	17.55	16.68	15.42	15.61	16.33	15.13	16.25	16.05	16.26	16.20	15.51	16.76
	BA/B_1	0.952	0.922	0.948	0.949	0.930	0.917	0.943	0.940	0.935	0.963	0.970	0.916	0.937	0.955	0.950	0.966	0.954	0.926	—	0.968	0.953	0.942	0.940	0.957
	Gravity Purity	82.6	82.3	82.0	83.2	84.0	82.3	83.4	82.5	82.5	79.8	79.1	81.5	84.4	84.2	82.5	83.2	81.5	79.5	82.0	81.4	82.3	85.2	82.6	82.5
CLARIFIED JUICE	Brix	14.68	14.08	13.88	13.37	14.54	14.50	13.16	12.98	13.57	12.68	11.87	13.62	13.84	13.11	12.74	12.39	13.80	12.22	12.66	11.85	13.28	13.22	12.73	13.25
	Gravity Purity	—	—	83.1	84.2	85.1	—	—	83.2	83.7	81.3	79.9	82.1	85.8	85.2	—	84.1	81.4	81.9	83.0	82.8	84.3	86.4	83.6	83.4
	Reducing sugar/sucrose ratio	3.9	4.2	4.0	4.3	3.2	3.8	—	4.7	4.1	4.5	5.3	4.0	3.0	4.2	4.6	4.0	4.8	5.3	3.8	3.9	3.2	3.3	3.8	4.1

Table XVII. Summary of chemical control data 1960.

(iii) FILTER CAKE, SYRUP, pH, FINAL MOLASSES, SUGAR

		Médine	Solitude	Beau Plan	The Mount	Labourdonnais	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St Aubin	St Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
FILTER CAKE	Sucrose per cent	7.60	1.52	2.28	2.14	1.96	4.41	1.30	1.07	1.91	1.00	5.80	1.64	7.45	1.20	5.68	1.88	2.39	1.23	6.00	4.70	6.27	3.12	2.86	2.69
	Weight per cent cane	2.0	3.2	4.6	2.8	3.3	3.8	3.7	3.4	3.7	3.7	3.2	4.7	2.0	2.1	2.1	4.1	3.7	2.5	2.2	1.9	1.8	2.0	3.6	3.0
SYRUP	Brix	59.1	45.2	54.4	57.2	52.9	65.2	59.1	59.6	50.1	55.7	51.6	57.3	62.1	54.7	64.0	69.4	55.4	55.4	52.5	52.2	58.0	62.6	59.7	57.1
	Gravity Purity	—	—	83.1	83.7	84.9	—	—	83.1	84.3	81.3	80.6	82.8	86.2	85.6	—	84.2	81.8	82.4	83.4	82.6	84.3	86.3	83.9	83.6
pH VALUES	Reducing sugar/sucrose ratio	5.3	4.4	3.5	4.0	3.3	3.5	—	4.2	3.9	4.3	5.6	3.7	3.1	3.3	4.7	4.1	5.1	5.0	3.1	6.0	3.3	3.4	4.0	4.1
	Limed juice	7.3	—	7.7	8.4	—	—	—	8.1	8.4	—	8.8	8.2	—	7.8	7.4	8.1	9.4	7.5	—	7.3	8.3	8.6	8.4	8.1
	Clarified juice	6.9	7.0	7.2	6.9	7.0	7.0	7.0	7.1	6.7	6.9	6.8	7.1	7.1	6.9	7.0	7.1	6.7	6.9	6.9	—	7.2	7.4	7.0	7.0
	Filter Press juice	—	—	7.5	—	—	—	—	6.9	6.2	—	—	8.6	8.0	—	6.5	—	6.5	6.5	—	—	7.4	7.4	7.0	7.1
	Syrup	—	—	6.8	—	—	—	—	6.9	6.5	6.8	6.2	6.9	6.6	—	—	7.0	4.5	6.7	—	—	7.0	7.3	6.8	6.6
FINAL MOLASSES	Brix	98.8	98.7	95.0	96.9	96.5	94.6	94.3	94.4	94.7	97.8	95.1	97.1	95.0	97.2	93.6	93.8	98.6	94.6	93.3	97.0	95.6	91.8	93.4	95.9
	Sucrose per cent	33.5	36.7	36.1	36.4	37.1	35.9	35.4	33.5	35.4	34.6	34.5	36.4	32.4	35.1	33.9	35.6	37.9	36.3	35.4	35.9	36.6	37.2	36.8	35.7
	Reducing sugar per cent	14.1	17.2	15.0	14.3	18.2	12.0	14.3	13.9	12.8	16.1	14.5	12.2	14.9	14.6	16.2	15.6	15.2	12.8	—	8.8	13.1	11.3	11.7	14.0
	Total sugars*	47.6	53.9	51.1	50.6	55.3	47.9	49.7	47.4	48.2	50.7	49.0	48.6	47.3	49.7	50.1	51.2	53.1	49.1	—	46.7	49.7	48.5	48.5	51.2
	Gravity Purity	33.9	37.3	37.9	37.5	38.4	37.5	37.5	35.5	37.4	35.4	36.3	37.4	34.1	36.1	36.2	37.9	38.5	38.4	37.9	37.0	38.3	40.6	39.4	37.2
	Reducing sugar/sucrose ratio	42.1	46.8	41.7	40.7	49.0	33.6	40.5	41.4	36.2	46.7	42.0	33.4	45.9	41.6	47.7	43.9	40.1	35.3	—	25.0	35.7	30.3	31.7	39.2
	Weight per cent cane at 95° Brix	2.95	3.43	3.23	3.00	2.90	3.63	3.22	3.21	2.94	3.36	3.48	3.53	2.66	2.69	2.76	2.67	3.52	2.86	3.04	2.88	2.85	2.88	2.83	3.08
SUGAR MADE†	White sugar recovered per cent cane	—	—	—	—	—	5.19	—	—	—	—	7.95	—	—	—	—	—	8.31	—	—	—	—	—	—	—
	Raw " " " "	10.94	9.87	10.69	10.24	10.59	4.51	10.93	9.90	9.74	9.53	0.16	9.21	10.76	9.88	8.83	9.36	0.09	8.66	9.27	8.97	9.46	10.33	8.96	—
	Total " " " "	10.94	9.87	10.69	10.24	10.59	9.70	10.93	9.90	9.74	9.53	8.11	9.21	10.76	9.88	8.83	9.36	8.40	8.66	9.27	8.97	9.46	10.33	8.96	9.84
	Average Pol. of sugars	98.63	98.88	98.57	98.77	98.82	99.17	98.66	98.74	98.62	98.57	99.31	98.62	98.71	98.75	98.58	98.65	99.60	98.79	98.63	98.42	98.82	98.37	98.54	98.73
	Total sucrose recovered per cent cane	10.79	9.76	10.54	10.11	10.47	~~11.32~~ 9.62	10.79	9.77	9.61	9.39	8.06	9.08	10.62	9.76	8.70	9.23	8.37	8.55	9.14	8.83	9.35	10.16	8.83	9.72
	Moisture content of raw sugar per cent	0.23	0.28	0.35	0.32	0.31	—	0.24	0.37	0.37	0.37	—	0.33	—	0.21	0.37	0.37	—	0.28	0.39	0.27	0.37	0.55	0.41	0.34
	Dilution indicator.	20.2	33.3	32.4	35.2	35.3	—	21.8	41.6	36.7	34.6	—	31.0	—	20.2	35.2	37.7	—	33.7	39.2	20.8	45.6	50.5	39.0	36.6

* *Sucrose % + Reducing sugars %.*

† *Provisional figures*

Table XVII. Summary of chemical control data 1960.

(iv) MASSECUITES.

		Medine	Solitude	Beau Plan	The Mount	Labourdonnais	St Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Benarés	Union St. Aubin	St Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
MAGMA	Apparent Purity	78.5	90.3	80.5	80.8	84.0	80.5	80.4	78.1	78.8	78.5	90.2	80.9	82.3	91.5	81.4	83.0	72.4	77.7	—	—	83.5	84.3	80.0	81.8
A—MASSECUITE	Brix	96.2	94.9	95.6	95.3	93.6	94.2	95.7	96.0	94.5	97.3	94.9	95.4	94.4	92.9	93.9	95.2	94.6	93.9	94.5	97.0	95.1	95.1	94.0	95.0
	Apparent Purity	81.4	81.9	77.4	82.9	78.3	82.4	80.6	77.7	81.0	76.7	79.7	80.8	82.9	80.9	83.7	74.3	81.0	81.6	78.6	72.9	76.9	78.9	81.3	79.7
	,, ,, of A—Molasses	62.0	61.4	55.4	61.4	58.7	63.5	56.3	53.8	60.5	50.8	63.8	60.6	60.5	60.4	61.3	51.6	64.1	64.5	59.4	51.8	56.2	59.3	62.0	59.1
	Drop in Purity	19.4	20.5	22.0	21.5	19.6	18.9	24.3	23.9	20.5	25.9	15.9	20.2	22.4	20.5	22.4	22.7	16.9	17.1	19.2	21.1	20.7	19.6	19.3	20.6
	Crystal per cent Brix in massecuite	51.1	53.1	49.3	55.7	47.5	51.8	55.6	51.7	51.9	52.6	43.9	51.3	56.7	51.8	57.9	46.9	47.2	48.2	47.3	48.0	47.3	48.2	50.8	50.4
	Cubic feet per ton Brix in Mixed Juice	26.9	22.7	29.5	22.8	35.0	—	31.6	18.8	27.2	23.5	27.2	24.4	25.8	28.7	22.8	31.6	26.2	24.1	23.6	35.2	28.0	24.5	26.7	25.4
	A—Massecuite per cent total massecuite	51.0	45.7	56.7	48.7	65.1	—	58.9	41.3	62.0	47.7	44.5	47.5	54.4	56.4	46.8	60.5	42.9	45.5	51.7	75.7	60.4	55.6	53.6	53.6
B—MASSECUITE	Brix	97.5	97.4	96.7	96.6	95.0	96.6	97.1	97.2	96.0	98.0	96.7	96.8	96.9	94.7	94.7	95.2	96.8	95.2	94.4	—	97.2	96.1	95.3	96.3
	Apparent Purity	68.7	69.1	67.3	71.7	68.2	71.7	70.6	70.7	69.8	65.2	70.3	68.2	68.1	71.0	73.5	60.8	71.2	71.6	68.6	—	68.5	69.0	72.3	69.4
	,, ,, of B—Molasses	47.8	49.9	46.5	51.7	49.7	51.5	48.2	48.7	49.6	43.3	57.1	49.5	48.3	51.4	47.9	43.4	54.1	55.9	51.4	—	50.7	48.9	52.1	49.9
	Drop in purity	20.9	19.2	20.8	20.0	18.5	20.2	22.4	22.0	20.2	21.9	13.2	18.7	19.8	19.6	25.6	17.4	17.1	15.7	17.2	—	17.8	20.1	20.2	19.5
	Crystal per cent Brix in massecuite	40.0	38.3	38.7	41.4	36.8	41.6	43.2	42.8	40.1	38.6	30.8	37.0	38.3	40.3	49.1	30.7	37.3	35.6	35.4	—	36.1	39.3	42.2	38.9
	Cubic feet per ton Brix in Mixed Juice	15.0	14.7	12.5	13.8	10.9	—	11.6	18.1	7.6	13.4	19.6	16.0	13.1	12.6	14.5	12.8	19.6	17.6	12.7	—	10.1	12.4	14.0	12.3
	B—Massecuite per cent total Massecuite	28.4	29.6	24.0	29.4	20.3	—	21.6	40.0	17.3	27.2	32.0	31.3	27.6	24.7	29.6	24.6	32.1	33.3	27.9	—	21.7	26.9	28.1	26.0
	Kgs. Sugar per cubic foot of A & B Massecuites	18.2	15.0	17.6	20.4	16.6	—	17.5	20.0	21.2	19.3	13.4	17.4	19.4	18.5	19.3	16.6	14.5	16.8	20.1	—	19.2	19.0	17.6	19.5
C—MASSECUITE	Brix	100.2	100.1	100.2	99.8	99.0	98.9	99.9	99.5	98.7	101.4	100.5	99.8	100.8	99.2	98.0	98.4	101.1	99.9	97.9	99.9	98.3	97.0	100.4	99.5
	Apparent Purity	55.7	57.6	55.8	56.1	56.4	57.7	55.9	56.8	56.4	55.8	58.0	55.2	54.7	56.4	57.6	50.3	54.5	56.0	58.1	58.3	57.3	60.8	57.4	56.5
	,, ,, of final molasses	31.1	36.0	35.2	36.2	36.3	35.5	32.3	33.3	35.7	31.9	33.9	37.4	30.1	34.5	32.5	34.6	35.4	37.4	36.3	37.0	36.1	36.7	36.7	34.9
	Drop in Purity	24.6	21.6	20.6	19.9	20.1	22.2	23.6	23.5	20.7	23.9	14.1	17.8	24.6	21.9	25.1	15.7	19.1	18.6	21.8	21.7	21.2	24.1	20.7	21.6
	Crystal per cent Brix in massecuite	35.7	33.8	31.8	31.2	31.6	34.4	34.9	35.2	32.2	35.1	21.3	28.4	35.2	33.4	37.2	24.0	29.6	29.7	34.2	34.4	33.2	38.1	32.7	33.2
	Cubic feet per ton Brix in Mixed Juice	10.9	12.3	10.0	10.2	7.8	—	10.3	8.3	9.1	12.3	14.3	10.8	8.6	9.6	11.5	7.8	15.2	17.6	9.3	11.3	8.3	7.7	9.1	9.6
	C—Massecuite per cent total massecuite	20.6	24.8	19.3	21.9	14.6	—	19.5	18.7	20.7	25.1	23.5	21.2	18.1	18.9	23.6	14.9	25.0	21.2	20.4	24.3	17.9	17.5	18.3	20.4
TOTAL MASSECUITE	Cubic feet per ton Brix in Mixed Juice	7.57	6.60	7.43	6.43	7.42	—	7.73	6.31	5.79	6.58	7.72	6.69	6.65	6.60	5.97	6.62	7.72	6.56	5.77	5.81	6.01	5.93	6.25	6.33
	,, ,, ,, sugar made	69.2	66.8	69.5	62.8	70.1	—	70.7	61.7	59.5	69.0	95.2	72.7	61.8	66.7	67.7	70.7	91.9	75.7	62.3	64.8	63.5	57.4	69.7	64.3

Table XVII. Summary of chemical control data 1960.

(v) MILLING WORK, SUCROSE LOSSES & BALANCE RECOVERIES.

		Médine	Solitude	Beau Plan	The Mount	Labourdonnais	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Desert	Totals & Averages
MILLING WORK	Imbibition water % cane	31.4	27.9	29.8	29.6	31.1	28.9	39.1	31.2	24.9	31.7	35.5	23.2	30.0	32.7	26.0	31.7	25.6	28.8	33.1	39.3	28.6	27.4	24.9	30.1
	„ „ % fibre	217	172	220	218	207	177	275	207	194	214	234	171	217	214	199	238	163	289	214	246	205	238	184	209
	Extraction ratio	36.0	42.8	37.5	33.9	43.6	32.5	30.6	40.5	37.3	31.9	43.4	36.1	44.9	48.6	60.8	37.5	45.4	38.0	43.3	41.3	44.2	47.7	44.9	39.6
	Mill extraction	94.8	93.1	94.9	95.4	93.4	94.7	95.6	93.9	95.2	95.3	93.4	95.1	93.8	92.5	92.0	95.0	92.9	95.1	93.3	93.4	93.8	94.5	94.0	94.3
	Reduced mill extraction	95.6	94.9	95.4	95.8	94.7	96.1	96.3	95.1	95.3	96.1	94.7	95.5	94.5	94.1	92.5	95.4	94.5	95.3	94.8	95.0	94.6	93.8	94.5	95.2
SUCROSE LOSSES	Sucrose lost in bagasse % cane	0.66	0.82	0.64	0.55	0.82	0.64	0.55	0.73	0.55	0.53	0.71	0.55	0.79	0.89	0.88	0.56	0.80	0.52	0.75	0.72	0.71	0.67	0.67	0.68
	„ „ in filter cake % cane	0.15	0.05	0.10	0.06	0.07	0.17	0.05	0.04	0.07	0.04	0.19	0.08	0.15	0.03	0.12	0.08	0.09	0.03	0.13	0.09	0.12	0.06	0.10	0.08
	„ „ in molasses % cane	0.95	1.21	1.16	1.07	1.06	1.31	1.15	1.08	1.05	1.14	1.20	1.39	0.86	0.92	0.95	1.03	1.29	1.04	1.10	1.02	1.04	1.11	1.06	1.09
	Undetermined losses % cane	0.14	0.02	0.06	0.33	0.13	0.31	0.17	0.37	0.27	0.26	0.68	0.10	0.36	0.31	0.40	0.36	0.68	0.32	0.15	0.30	0.29	0.20	0.43	0.26
	Industrial losses % cane	1.24	1.28	1.32	1.46	1.26	1.80	1.37	1.49	1.39	1.44	2.07	1.57	1.37	1.26	1.47	1.47	2.05	1.39	1.38	1.41	1.45	1.37	1.59	1.43
	Total losses % cane	1.90	2.10	1.96	2.01	2.08	2.44	1.92	2.22	1.94	1.97	2.78	2.12	2.16	2.15	2.35	2.03	2.85	1.91	2.13	2.13	2.16	2.04	2.26	2.11
SUCROSE BALANCE	Sucrose in bagasse % sucrose in cane	5.20	6.93	5.08	4.55	6.56	5.31	4.33	6.09	4.77	4.66	6.55	4.90	6.18	7.47	7.96	4.98	7.13	4.95	6.65	6.57	6.20	5.50	6.05	5.71
	„ „ filter cake % sucrose in cane	1.18	0.42	0.83	0.50	0.52	1.41	0.39	0.33	0.61	0.36	1.75	0.69	1.17	0.26	1.09	0.68	0.79	0.29	1.15	0.82	1.00	0.46	0.92	0.68
	„ „ molasses % sucrose in cane	7.49	10.20	9.32	8.81	8.43	10.86	9.05	9.23	9.09	10.03	11.07	12.41	6.73	7.72	8.60	9.11	11.46	9.94	9.76	9.31	8.99	9.09	9.57	9.21
	Undetermined losses % sucrose in cane	1.10	0.17	0.45	2.72	1.09	2.65	1.34	3.09	2.34	2.29	6.27	0.90	2.82	2.60	3.62	3.26	6.03	3.06	1.33	2.73	2.61	1.66	3.81	2.26
	Industrial losses % sucrose in cane	9.77	10.80	10.60	12.05	10.04	14.92	10.78	12.43	12.03	12.68	19.10	14.01	10.72	10.58	13.31	13.05	18.31	13.29	12.24	12.86	12.60	11.22	14.30	12.15
	Total losses % sucrose in cane	14.97	17.72	15.68	16.58	6.60	20.23	15.11	18.74	16.81	17.34	25.65	18.90	16.90	18.05	21.27	18.03	25.44	18.24	18.89	19.43	18.80	16.71	20.35	17.86
RECOVERIES	Boiling house recovery	89.7	88.4	88.8	87.4	89.3	84.3	88.7	86.8	87.4	86.7	79.5	85.3	88.6	88.6	85.6	86.3	80.3	85.9	86.8	86.2	86.6	88.1	84.8	87.1
	Reduced boiling house recovery (Pty.M.J.85°)	90.5	89.9	90.3	88.2	89.3	86.5	89.5	88.7	88.9	90.3	81.9	88.4	88.3	88.5	87.6	87.1	83.9	89.9	88.8	89.0	88.2	87.4	86.7	88.5
	Overall recovery	85.0	82.3	84.3	83.4	83.4	79.8	84.9	81.5	83.2	82.7	74.3	81.1	83.1	81.9	78.7	82.0	74.6	81.7	81.1	80.5	81.2	83.3	79.6	82.1
	Reduced overall recovery (Pty M.J.85°, F% C12.5)	86.6	85.3	86.1	84.5	84.6	83.1	86.2	84.4	84.7	86.8	77.6	84.4	83.4	83.2	81.0	83.1	79.3	85.6	84.1	84.6	83.4	82.1	81.9	84.3
	Boiling house efficiency	99.0	99.9	100.8	97.9	99.8	95.5	99.5	100.0	98.6	98.5	92.1	97.4	96.7	97.8	96.1	96.9	92.2	100.8	99.8	98.1	98.3	98.7	96.9	98.1

Table XVIII. Production and utilisation of molasses.

Year	Production M. tons	Exports M. tons	Used for production of alcohol M. tons	Available as fertilizer M. tons	N.P.K. equivalent in molasses available as fertilizer M. tons		
					N	P_2O_5	K_2O
1948	85,308	—	42,640	42,768	222	107	2,198
1949	96,670	1,867	41,728	53,075	276	133	2,728
1950	98,496	79	25,754	72,643	378	182	3,734
1951	125,819	3,601	44,896	77,322	402	193	3,974
1952	113,756	40,537	29,878	43,339	225	108	2,228
1953	141,449	67,848	16,037	57,564	299	144	2,958
1954	120,495	89,912	8,300	22,383	116	56	1,145
1955	106,839	53,957	9,005	43,877	228	110	2,255
1956	181,716	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	9,965	48,106	250	120	2,470

Table XIX. Importation of inorganic fertilizers, in metric tons, 1950 - 1959.

	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

Table XX. Sales of herbicides, 1959 - 1960.

HERBICIDES	1959			1960		
	Quantity		Sales in Rupees	Quantity		Sales in Rupees
	Imperial gallons	Kgs		Imperial gallons	Kgs	
MCPA — Metallic Salt	11,944	—	173,625	22,405	—	315,386
2,4 - D — Amines	42,971	—	793,971	49,010	—	883,933
2,4 - D — Esters	5,346	—	263,389	5,214	—	246,936
Pentachlorophenol	1,534	—	25,125	2,641	—	44,749
Sodium Chlorate	—	173,383	245,120	—	304,851	372,215
Sodium Trichloroacetate (TCA)	—	264,389	873,622	—	377,063	1,231,815
Sodium 2,2 Dichloropropionate (Dalapon)	—	—	—	—	400	4,200
Sodium Arsenite	150	7,000	15,625	—	6,000	12,000
Substituted Ureas (DCMU, Karmex)	—	—	—	—	12,500	412,500
Triazine Compounds (Simazine)	—	—	—	—	568	15,283
Unclassified	—	1,310	22,122	—	—	—
			2,412,599			3,539,017

Table XXI. List of crosses made in 1960.

CROSS		Réduit: In greenhouse: Number of crosses made	Réduit: In greenhouse: Number of seedlings obtained	Réduit: In field: Number of crosses made	Réduit: In field: Number of seedlings obtained	Pamplemousses: In field: Number of crosses made	Pamplemousses: In field: Number of seedlings obtained	TOTAL: Number of crosses made	TOTAL: Number of seedlings obtained
B.34104	x Co.290	1	3	—	—	—	—	1	3
,,	x Co.419	2	0	—	—	—	—	2	0
,,	x E.1/37	2	0	—	—	—	—	2	0
,,	x M.63/39	4	24	1	0	4	814	9	838
,,	x M.213/40	—	—	—	—	4	3650	4	3650
,,	x M.147/44	5	1	1	20	2	700	8	721
,,	x M.202/46	—	—	—	—	1	0	1	0
,,	x M.81/52*	—	—	—	—	1	80	1	80
,,	x NCO.310	1	0	—	—	—	—	1	0
,,	x R.397	2	0	—	—	—	—	2	0
,,	x Uba Marot	1	0	—	—	—	—	1	0
,,	x U.S.48-34	1	0	—	—	—	—	1	0
,,	x 47R.2777	2	5	—	—	—	—	2	5
,,	x Selfed	3	7	—	—	—	—	3	7
B.37161	x M63/39	—	—	—	—	1	6	1	6
B.37172	x E.1/37	—	—	—	—	2	0	2	0
,,	x M.147/44	—	—	—	—	4	0	4	0
CB.38-22	x B.34104	1	10	—	—	—	—	1	10
,,	x Co.213	1	180	1	90	—	—	2	270
,,	x Co.421	—	—	1	0	—	—	1	0
,,	x Cp.36-13	—	—	1	72	—	—	1	72
,,	x M.99/34	1	170	1	1475	2	191	4	1836

* *Reciprocal back cross*
† *Back cross*
‡ *Sib-cross*

CROSS		Réduit				Pamplemousses		TOTAL	
		In greenhouse		In field		In field			
		Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained
C.B.38-22	x M.63/39	1	160	1	2	—	—	2	162
,,	x M.213/40	1	5	—	—	—	—	1	5
,,	x M.241/40	1	160	—	—	—	—	1	160
,,	x M.423/41	1	250	—	—	—	—	1	250
,,	x M.147/44	5	1093	3	994	2	1450	10	3537
,,	x M.202/46	—	—	—	—	1	7	1	7
,,	x M.63/47	1	0	—	—	—	—	1	0
,,	x M.85/53	—	—	1	4	—	—	1	4
,,	x M.92/53	1	320	—	—	—	—	1	320
,,	x N.Co.310	1	875	1	160	—	—	2	1035
,,	x P.O.J.2940	2	7	—	—	—	—	2	7
,,	x PR.1000	1	15	1	0	—	—	2	15
,,	x R.397	3	150	—	—	1	45	4	195
,,	x Uba Marot	1	225	—	—	—	—	1	225
,,	x 47R2777	2	1000	—	—	—	—	2	1000
Co.213	x M.241/40	1	980	—	—	—	—	1	980
,,	x M.147/44	—	—	1	325	—	—	1	325
Co.281	x M.147/44*	1	0	—	—	2	340	3	340
,,	x M.202/46*	—	—	—	—	1	1	1	1
Co.290	x B.34104	1	3	—	—	—	—	1	3
,,	x M.63/39	1	1	—	—	—	—	1	1
,,	x M.98/54	1	1	—	—	—	—	1	1
Co.419	x B.34104	1	0	—	—	—	—	1	0
,,	x E.50/47	1	0	—	—	—	—	1	0

CROSS		Réduit				Pamplemousses		TOTAL	
		In greenhouse		In field		In field			
		Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained
Co.419	x M.63/39	—	—	1	2	—	—	1	2
,,	x M.147/44	1	650	2	2800	—	—	3	3450
,,	x M.349/55	1	0	—	—	—	—	1	0
,,	x P.R.1000	1	0	—	—	—	—	1	0
,,	x B.397	1	150	—	—	—	—	1	150
,,	x Self	4	200	—	—	—	—	4	200
Co.421	x C.B.38-22	—	—	1	1875	—	—	1	1875
,,	x M.99/34	3	1675	—	—	—	—	3	1675
,,	x M.213/40	—	—	—	—	3	2240	3	2240
,,	x M.241/40	—	—	1	0	—	—	1	0
,,	x M.147/44	4	1050	2	1475	2	1550	3	4075
,,	x M.202/46	—	—	—	—	2	73	2	73
,,	x M.85/53*	1	54	—	—	—	—	1	54
,,	x M.349/55	—	—	1	0	—	—	1	0
,,	x N.Co.310*	1	1750	1	88	1	900	3	2738
,,	x P.O.J.2940	1	35	—	—	—	—	1	35
,,	x P.R.1000	—	—	1	1	—	—	1	1
,,	x R.397	2	1425	—	—	—	—	2	1425
,,	x 36MQ.2717	2	2210	—	—	—	—	2	2210
,,	x Self	1	35	2	0	—	—	3	35
Co.779	x M.63/39	1	3	—	—	—	—	1	3
,,	x M.241/40	1	20	—	—	—	—	1	20
,,	x M.147/44	1	125	—	—	—	—	1	125
Cp.34-12	x Co.419	1	225	—	—	—	—	1	225

CROSS		Réduit				Pamplemousses		TOTAL	
		In greenhouse		In field		In field			
		Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained
Cp.34 12	x M.241/40	1	6	—	—	—	—	1	6
„	x M.147/44	1	25	1	500	—	—	2	525
Cp.36-13	x M.63/39	1	0	—	—	—	—	1	0
„	x M.147/44	—	—	1	565	—	—	1	565
„	x P.R.1000	1	2	—	—	—	—	1	2
Cp.36-105	x M.147/44	1	180	—	—	—	—	1	180
E.1/37	x Co.290	—	—	—	—	1	0	1	0
„	x M.99/34	1	1	—	—	—	—	1	1
„	x M.63/39	3	0	—	—	4	1925	7	1925
„	x M.213/40	—	—	—	—	4	4275	4	4275
„	x M.241/40	2	0	—	—	—	—	2	0
„	x M.147/44	3	20	—	—	8	200	11	220
„	x M.202/46	6	40	1	3	7	29	14	72
„	x M.39/49*	1	0	—	—	—	—	1	0
„	x M.81/52	1	—	—	—	3	9	3	9
„	x M.98/54*	1	0	—	—	—	—	1	0
„	x M.103/57	1	0	—	—	—	—	1	0
„	x M.442/57	2	0	—	—	—	—	2	0
„	x N.Co.310	3	100	—	—	—	—	3	100
„	x P.O.J.2940	—	—	1	10	—	—	1	10
„	x R.397	1	12	1	1	—	—	2	13
„	x 39MQ.841	—	—	1	0	—	—	1	0
„	x Selfed	—	—	—	—	4	1	4	1
E.1/44	x E.1/37†	1	4	—	—	—	—	1	4

CROSS		Réduit: In greenhouse: Number of crosses made	Réduit: In greenhouse: Number of seedlings obtained	Réduit: In field: Number of crosses made	Réduit: In field: Number of seedlings obtained	Pamplemousses: In field: Number of crosses made	Pamplemousses: In field: Number of seedlings obtained	TOTAL: Number of crosses made	TOTAL: Number of seedlings obtained
E.1/44	x M.63/39	—	—	1	5	—	—	1	5
,,	x M.147/44	3	275	1	0	—	—	4	275
,,	x M.202/46	1	1	—	—	—	—	1	1
,,	x M.99/48	—	—	—	—	1	1	1	1
,,	x N.Co.310	—	—	—	—	1	3	1	3
,,	x P.O.J.2940	1	4	—	—	—	—	1	4
,,	x R.397	1	8	—	—	1	20	2	28
E.3/48	x M.241/40	1	4	—	—	—	—	1	4
,,	x M.147/44	1	585	—	—	—	—	1	585
E.50/47	x Co.419	1	0	—	—	—	—	1	0
,,	x E.1/37	1	0	—	—	—	—	1	0
,,	x M.63/39	1	3	—	—	—	—	1	3
,,	x M.147/44	5	125	—	—	2	0	7	125
,,	x M.19/51	1	0	—	—	—	—	1	0
,,	x M.55/55	1	0	—	—	—	—	1	0
M.336	x M.241/40	—	—	1	2	—	—	1	2
,,	x M.147/44	2	0	4	1935	—	—	5	1935
,,	x PR.1000	—	—	1	0	—	—	1	0
M.26/20	x M.112/34	1	0	—	—	—	—	1	0
,,	x R.397	1	0	—	—	—	—	1	0
M.134/32	x E.1/37	—	—	—	—	3	30	3	30
,,	x M.147/44	—	—	—	—	4	213	4	213
,,	x M.202/46	—	—	—	—	3	2	3	2
,,	x M.349/55	1	0	—	—	—	—	1	0

CROSS		Réduit — In greenhouse — Number of crosses made	Réduit — In greenhouse — Number of seedlings obtained	Réduit — In field — Number of crosses made	Réduit — In field — Number of seedlings obtained	Pamplemousses — In field — Number of crosses made	Pamplemousses — In field — Number of seedlings obtained	TOTAL — Number of crosses made	TOTAL — Number of seedlings obtained
M.134/32	x M.128/56*	—	—	1	60	—	—	1	60
,,	M.103/57	—	—	1	0	—	—	1	0
,,	x R.397	—	—	1	1	—	—	1	1
M.99/34	x Co.421	3	900	—	—	—	—	3	900
,,	x E.1/37	1	0	—	—	—	—	1	0
,,	x M.63/39*	1	80	—	—	—	—	1	80
,,	x M.241/40	1	125	—	—	—	—	1	125
,,	x M.147/44	2	1550	—	—	—	—	2	1550
,,	x M.13/54	1	45	—	—	—	—	1	45
,,	x M.403/54	1	10	—	—	—	—	1	10
,,	x M.9/56	1	0	—	—	—	—	1	0
,,	x M.212/56	1	7	—	—	—	—	1	7
,,	x N.Co.310	2	350	—	—	—	—	2	350
,,	x Selfed	3	565	1	135	—	—	4	700
M.112/34	x M.26/20	1	1	—	—	—	—	1	1
,,	x M.63/39	2	1090	—	—	—	—	2	1090
,,	x M.147/44	1	180	1	260	3	765	5	1205
,,	x M.19/51	1	5	—	—	—	—	1	5
,,	x Selfed	—	—	1	0	—	—	1	0
M.84/35	x M.147/44	—	—	—	—	1	340	1	340
M.47/38	x M.147/44	—	—	—	—	2	440	2	440
M.63/39	x B.34104	0	0	—	—	—	—	1	1
,,	x E.1/37	1	0	—	—	—	—	1	0
,,	x M.147/44*	1	0	—	—	—	—	1	0

CROSS		Réduit: In greenhouse: Number of crosses made	Réduit: In greenhouse: Number of seedlings obtained	Réduit: In field: Number of crosses made	Réduit: In field: Number of seedlings obtained	Pamplemousses: In field: Number of crosses made	Pamplemousses: In field: Number of seedlings obtained	TOTAL: Number of crosses made	TOTAL: Number of seedlings obtained
M.63/39	x M.403/54*	1	0	—	—	—	—	1	0
,,	x M.349/55	1	125	—	—	—	—	1	125
,,	x R.397	1	0	—	—	—	—	1	0
M.213/40	x C.B.38-22	1	55	—	—	—	—	1	55
M.241/40	x B.34104	1	0	—	—	—	—	1	0
,,	x Co.213	1	145	—	—	—	—	1	145
,,	x Co.779	1	5	—	—	—	—	1	5
,,	x Cp.34-120	1	35	—	—	—	—	1	35
,,	x E.1/37	2	0	—	—	2	19	4	19
,,	x M.99/34	1	2300	—	—	—	—	1	2300
,,	x M.63/39	1	6	1	10	—	—	2	16
,,	x M.76/39	1	0	—	—	—	—	1	0
,,	x M.213/40	—	—	—	—	2	1160	2	1160
,,	x M.147/44	5	1400	1	890	3	3500	9	5790
,,	x M.202/46	—	—	—	—	2	1	2	1
,,	x M.19/51	1	10	—	—	—	—	1	10
,,	x M.272/52	1	0	—	—	—	—	1	0
,,	x 47R.2777	2	225	—	—	—	—	2	225
,,	x 36MQ.2717	1	16	—	—	—	—	1	16
,,	x Selfed	3	120	—	—	—	—	3	120
M.143/41	x M.147/44	—	—	1	9	—	—	1	9
M.11/43	x M.147/44	1	3	—	—	—	—	1	3
,,	x N.Co.310	1	0	—	—	—	—	1	0
M.147/44	x Co.281†	1	0	—	—	—	—	1	0

CROSS		Réduit: In greenhouse: Number of crosses made	Réduit: In greenhouse: Number of seedlings obtained	Réduit: In field: Number of crosses made	Réduit: In field: Number of seedlings obtained	Pamplemousses: In field: Number of crosses made	Pamplemousses: In field: Number of seedlings obtained	TOTAL: Number of crosses made	TOTAL: Number of seedlings obtained
M.147/44	x Co.421	1	21	—	—	—	—	1	21
,,	x E.50/47	2	30	—	—	—	—	2	30
,,	x M.99/34	1	1	—	—	—	—	1	1
,,	x M.63/39†	11	65	—	—	2	212	13	277
,,	x M.202/46‡	—	—	—	—	1	67	1	67
,,	x M.423/51	1	20	—	—	—	—	1	20
,,	x M.272/52	1	20	—	—	—	—	1	20
,,	x M.99/53	1	0	—	—	—	—	1	0
,,	x M.98/54	1	0	—	—	—	—	1	0
,,	x M.107/55	1	0	—	—	—	—	1	0
,,	x M.146/56*	1	20	—	—	—	—	1	20
,,	x P.R.1000	2	30	—	—	—	—	2	30
,,	x Selfed	26	553	1	7	4	180	31	740
M.61/46	x M.147/44	2	1615	—	—	—	—	2	1615
,,	x R.397	2	0	—	—	—	—	2	0
M.202/46	x E.1/37	6	35	1	0	—	—	7	35
,,	x M.99/34	1	0	—	—	—	—	1	0
,,	x M.241/40	1	0	—	—	—	—	1	0
,,	x M.147/44‡	2	160	—	—	—	—	2	160
,,	x N.Co.310	2	1	—	—	—	—	2	1
,,	x 47R2777	1	35	—	—	—	—	1	35
,,	x 36MQ2717	1	0	—	—	—	—	1	0
,,	x Selfed	1	0	—	—	—	—	1	0
M.63/47	x N.Co.310	1	0	—	—	—	—	1	0

CROSS		Réduit: In greenhouse: Number of crosses made	Réduit: In greenhouse: Number of seedlings obtained	Réduit: In field: Number of crosses made	Réduit: In field: Number of seedlings obtained	Pamplemousses: In field: Number of crosses made	Pamplemousses: In field: Number of seedlings obtained	TOTAL: Number of crosses made	TOTAL: Number of seedlings obtained
M.63/47	x Selfed	1	0	—	—	—	—	1	0
M.93/38	x E.1/37†	—	—	—	—	2	511	2	511
,,	x M.63/39†	—	—	—	—	2	13	2	13
,,	x M.213/40	—	—	—	—	1	0	1	0
,,	x M.147/44	—	—	—	—	3	153	3	153
,,	x M.202/46	—	—	—	—	3	0	3	0
,,	x M.81/52	—	—	—	—	1	4	1	4
M.99/48	x M.99/34	—	—	—	—	1	5500	1	5500
M.39/49	x E.1/37†	1	0	—	—	—	—	1	0
,,	x M.147/44	1	0	—	—	—	—	1	0
,,	x P.R.1000	1	0	—	—	—	—	1	0
M.19/51	x E.50/47	1	10	—	—	—	—	1	10
,,	x M.112/34	1	4	—	—	—	—	1	4
,,	x M.241/40	1	0	—	—	—	—	1	0
,,	x M.98/54	1	0	—	—	—	—	1	0
,,	x 47R2777	1	2	—	—	—	—	1	2
M.277/51	x M.147/44	6	240	—	—	—	—	6	240
,,	x M.349/55	1	1	—	—	—	—	1	1
,,	x R.397	1	5	—	—	—	—	1	5
M.381/51	x M.213/40	—	—	—	—	1	0	1	0
,,	x M.147/44	1	0	—	—	1	0	2	0
M.423/51	x M.147/44	3	6	—	—	—	—	3	6
,,	x R.397	2	0	—	—	—	—	2	0
M.428/51	x M.63/39	1	10	—	—	—	—	1	10

CROSS		Réduit				Pamplemousses		TOTAL	
		In greenhouse		In field		In field			
		Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained
M.428/51	x M.147/44	1	390	—	—	—	—	1	390
,,	x M.349/55	1	190	—	—	—	—	1	190
M.422/51	x M.147/44	1	100	—	—	—	—	1	100
M.716/51	x E.1/37†	1	0	—	—	1	0	2	0
,,	x M.147/44	—	—	—	—	1	100	1	110
M.179/52	x N.Co.310	1	0	—	—	—	—	1	0
M.272/52	x M.63/39	1	0	—	—	—	—	1	0
,,	x M.241/40	1	1	—	—	—	—	1	1
,,	x M.147/44	1	865	—	—	—	—	1	865
,,	x R.397	1	100	—	—	—	—	1	100
M.85/53	x M.147/44	—	—	1	525	—	—	1	525
,,	x N.Co.310	2	3375	—	—	—	—	2	3375
M.92/53	x Selfed	1	32	—	—	—	—	1	32
M.351/53	x Q44	1	20	—	—	—	—	1	20
M.99/53	x M.147/44	2	23	—	—	—	—	2	23
,,	x P.O.J.2940	—	—	1	0	—	—	1	0
M.13/54	x M.99/34	1	35	—	—	—	—	1	35
,,	x M.147/44	1	600	—	—	—	—	1	600
M.98/54	x Co.290	1	0	—	—	—	—	1	0
,,	x E.1/37†	2	0	—	—	—	—	2	0
,,	x M.63/39†	5	49	—	—	—	—	5	49
,,	x M.147/44	2	30	—	—	—	—	2	30
,,	x M.19/51	1	0	—	—	—	—	1	0
,,	x M.403/54	1	0	—	—	—	—	1	0

CROSS		Réduit				Pamplemousses		TOTAL	
		In greenhouse		In field		In field			
		Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained
M.120/54	x M.147/44	1	3	1	0	—	—	2	3
M.403/54	x M.99/34	1	0	—	—	—	—	1	0
,,	x M.63/39†	1	0	1	20	—	—	2	20
,,	x M.147/44	1	8	—	—	—	—	1	8
,,	x M.98/54	1	0	—	—	—	—	1	0
,,	x POJ.2940	1	11	—	—	—	—	1	11
M.462/54	x M.147/44	1	0	—	—	—	—	1	0
M.55/55	x E.50/47	1	0	—	—	—	—	1	0
M.87/55	x M.63/39	—	—	1	460	—	—	1	460
M.107/55	x M.63/39	1	1	—	—	—	—	1	1
,,	x M.147/44	2	1270	1	110	—	—	3	1380
M.290/55	x M.147/44†	2	1	—	—	—	—	2	1
M.292/55	x M.63/39	2	7	—	—	—	—	2	7
,,	x M.147/44†	1	12	—	—	—	—	1	12
M.349/55	x Co.419	1	26	—	—	—	—	1	26
,,	x E.1/37	—	—	1	170	—	—	1	170
,,	x M.63/39	1	920	—	—	—	—	1	920
,,	x Selfed	2	200	—	—	—	—	2	200
M.359/55	x M.147/44	1	0	—	—	—	—	1	0
M.9/56	x E.1/37	2	6	—	—	—	—	2	6
,,	x M.99/34	1	0	—	—	—	—	1	0
,,	x M.63/39	2	9	—	—	—	—	2	9
,,	x M.423/41	1	15	—	—	—	—	1	15
,,	x M.147/44	3	40	—	—	—	—	3	40

CROSS	Réduit — In greenhouse — Number of crosses made	Réduit — In greenhouse — Number of seedlings obtained	Réduit — In field — Number of crosses made	Réduit — In field — Number of seedlings obtained	Pamplemousses — In field — Number of crosses made	Pamplemousses — In field — Number of seedlings obtained	TOTAL — Number of crosses made	TOTAL — Number of seedlings obtained
M.9/56 x M.442/57	1	0	—	—	—	—	1	0
M.146/56 x M.147/44†	1	0	3	175	—	—	4	175
,, x N.Co.310	1	2050	—	—	—	—	1	2050
,, x POJ.2940	—	—	1	45	—	—	1	45
,, x R.397	1	240	—	—	—	—	1	240
,, x 39MQ841	1	0	—	—	—	—	1	0
,, x Selfed	1	150	—	—	—	—	1	150
M.212/56 x M.99/34	1	0	—	—	—	—	1	0
,, x M.63/39†	—	—	1	0	—	—	1	0
M.219/56 x Selfed	1	10	—	—	—	—	1	10
M.332/56 x M.63/39	1	450	—	—	—	—	1	450
M.103/57 x Selfed	—	—	3	0	—	—	3	0
M.394/57 x M.99/34	—	—	1	0	—	—	1	0
M.440/57 x M.147/44	2	200	—	—	—	—	2	200
M.442/57 x E.1/37	3	16	—	—	—	—	3	16
,, x M.63/39	2	1	—	—	—	—	2	1
,, x Selfed	2	0	—	—	1	0	3	0
M.204/58 x Cp.36-13	2	175	—	—	—	—	2	175
,, x NCo.310†	1	775	—	—	—	—	1	775
Nco.310 x Co.419	2	160	—	—	—	—	2	160
,, x Cp.36-13	2	1360	—	—	2	600	4	2060
,, x E.1/37	1	0	—	—	—	—	1	0
,, x M.99/34	2	3090	—	—	—	—	2	3090
,, x M.63/39	3	225	1	0	—	—	4	225

CROSS		Réduit In greenhouse Number of crosses made	Réduit In greenhouse Number of seedlings obtained	Réduit In field Number of crosses made	Réduit In field Number of seedlings obtained	Pamplemousses In field Number of crosses made	Pamplemousses In field Number of seedlings obtained	TOTAL Number of crosses made	TOTAL Number of seedlings obtained
NCo.310	x M.11/43	1	1780	—	—	—	—	1	1780
,,	x M.147/44	5	1575	1	900	—	—	6	2475
,,	x M.202/46	1	1580	—	—	—	—	1	1580
,,	x M.63/47	1	0	—	—	—	—	1	0
,,	x M.179/52	1	0	—	—	—	—	1	0
,,	x M.85/53	5	3550	1	360	—	—	6	3910
,,	x M.92/53	1	960	—	—	—	—	1	960
,,	x M.146/56	2	1115	—	—	—	—	2	1115
,,	x POJ.2878	1	665	—	—	—	—	1	665
,,	x POJ.2940	1	55	—	—	—	—	1	55
,,	x R.397	3	2700	—	—	—	—	3	2700
,,	x Uba Marot	1	225	—	—	—	—	1	225
,,	x 47R2777	1	0	—	—	—	—	1	0
,,	x 39MQ841	—	—	1	0	—	—	1	0
,,	x Self	12	18052	—	—	3	1420	15	19472
,,	Wind pollinated	—	—	2	30	—	—	2	30
NCo.376	x B34104	1	30	—	—	—	—	1	30
,,	x Co.421†	1	37	—	—	—	—	1	37
,,	x Cp.36-13	2	1000	2	1275	—	—	4	2275
,,	x M.99/34	1	500	—	—	1	290	2	790
,,	x M.63/39	1	215	—	—	—	—	1	215
,,	x M.423/41	1	430	—	—	—	—	1	430
,,	x M.147/44	4	1375	3	2750	2	600	9	4805
,,	x M.99/48	—	—	—	—	1	28	1	28

CROSS		Réduit — In greenhouse: Number of crosses made	Réduit — In greenhouse: Number of seedlings obtained	Réduit — In field: Number of crosses made	Réduit — In field: Number of seedlings obtained	Pamplemousses — In field: Number of crosses made	Pamplemousses — In field: Number of seedlings obtained	TOTAL: Number of crosses made	TOTAL: Number of seedlings obtained
NCo.376	x M.85/53	—	—	1	12	—	—	1	12
,,	x M.349/55	1	1215	—	—	—	—	1	1215
,,	x M.219/56	1	210	—	—	—	—	1	210
,,	x M.442/57	1	0	1	0	—	—	2	0
,,	x NCo.310	2	2700	—	—	—	—	2	2700
,,	x POJ.2940	1	35	—	—	—	—	1	35
,,	x R.397	1	685	—	—	1	32	2	717
,,	x Uba Marot	1	2325	—	—	—	—	1	2325
,,	x 47R2777	1	1275	—	—	—	—	1	1275
POJ.2364	x M.147/44	—	—	1	360	—	—	1	360
,,	x NCo.310	1	0	—	—	—	—	1	0
POJ.2878	x B.34104	1	70	—	—	—	—	1	70
,,	x M.147/44	1	46	—	—	2	1100	3	1146
,,	x M.202/46	—	—	—	—	1	29	1	29
,,	x M.81/52	—	—	—	—	3	1125	3	1125
,,	x NCo.310	1	550	—	—	—	—	1	550
POJ.2940	x M.241/40	—	—	1	0	—	—	1	0
,,	x M.147/44	—	—	1	20	—	—	1	20
,,	x M.403/54	1	0	—	—	—	—	1	0
,,	x M.146/56	—	—	2	13	—	—	2	13
,,	x R.397	1	4	—	—	—	—	1	4
,,	x Selfed	4	2	1	0	—	—	5	2
POJ.3016	x E.1/37	—	—	1	36	—	—	1	36
PR.1000	x Co.419	1	8	—	—	—	—	1	8

CROSS		Réduit				Pamplemousses		TOTAL	
		In greenhouse		In field		In field			
		Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained
PR.1000	x E.1/37	2	1	—	—	—	—	2	1
,,	x M.99/34	—	—	—	—	1	1585	1	1585
,,	x M.63/39	3	700	—	—	—	—	3	700
,,	x M.147/44	8	5185	2	2060	3	3182	13	10427
,,	x M.202/46	—	—	—	—	3	187	3	187
,,	x M.39/49	1	70	—	—	—	—	1	70
,,	x R.397	—	—	—	—	1	825	1	825
,,	x 47R2777	1	0	—	—	—	—	1	0
,,	x 36MQ2717	1	0	—	—	—	—	1	0
,,	x Selfed	1	10	—	—	—	—	1	10
Q44	x E.1/37	1	20	—	—	—	—	1	20
,,	x M.63/39	1	0	—	—	—	—	1	0
,,	x M.147/44	2	21	—	—	1	20	3	41
,,	x M.351/53	1	5	—	—	—	—	1	5
Q47	x M.147/44	—	—	—	—	2	67	2	67
Q50	x M.147/44	1	1	—	—	—	—	1	1
R.397	x B.34104	2	2	—	—	—	—	2	2
,,	x Co.419	1	0	—	—	—	—	1	0
,,	x E.1/37	1	22	—	—	—	—	1	22
,,	x E.1/44	1	0	—	—	—	—	1	0
,,	x M.26/20	1	7	—	—	—	—	1	7
,,	x M.147/44	3	1400	—	—	—	—	3	1400
,,	x M.61/46	1	10	—	—	—	—	1	10
,,	x M.272/52	1	20	—	—	—	—	1	20

CROSS		Réduit				Pamplemousses		TOTAL	
		In greenhouse		In field		In field			
		Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained	Number of crosses made	Number of seedlings obtained
R.397	x NCo.310	2	1765	—	—	—	—	2	1765
,,	x POJ.2940	1	30	—	—	—	—	1	30
,,	x Selfed	11	147	—	—	—	—	11	147
Uba Marot	x B.34104	1	475	—	—	—	—	1	475
,,	x Co.419	—	—	1	3	—	—	1	3
,,	x M.147/44	—	—	1	20	—	—	1	20
,,	x N.Co.310	1	1400	—	—	—	—	1	1400
,,	x Selfed	2	575	—	—	—	—	2	575
US48-34	x M.146/56	1	0	—	—	—	—	1	0
,,	x S.Spont. Self	2	1120	—	—	—	—	2	1120
,,	x Selfed	4	42	—	—	—	—	4	42
47R2777	x B.34104	2	510	—	—	—	—	2	510
,,	x Co.213	1	865	—	—	—	—	1	865
,,	x M.63/39	1	3	—	—	—	—	1	3
,,	x M.147/44	2	1000	—	—	—	—	2	1000
,,	x M.202/46	1	4	—	—	—	—	1	4
,,	x N.Co.310	1	125	—	—	—	—	1	125
,,	x PR.1000	1	0	—	—	—	—	1	0
,,	x 36MQ2717	1	146	—	—	—	—	1	146
,,	x Self	4	546	—	—	—	—	4	546
36MQ2717	x Co.421	1	20	—	—	—	—	1	20
,,	x M.63/39	1	145	—	—	—	—	1	145
,,	x M.241/40	1	0	—	—	—	—	1	0
,,	x M.147/44	2	100	1	110	—	—	3	210

CROSS	Réduit — In greenhouse — Number of crosses made	Réduit — In greenhouse — Number of seedlings obtained	Réduit — In field — Number of crosses made	Réduit — In field — Number of seedlings obtained	Pamplemousses — In field — Number of crosses made	Pamplemousses — In field — Number of seedlings obtained	TOTAL — Number of crosses made	TOTAL — Number of seedlings obtained
36 MQ2717 x M.202/46	1	0	—	—	—	—	1	0
,, x PR.1000	1	0	—	—	—	—	1	0
,, x 47R2777	1	0	—	—	—	—	1	0
,, x Self	1	17	—	—	—	—	1	17
39MQ832 x E.1/37	—	—	1	0	—	—	1	0
39MQ841 x M.147/44	—	—	1	20	—	—	1	20
,, x M.146/56	1	55	—	—	—	—	1	55
S. Spont. Seedl. sibbed	4	244	—	—	—	—	4	244
,, x US.48-34	1	245	—	—	—	—	1	245
(NCo310 x US48-34) x US.48-34†	5	2	—	—	—	—	5	2
,, Sibbed	5	0	—	—	—	—	5	0
Total	537	108150	94	23250	149	43000	780	174400